

Metro

Canemah Bluff Oak and Prairie Restoration Plan (Website Version)



**Prepared for Metro
By Institute for Applied Ecology**



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This document was prepared for Metro by staff at
the Institute for Applied Ecology (IAE):

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conserve native ecosystems through restoration, research, and education.



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Special note:

This report has been modified from its original format by removing maps and/or appendices that include information on the location of rare and sensitive species.

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1 Introduction

1.1 Project background

In November 2013, the Institute for Applied Ecology (IAE) was contracted by Metro to prepare a restoration plan for Canemah Bluff Natural Area (Canemah). A Natural Resources Conservation and Site Management Plan (SMP) (Metro 2011) provides background for conservation targets and includes specific restoration goals and objectives for habitats within Canemah.

The Canemah SMP addresses 113.5 acres of diverse habitats owned by Metro that have been purchased since 1996. The following restoration plan is limited to the prairie, savanna, and Oregon white oak (*Quercus garryana*) woodland habitats present on approximately 20 acres at Canemah. It augments the SMP by developing the next stage of planning, a restoration and implementation strategy specifically for the Prairie and Oak Woodland areas. The plan is intended to guide the enhancement of prairie and oak woodland habitats with the goal of increasing the diversity and abundance of native grass and forb species and decreasing the cover of non-native and invasive species. Special attention will be given to the augmentation of *Delphinium leucophaeum* (white rock larkspur).

Restoration will be implemented over many years at Canemah and management will be ongoing. To ensure the site objectives established in the SMP are being addressed, this restoration plan integrates restoration activities with measurable and time bound objectives, long term management considerations, and action thresholds. Techniques, timing, and goals should be re-evaluated and adapted to new conditions as the restoration progresses. Allowing for this flexibility will allow for informed modifications to the plan and will result in a higher quality product.

1.2 Habitats

1.2.1 Habitat types

Wet prairie and upland prairie mosaic

The prairie includes upland and wetland areas totaling 5 acres. Most of the area is drought prone and has thin soils, however these areas transition into relatively small drainages that have deeper soils and hold water through the growing season.

Oregon white oak woodland and savanna mosaic

The Oregon white oak woodland and savanna is a mosaic of openings among mature oaks at forest densities. The total area of this management section is 14.5 acres.

Delphinium leucophaeum population

Delphinium leucophaeum is listed as endangered by the State of Oregon and is a federal species of concern. Found on the edges of oak woodlands, in moist meadows, on basalt cliffs, in dry roadside ditches and along river banks and bluffs, this species is known to occur only in Clackamas, Marion, Multnomah, Washington, and Yamhill counties in Oregon.

A natural population of *D. leucophaeum* occurs at Canemah. Originally located along the edge of the prairie unit on the top of the bluff overlooking the Willamette River, the natural population appears to have disappeared. However, researchers from Reed College introduced *D. leucophaeum* in three areas within the restoration area in 2008, and Metro staff seeded additional areas along the trail that same year. Although not all of the reintroductions persisted, several patches of this species remain at the site to date.



Figure 1. *Delphinium leucophaeum* plant (left) and flower (right). Photos courtesy of U.S. Fish and Wildlife Service and Oregon Department of Agriculture.

1.2.2 Management unit delineation

The Prairie and Oak Woodland units included in this plan (Figure 2) are primarily distinguished by the presence or absence of mature trees. Additionally, the Oak Woodland unit has greater topographic variation. Abiotic habitat conditions are variable in both units, but the small scale of the variation does not permit mapping.

Canemah Bluff Restoration Units

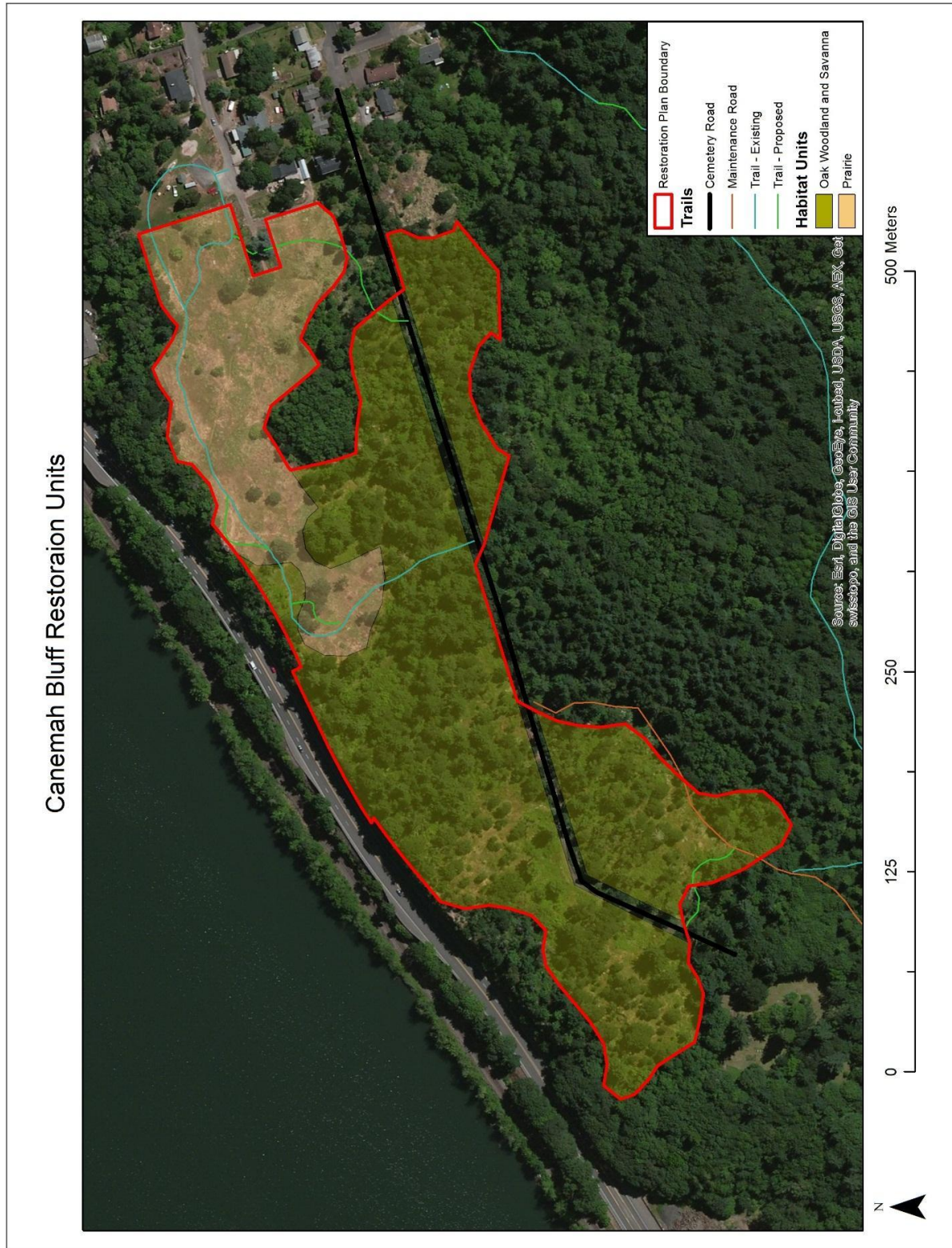


Figure 2. Restoration units at Canemah.

1.2.3 Canemah site management plan conservation targets

The Canemah SMP (Section 4.4) outlines three conservation targets for the site. Goals for each conservation target are quoted below.

Wet prairie and upland prairie mosaic (habitat target):

Short-term goal: By 2016, increase presence of native grass and forb species to greater than 20 species in the prairie habitat area. Decrease cover of non-native grass and shrub species. Increase extent of seasonally saturated soils.

Long-term goal: The long-term desired future condition is to have all condition key ecological attributes (KEAs) at good levels and provide suitable habitat for prairie dependent wildlife species.

Table 1. Prairie Key Ecological Attributes (KEAs).

KEA	Indicator	“Good” Rating Criteria
Native Grass and Forb Presence	Native species richness (for the mosaic)	40-59 native herbaceous plant species with high fidelity to the system types present at the patch.
Native grass and forb abundance	Frequency of native herbaceous species in (11 sq ft) quadrats	At least 3 native high fidelity herbaceous prairie species occurring with >75% frequency and at least 9 additional species occurring with at least 25% frequency
Native forb and grass abundance	Percent cover native forbs & grasses	30-50% of total herbaceous cover is native
Vegetative Cover: woody species	Area of woody vegetation (trees and shrubs) with cover less than 5%	Total woody cover <5% over at least 90% of the area being managed for prairie, though trees saplings and/or shrub sprouts may be present within these areas.

Oregon white oak woodland and savanna mosaic (habitat target):

Short-term goal: By 2016, decrease cover of non-native broadleaf weed species to less than 20 percent cover; maintain less than 10% canopy cover over Oregon White Oak trees; and increase native herbaceous species richness by seeding and planting bulbs and plugs.

Long-term goal: The desired future condition is to have all key ecological attributes ranked as good, thereby maintaining and restoring habitat suitable for oak dependent wildlife species.

Table 2. Oak woodland/savannah Key Ecological Attributes (KEAs).

KEA	Indicator	“Good” Rating Criteria
Native grass and forb presence	Native species richness (for the patch)	40 -59 native herbaceous plant species with high and moderate fidelity to oak woodland occur within the patch.
Native grass and forb abundance	Frequency of native herbaceous species in 1 sq m (11 sq ft) quadrats	At least 3 native high and moderate fidelity herbaceous prairie species occurring with >75% frequency and at least 9 additional species occurring with at least 25% frequency
Native grass and forb abundance	Relative cover of native forb and grass species	30-50% of total herbaceous cover is native
Vegetation structure	Canopy cover and architecture of woody vegetation	Woody vegetation encroaching but total native canopy cover is 30-60% at least 90% of the target area.

***Delphinium leucophaeum* (species target):**

Short-term goal: By 2016, maintain current size of population. Add additional patches of plants to Oregon oak woodland habitat as restoration actions occur.

Long-term goal: The long-term desired future condition is to have all KEAs functioning at a good level, thus creating a naturally sustaining population.

Table 3. *Delphinium leucophaeum* Key Ecological Attributes (KEAs).

KEA	Indicator	“Good” Rating Criteria
Extent of suitable habitat for the species	Area of habitat	Increased extent
Number of patches or plants	Each	1-3 patches/2 ha (5 acres) of at least 0.1 sq m (1 sf)/ of habitat OR 30-59 plants/4 ha (10 acres) of habitat
Abundance of <i>D. leucophaeum</i> within suitable habitat	Cover of species	3-5% cover within suitable habitat

1.2.4 Habitat connectivity

Canemah is one of a small set of sites that contain bluff top prairies on the Willamette River. These areas are extremely rare. The Canemah restoration is vital in preserving these unique habitats. It also provides value as a link in the wildlife corridor along the Willamette River through connectivity with parks and natural areas along the river. Finally, it is one of the few remaining sites that contains a

population of the extremely rare white rock larkspur. Preserving and expanding this population is very important for the recovery of this species.

2 Restoration Strategy

Work at Canemah will continue to focus on restoring invaded remnant prairie and forest to create high quality woodland, savanna, and prairie. The strategy for reaching desired future conditions combines recommendations from the SMP and expertise of IAE restoration ecologists and other restoration colleagues and partners involved with this project. Knowledge gained from the scheduled monitoring will inform adaptive management and prioritization of restoration and maintenance activities.

The plan is intentionally simple and concise to facilitate efficient and adaptive implementation. The strategy should be revised to incorporate new information as it becomes available. This plan will be updated in the winter of 2017-2018.

2.1 Prairie

2.1.1 Target habitat (from Canemah SMP)

The prairie will support a diversity of native forbs and grasses providing habitat for wildlife including native birds and amphibians. Matrix species of bunchgrasses and forbs will be the dominant species and provide habitat stability. Though Canemah will host a relatively small prairie area compared to the needs of many prairie dependent species, it will provide an example the surround community can engage with and learn from.

2.1.2 Baseline conditions

Native species are established throughout the prairie, albeit at reduced numbers and diversity. The primary concern is non-native grasses. Both annual and perennial invasive grasses are present on the site. The secondary concern is native and non-native woody encroachment.

2.1.3 Prairie restoration goals and objectives

The three strategies for restoration of the prairie are to:

- Control weeds, especially invasive grasses and non-native shrubs.
- Control woody encroachment
- Maintain and augment herbaceous plant diversity.

See Table 4 for a complete schedule of proposed restoration and management activities.

Goal 1: Control herbaceous weeds

Objective 1.1: Reduce non-native grasses by 80% to prevent competition with native species.

- Spot spray of grass specific herbicide to reduce non-native grass species in the spring (before grass sets seed) and fall (Year 1 and 2).

- Grasses can develop resistance to grass selective herbicides. If a treatment is ineffective and the application was done appropriately, a change in strategy is needed. Consider treating with a broad spectrum herbicide when the grasses are actively growing but native species are senesced or have not yet germinated.
- Allow one month before assessing the effectiveness of the grass specific herbicide treatment.

Objective 1.2: Reduce non-native forbs by 50%

- Spot treat non-native forbs using appropriate herbicide.
- Annually spot treat as needed and as funding is available. Refer to action thresholds for prioritization of actions (Table 5).

Goal 2: Prevent woody species encroachment

Objective 2.1: Reduce non-native woody species by 80%

- Spot treat non-native woody species annually in the spring and/or fall using appropriate herbicide.

Objective 2.2: Prevent woody species encroachment to maintain < 5% cover of woody species

- Mow on a three year rotation with a walk-behind mower to prevent woody species establishment. Mowing should occur after August 15th and before October 31st to avoid disturbing nesting bird populations and native plant establishment, or
- Once yearly, remove woody vegetation manually through either pulling or cutting as appropriate.

Goal 3: Maintain and augment native herbaceous plant diversity

Objective 3.1: Increase native herbaceous species diversity to at least 40 species, 3 native high fidelity herbaceous prairie species occurring with >75% frequency and at least 9 additional species occurring with at least 25% frequency

- Planting and seeding schedule will coincide with Section 2.2.
- Seed mixes will be developed for wet and dry conditions

2.2 Oak woodlands and savanna

2.2.1 Target habitat (from Canemah SMP)

The oak woodlands and savanna will support a diversity of native trees and shrubs with an open canopy that allows for a robust herbaceous community. The area will provide habitat, both structure and food sources, for wildlife.

Removal of conifers in the woodland and savanna areas has been completed though encroachment will be an ongoing management concern due to natural successional processes. Woodland and savanna

habitats will support *D. leucophaeum* as well as a variety of bird and insect species that will not be able to utilize the prairie area. The current plan will focus on maintaining these stands of trees while restoring the understory.

2.2.2 Baseline conditions

- Mature stands of shrubs and trees
- Mixture of desirable (native) and invasive non-native grasses
- Non-native shrubs and forbs including non-native blackberry (*Rubus spp.*), Scotch broom (*Cytisus scoparius*), and tansy ragwort (*Senecio jacobaea*)

2.2.3 Oak woodland restoration goals and objectives

The four strategies for the woodlands and savanna are to:

- Maintain appropriate canopy density to provide open oak woodland habitat.
- Control weeds, especially invasive grasses and non-native shrubs, while newly planted areas establish.
- Maintain and augment shrub and herbaceous plant diversity.

Goal 4: Maintain appropriate density of Oregon white oak and madrone (*Arbutus menziesii*) for a woodland and savanna mosaic.

Objective 4.1: Maintain native canopy cover of 30-60% on at least 90% of the target area.

- Current canopy cover is appropriate. No immediate action is required.
- Year 4 – Assess recruitment and allow for stand replacement
 - Desirable seedlings (plants less than 1.5 m tall) will not be removed.
 - Desirable saplings (plants greater than 1.5 m tall and less than 4" DBH) will be reduced to 5 per acre.
 - Desirable trees (plants greater than 4" DBH) will be selectively removed to maintain less than 40 per acre. Preference will be given to healthy trees with open growth structure evidenced by ample epicormic branching. These conditions do not currently exist on site. This will only need to be implemented if there is strong establishment of desirable species that compete with each other. Consider creating snags from plants that will not interfere with future management through basal bark treatment or girdling.
 - Remove all undesirable tree species including conifers, maples, and ash. Removal to be done at least every three years or before the trees reach one meter tall to reduce need for retreatment and reduce public concern.

Goal 5: Control non-native weeds throughout oak woodland area.

Objective 5.1: Reduce invasive shrub species by 80%

- Use hand crew to cut and stump treat all non-native blackberry or cut and fall foliar spray treatment of the regrowth. (Year 1)
- Hand pull all other non-native shrubs (Year 1)
- After Year 1, annually grid the area and spot treat emerging species of concern.

- Woody species are generally best treated with herbicide in early fall prior to color change in leaves.
- Mechanical treatments can be done at any time of year

Objective 5.2: Reduce invasive grasses and forbs by 40%

- Apply spring and fall chemical treatments with appropriate chemicals using backpack sprayers (Year 1 and Year 2).
 - Target all aggressive weeds including (velvet grass (*Holcus lanatus*), thistles (*Cirsium spp.*), Scotch broom (*Cytisus scoparius*), and invasive blackberry (*Rubus spp.*).
 - Two spring treatments may be needed to treat all weeds.
 - Before applying treatments, delineate *D. leucophaeum* populations and follow take avoidance protocols (See Appendix 1).
- After Year 2, annually spot treat entire area during native seed establishment in the early and late spring
- After Year 2, annually spot treat as funding is available. Refer to action thresholds for prioritization of actions (Table 5).

Goal 6: Maintain and improve plant diversity.

Objective 6.1: Increase native herbaceous diversity to at least 20 species

- Create plant list (Year 1).
 - Survey the site at least three times to establish a plant list.
 - Create a working planting list document for managers to be updated on an ongoing basis.
- Confirm successful site preparation treatments (Year 2).
 - Invasive species presence in should be minimal (less than 5% cover in planting areas).
- Seed site with hand broadcast seeder (Fall Year 2).
 - Due to the extreme variability of site conditions intensive seeding management will be needed. Seed placement will need to be determined by the seeding crew. Metro program staff would be ideal seeders.
 - Seed mixes will need to be divided into these categories:
 - Sunny and wet
 - Sunny and dry
 - Shaded and wet
 - Shaded and dry
- Plant other plant materials (Year 2).
 - Plant non-seed propagules of species appropriate to the site.
 - Planting will require similar care to seeding for plant placement.
- Year 3 and 4 – Monitor for seeding and planting success (Year 3 and 4).
 - Consider augmentation in areas where seed established poorly.
 - Areas of poor establishment should be reassessed for appropriate seed mixes.

Objective 6.2: Maintain shrub diversity

- Year 4 - Monitor shrub diversity and consider augmenting species only after herbaceous community is well established.

2.3 *Delphinium leucophaeum*

2.3.1 Baseline conditions

In May of 2015 there were a total of 33 flowering individuals in four patches present at the site (Figure 3). All patches were introduced, either from seed (2 sites) or tubers (2 sites). The historical population appears to be extirpated (repeated searches over the last several years have failed to relocate the plants).

Figure 3. Location of current *Delphinium leucophaeum* patches (blue pins, labeled DELE) and estimated location of historical (and presumed extirpated) patch (yellow pin, labeled original population) at Canemah. (This figure has been removed to protect locations of sensitive species)

2.3.2 *D. leucophaeum* goals and objectives

Goal 7: Maintain current *D. leucophaeum* population and habitat

Objective 7.1: Monitor current population annually to establish baseline and measure response to habitat restoration treatments (Year 1, 2, 3)

- Follow protocols outlined in in Appendix 4.

Objective 7.2: Maintain and improve habitat

- Treat poison oak (*Toxicodendron diversilobum*) and other native shrubs in patches where it is overgrowing *D. leucophaeum* through mowing every 2 to 5 years as needed or treat the poison oak in up to 50% of *D. leucophaeum* patch with appropriate herbicides after *D. leucophaeum* has senesced.
- Treat non-native grasses with grass-specific herbicide in areas that formerly or currently contain *D. leucophaeum*.
- Follow *D. leucophaeum* take avoidance protocols when implementing habitat restoration treatments in the vicinity of the populations (see Appendix 1).

Goal 2: Augment *D. leucophaeum* population

*Objective 1: Grow *D. leucophaeum* tubers for introduction (Year 2, 3)*

- Collect seed from nearby natural populations with similar habitat (See Appendix 2 for seed collection protocol)
- Cultivate tubers (See Appendix 3 for cultivation protocol)

*Objective 2: Establish *D. leucophaeum* seed production field*

- Collect seed from natural *D. leucophaeum* populations within the Portland recovery zone (Year 1 and 2)
- Establish small seed production bed (Fall Year 2)
- Harvest seed (Year 4+)

*Objective 3: Augment *D. leucophaeum* population (Year 4)*

- Ensure restoration efforts have been successful in proposed *D. leucophaeum* outplanting sites (compare against target conditions in Table 5).
- Consider delaying planting until high quality habitat has been achieved.
- Plant *D. leucophaeum* tubers and/or seed.
- Selectively plant in areas selected for optimal growth and minimal disturbance.
- Mark or map all plants to enable efficient monitoring of establishment.

3 Outreach

Canemah has an ongoing need for outreach and engaging the public. The surrounding community uses the site actively and has a strong interest in restoration activities on site. Public will be engaged in the restoration process through signage and volunteer events.

Planning for trail improvement, rerouting, and decommissioning is in progress. Formalizing and improving trails will provide recreational access with minimal disturbance to sensitive habitats.

4 Schedule

Table 4. Schedule of tasks.

Treatment		Spot spray herbaceous	Spot spray grass specific	Cut blackberry	Foliar blackberry	Hand pull non-native shrubs	Confirm site prep.	Seeding	Planting	Weed assessment	Monitor shrub diversity	Monitor DELE	Treat shrubs around DELE	Collect DELE seed	Establish DELE seed bed	Augment DELE population
2016	A		X													
	M	X									X					
	J	X											X			
	J			X												
	A															
	S															
	O		X		X											
	N					X										
	D															
	2017	J														
F																
M											X					
A			X													
M		X														
J		X				X							X			
J																
A															X	
S																
O			X		X			X					X			
N					X			X								
D																

Continued on next page.

		Treatment
2018	J	
	F	
	M	
	A	
	M	X
	J	X
	J	
	A	
	S	
	O	X
	N	X
	D	
2019	J	
	F	
	M	
	A	
	M	X
	J	X
	J	
	A	
	S	
	O	X
	N	X
	D	
		Spot spray herbaceous
		Spot spray grass specific
		Cut blackberry
		Foliar blackberry
		Hand pull non-native shrubs
		Confirm site prep.
		Seeding
		Planting
		Weed assessment
		Monitor shrub diversity
		Monitor DELE
		Treat shrubs around DELE
		Collect DELE seed
		Establish DELE seed bed
		Augment DELE population

5 Monitoring and Adaptive Management

5.1 Monitoring goals

- Locate and map invasive species and assess success of invasive species control efforts.
- Evaluate the establishment rates of plantings and the intensity of wildlife browse to plantings.
- Assess the effects of habitat restoration, management and enhancement tools (e.g., mowing, herbicide treatment) on plant community composition.
- Track bird and amphibian response to restoration activities.
- Inform adaptive management.

5.2 Vegetation monitoring

Informal monitoring to assess weed control issues, chemical treatment effectiveness, and seeding establishment should occur at least twice a year. Informal monitoring will consist of walking through the site such that all areas are visually covered and noting conditions of interest (treatment effectiveness, presence of invasive or woody species of concern, and seeding or planting establishment). Invasive species detection will be accomplished through Metro invasive species mapping for chosen species and through regular site visits.

5.3 Wildlife monitoring

Existing data from bird and amphibian surveys will be used as baseline for species presence. Repeat surveys, utilizing the same methodology, are recommended every 3 to 5 years.

5.4 *Delphinium leucophaeum* monitoring

Populations of *D. leucophaeum* should be monitored annually until target population size is achieved and maintained. When patches are small, as they are currently, a complete census of flowering plants should be conducted in May-June when this species is flowering and distinguishable from other *Delphinium* species. Monitoring data should be used to determine outplanting survival, reproduction, and population response to restoration treatments if relevant. Once population targets have been achieved, monitoring frequency can be reduced to every three years (although visual checks should be made annually to ensure no major decline in population size has occurred). See Appendix 4 for *D. leucophaeum* monitoring protocol.

5.5 Adaptive management

Adaptive management is a process that allows land managers and restoration practitioners to incorporate new information in their practices as it becomes available. Information learned from long-term monitoring is especially useful to modify management at a site and help reach project goals. Restoration in the Willamette Valley on thin soils such as those present at Canemah is relatively novel. Lessons learned at this site will help to guide further restoration actions on the site and on similar sites.

The schedule and techniques presented in this plan may be modified through the adaptive management process. Monitoring results will be reviewed as monitoring is completed, and used to modify upcoming management processes. Examples may include, but are not limited to:

- If a new species of concern (bird, amphibian, plant, etc.) is found on a site plans may need to be adjusted to improve habitat for this species.
- If prairie species establish poorly from seed, restoration plan may be modified to add additional site preparation for future plantings, and planting more plugs may be considered.

6 Restoration and Management Challenges

A variety of challenges will be provided by the location and nature of Canemah restoration project. They are outlined here to provide the context for restoration activities.

6.1 Cultural resources

There are known historical remnants on site. Protocols must be followed to avoid disturbing these as well as unknown resources. Protocols are established in Metro's Inadvertent Discovery and Archaeological Monitoring Plan prepared by Willamette Cultural Resources Associates.

6.2 Burning

While an extremely effective habitat restoration tool, prescribed burning will not be possible at Canemah due to the proximity to the adjoining neighborhood and the Portland Metro Area. A flame-weeder should be considered to mimic fire when needed. Flame-weeding will reduce concern about safety and simplify burn plans.

6.3 Recreation/Trails

Metro plans to develop trails that will promote passive recreation at Canemah. This will provide opportunities for interpretive signs or other educational materials with information about habitat restoration. Trail locations may be able to complement restoration by providing a border that can serve as a fire break and weed barrier. Foot traffic that is confined to trails should not threaten sensitive plant or wildlife species. There may be times when public access may need to be diverted, such as during herbicide treatment.

6.4 Chemical Limitations

All herbicides used in restoration activities will be used within the guidelines of their labeling, particularly regarding required setbacks from water courses. Suggested Integrated Pest Management (IPM) guidelines specific to the species at Canemah are included in the Metro IPM and relevant USFWS-NOAA Biological Opinions for fish species (National Marine Fisheries Service 2009).

6.5 Maintenance

Maintenance is a priority at Canemah during and after restoration is complete. Maintenance activities will include invasive weed control and regular mowing and supplemental plantings as needed (Table 4). After initial restoration activities are completed, additional maintenance activities may be triggered by action thresholds outlined in Table 5.

Table 5. Action thresholds for additional maintenance activities.

Action Thresholds			
<ul style="list-style-type: none"> All thresholds are relative cover per management unit unless otherwise noted. All thresholds are intended to guide maintenance actions. Weed control measures during establishment are addressed above. Thresholds listed in order of priority of treatment. 			
Threshold	Symptom	Areas of Highest Concern	Solution
< 50% native herbaceous prairie species cover (KEA good)	Poor seedling establishment, invasive grass dominance	All	Implement more intensive grass management. Supplement native seeding and planting.
	Encroachment of aggressive exotic species	All	See below for individual species.
< 20 native high fidelity herbaceous species present on site	Selected diversity species did not survive over time.	All	Examine plant selection. Either replant the species in different areas or interplant with different species that are expected to succeed while filling the same ecological niche.
Any new noxious weeds	Weed seed or plant materials vectored to the site.	All	Rapid response to eliminate small unestablished populations.
> 1% cover of Scotch broom (<i>Cytisus scoparius</i>)		All open areas	Yearly scheduled manual remove of any plants.
> 15% cover of oxeye daisy (<i>Leucanthemum vulgare</i>)		All open areas	Treat according to IPM. Reseed appropriate seed into large disturbance areas.
> 5% cover of non-native blackberry (<i>Rubus spp.</i>)		All	Treat according to IPM. Reseed appropriate seed into large disturbance areas.
> 10% cover of false dandelion (<i>Leontodon taraxacoides</i> , <i>Hypochoeris radicata</i>)		Prairie and savanna areas	Treat according to IPM. Reseed appropriate seed into large disturbance areas.
> 10% cover of tansy ragwort (<i>Senecio jacobaea</i>)		All	Reseed appropriate seed into large disturbance areas. Do not use chemical control if cinnabar moth (biological control) is present.

7 Future Management

7.1 Best management practices overview

The following best management practices include those recommended by the U.S. Fish and Wildlife Service for use in areas with sensitive species of the Willamette Valley in the programmatic formal consultation on Western Oregon prairie restoration (USFWS 2008) and the USFWS programmatic restoration biological opinion for the Partners for Wildlife Program (USFWS 2010a). Following best management practices will help to avoid damaging rare resources.

7.2 Chemical treatment

Chemical treatments may be used to control aggressive exotic species for which manual control is not logistically efficient or has not proven successful.

- Herbicides will be applied by a licensed applicator, using appropriate equipment and best management practices.
- Exposure of non-target species to herbicides associated with drift, leaching to groundwater, and surface runoff will be avoided or minimized.
- Chemical treatments will follow labeled restrictions, including limitations for use near water.

7.3 On-going maintenance activities

Primary maintenance activities in the restoration area, in Year 4 (expected to be 2018) and beyond, will include mowing and control of invasive species. The best management practices described above (Section 7.1-7.4) should be followed. General maintenance activities will include the following:

- Fall mowing where possible of the prairie and savanna will occur each year to reduce competition for native species and minimize tree and woody shrub species encroachment into the prairie. These activities should only occur on 1/3 of the entire site area in any given year. This will result in a three year disturbance interval for any given area which will allow refugia for plants and animals.
- Any small conifers that are not eliminated through mowing should be cut or pulled annually. The edges will be the primary area of concern for conifers.
- Weed control will need to be ongoing. Searches for new exotic species and spot-spraying with herbicide should occur on a regular basis. Weed surveys should be completed at least twice yearly (spring and fall) to inform control efforts.
- Any areas of bare soil created through tree removal, weed control, or other disturbance should be seeded in September or October using the species designated for the habitat in the seeding list.

These tasks will be able to be targeted to individual areas at the end of the restoration phase. At that point, needs for the individual areas will be more apparent and a more reliable management guide can be created.

8 References

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9 Appendices

Appendix 1: Delphinium leucophaeum conservation measures

In order to avoid or minimize adverse effects to *Delphinium leucophaeum* populations, the following conservation measures should be followed when performing ground or vegetation disturbing activities in their vicinity. These measures are adapted from the *Recovery Plan for Prairie Species of Western Oregon and Southwestern Washington* (USFWS 2010), the *Benton County Prairie Species Habitat Conservation Plan* (Benton County 2010), and the *Final Projects Biological Opinion* (USFWS 2015):

1. Buffers
 - a. Establish clearly marked buffers to avoid or minimize effects to *D. leucophaeum* populations. Mark buffered population areas with flagging or fencing prior to restoration activities.
 - b. Vehicle and equipment staging areas will be located at least 15 m (50 feet) from all *D. leucophaeum* plants.
 - c. Manual and mechanical methods to remove invasive/non-native plants at project sites occupied by *D. leucophaeum* will maintain a buffer of 2 m (6 ft) around green growing plants. If plants have senesced (i.e. no green plant material is visible), this buffer is no longer required.
 - d. Tilling, disking, plowing, excavation, raking or sod rolling (i.e., larger scale subsurface ground disturbances) or other use of heavy equipment will not occur within 10 m (33 ft) of *D. leucophaeum* plants.
 - e. Dust-abatement additives and stabilization chemicals will not be applied within 10 m (33 feet) of *D. leucophaeum* plants.
2. Prior to restoration activities at areas with listed plants, all project staff will be familiarized with identification of any listed plants in the area and will be aware of listed plant locations within the project area.
3. Access points and tracks within occupied or suitable (i.e. potential introduction sites) habitats for *D. leucophaeum* must be limited and clearly marked to avoid soil compaction and damage to listed plant species from vehicles and/or foot traffic.
4. Herbicide applications
 - a. Because herbicides (and associated chemicals) may have negative impacts on non-target native species and invertebrate larvae, they will be used sparingly, and as part of an Integrated Pest Management Plan, to control or remove invasive native and non-native vegetation.
 - b. Broadcast applications of herbicides will maintain a minimum distance of 3 m (16 feet) from *D. leucophaeum* plants, unless they are dormant, in which case no buffer is required.
 - c. For all broadcast herbicide applications occurring within 2 m (6 ft) of *D. leucophaeum*, plants will be physically shielded (e.g., covered with buckets or some other barrier that will not harm the plants) as needed to protect them from spray or drift, unless they are

dormant, in which case shielding is not necessary. Plants will be uncovered immediately after spraying has been completed.

- d. In situations where there are severe weed infestations within the *D. leucophaeum* population, broadcast application of grass-specific herbicides may be used in on up to half of an occupied area between March 1 and July 31.
- e. If using a weed wiper to apply a grass-specific herbicide during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species.
- f. All other broadcast applications will only occur after July 31 when *D. leucophaeum* is dormant.
- g. Spot and hand applications of herbicide will maintain a minimum distance of 1 m (3.3 feet) from *D. leucophaeum* plants, unless they are dormant (i.e. no green plant material is visible), in which case no buffer is required.
- h. Appropriate protective measures must be used to protect listed plants to herbicide exposure, as listed in PDC 29 and PDC 51 within the PROJECTS biological opinion and as determined necessary during project design by the appropriate species' leads (USFWS 2015).
- i. Herbicides will not be applied at locations where nearby listed plants may be in the path of surface runoff from the project.
- j. Herbicide treatments will be followed with native seed or plant introductions if necessary to minimize or eliminate the establishment of invasive and non-native vegetation.

5. Mowing

- a. Mowing activities will not occur within 2 m (6 ft) of *D. leucophaeum* plants, unless plants are senesced (i.e. no green plant material is visible, typically August-February). If *D. leucophaeum* plants are dormant, no buffer is necessary.
- b. Tractor mowing should occur when soils are dry enough not to be disturbed by tires/tracks, and the mowing deck must be set a minimum of 15 cm (6 in) above the ground for all covered plants.
- c. No tractor mowing will occur when soil is saturated to avoid compaction and rutting.
- d. Spring mowing is only allowed where it is necessary to control a weed infestation involving a weed species reproducing mainly by seed (e.g., meadow knapweed), in which case up to ½ of the *D. leucophaeum* population may be mowed in an effort to control invasive species seed set.
- e. Flail mowers will not be used.

6. Shade cloth

- a. Shade cloth involves placing a dark cloth over a dense weed infestation and fastening it to the ground with stakes. The cloth is generally removed after two years.
- b. Shade cloths shall be installed during the growing season, but will not be used directly over or within 2 m (6 ft) of any *D. leucophaeum* plants.

7. Solarization

- a. Solarization is used to control dense weed infestations and may be combined with tilling prior to treatment. The weed infestation is covered with plastic sheeting and remains in place for at least three months during the subsequent growing season. Once the plastic is removed, follow-up weeding may be necessary.
- b. Solarization will be used not be used directly over or within 2 m (6 ft) of any *D. leucophaeum* plants.
- c. Solarization can be used for site preparation prior to reintroduction or augmentation of *D. leucophaeum*.

8. Tilling/Disking

- a. Tilling/disking will, to the extent practicable, be implemented along existing ground contours.
- b. Tilling/disking shall not occur during the wet season to minimize alterations to site hydrology and destruction of the soil structure.
- c. Tilling/disking will be immediately followed by planting native plant species groundcover via seeding or outplanting, unless additional weed treatments (i.e. second application, solarization) are needed.
- d. This technique will be used no closer than 10 m (33 ft) to *D. leucophaeum* plants.

9. Raking

- a. Raking is used to reduce thatch build up, and may be tractor mounted or hand held.
- b. Raking will occur after *D. leucophaeum* has gone dormant for the season (August-February).
- c. While raking, efforts will be made to avoid disturbing the underlying soil
- d. If rakes are tractor-mounted, tractors shall be equipped with rubber tracks to minimize soil compaction when needed.
- e. Thatch and leaf litter will be removed off site or at least 10 m (33 ft) away from *D. leucophaeum* plants and habitat.

10. Woody species removal

- a. Directional falling shall be used to avoid impacts to *D. leucophaeum* plants as much as possible.
- b. To reduce potential impacts, cutting in the vicinity of *D. leucophaeum* will occur only when this species is dormant (typically late July through February).
- c. Cutting of woody species may be combined with application of herbicide to the cut stems to reduce resprouting.
- d. Girdling trees (removal of a ring of bark near the base of the tree with either an ax or chainsaw) may occur at any time of year. Workers shall enter the site on foot and take care to avoid trampling *D. leucophaeum* plants. Girdled trees may remain on site or be removed during the dry season (August-October), depending on management objectives for the site.
- e. Handheld power tools may be used to cut down, control, or remove woody vegetation when *D. leucophaeum* is either dormant (August-February) or during the flowering

season (March-July) so long as workers take precautions to avoid trampling of any *D. leucophaeum* plants by working no closer than 2 m (6 ft) from all plants.

- f. Vehicle-supported stump removal will occur only during dry periods (August-October)
- g. All cut material will be piled or chipped and spread at least 10 m (33 ft) away from any *D. leucophaeum* plant populations or hauled off-site for disposal.

11. Post-activity seeding

- a. Ground-disturbance activities (e.g., tilling, disking, and plowing) and herbicide use should be followed with native seed or plant introductions to minimize or eliminate the establishment of invasive and non-native vegetation, unless it is determined the local seed source/bank is sufficient.

Appendix 2: Delphinium leucophaeum seed collection protocol

In order to maximize efficiency and not negatively impact the seed source populations of *Delphinium leucophaeum*, the following seed collection protocols should be observed:

- Collect seed when ripe. Fruits (follicles) should be dry (no longer green) but not dehisced. Generally, seed collection should occur in late June through early July, but conditions vary from year to year, so it is important to scout the source populations to assess phenology in mid-June and plan collection accordingly.
- Select source populations that are either 1) large enough to support collection (populations with at least or 2) small and vulnerable enough to not potentially count towards recovery (i.e. small roadside populations).
- Collect no more than 25% of seed present at the time of collection, and collect from as many different individuals as possible.
- If collecting seed to establish a seed production bed/field, collect from as many populations as possible from within the target recovery zone.
- Do not collect from Champoeg State Park population, since the *Delphinium* population there exhibits intermediate characteristics between *D. leucophaeum* and *D. pavonaceum*.
- An Oregon Department of Agriculture listed plant permit is required in order to collect and transport a state-listed plant.
- Allow fruits/seed to thoroughly dry out in a warm, dry setting (spread out in trays works well) before cleaning and storing.
- Due to the fact that wild *D. leucophaeum* plants tend to have respectable levels of seed production and high levels of seed germinability, a single year should be adequate to supply enough viable seeds for cultivation projects (unless seed source populations are extremely small).
- Based upon historic seed production estimates, *D. leucophaeum* can be expected to produce, on average, about 4 fruits per plant, yielding a total of about 66 seeds/plant. Typically, the lowest fruits on fruiting stems tend to produce the most seeds (Gisler 2004).

Appendix 3: Delphinium leucophaeum cultivation protocol

Delphinium leucophaeum has been successfully cultivated in greenhouse and outdoor garden settings from seeds. The following guidelines should be followed when cultivating this species (adapted from Gisler 2004):

- *D. leucophaeum* seeds need cold stratification in order to germinate.
- If sowing seed in flats and leaving outside during the winter, approximately 60-100 percent germination has been reported.
- Artificial cold stratification is much faster and equally as effective. Place seeds in refrigerator for at 5°C for 5-8 weeks.
- Regardless of which cold stratification method is used, seeds should be kept in a dark place to foster germination.
- Once *D. leucophaeum* seedlings are obtained, they may be grown outdoors, in which case it may take 5 or more years for them to develop into reproductively mature plants. However, flowering plants can be obtained in a single year if the cultivated plants are exposed to artificially accelerated cycles of growth and dormancy.

Appendix 4: Delphinium leucophaeum monitoring protocol

In general, monitoring protocols for *D. leucophaeum* are similar to those of other listed Willamette Valley prairie species. The following recommended protocols have been adapted from *Developing standardized survey and monitoring protocols for four threatened and endangered Willamette Valley prairie plant species* (Currin and Meinke 2013).

When to monitor:

Because flowers must be present in order to distinguish between *Delphinium* species, *D. leucophaeum* should be monitored in May-June, when it is in full bloom.

What to count:

1. Flowering individuals: Typically vegetative plants have already senesced by the time *D. leucophaeum* is flowering (and identifiable). It is recommended that annual monitoring of the population focuses on counting flowering individuals.
2. Reproductive output: If there is sufficient time and resources, and an interest in reproductive output at a population, the number of flowers and/or fruits should also be recorded for each individual. This information may provide insights into the vigor and sustainability of the population over time.
3. Seedlings: Although population size should involve counting flowering individuals, newly seeded areas should be monitored for seed germination and seedling establishment in order to determine initial success or provide information about possible causes of failure. Several visits may be necessary to determine the appropriate time to monitor seedlings at each site, but in general, seedlings should be monitored in April.
4. Vegetative plants: Much like with seedlings, it may be desirable to monitor newly outplanted tubers earlier in the growing season in order to capture information about the number of surviving vegetative plants that will not flower the first year after outplanting. As with seedlings, this monitoring should take place in April.

Census vs. Sample:

Unless a population numbers in the thousands, it is recommended that *D. leucophaeum* be censused rather than sampled. Currently, there are only a handful of individuals at Canemah, and we recommend censusing the flowering individuals. If the Canemah population grows in size to the point where censusing becomes time and cost prohibitive, refer to the sampling protocols outlined in Currin and Meinke (2013) for more information.

Monitoring equipment:

- Pin flags: Enough to mark every individual in the largest patch + extras for newly recruited individuals. Chose a color that will stand out (orange or pink work well) in the habitat. White flags are not recommended, since they are difficult to see in the dappled light where *D. leucophaeum* is often found.
- Meter plot frames or meter tapes: To assist in monitoring of newly outplanted sites. Depends on configuration of outplanted areas.
- GPS unit: Helpful to have preloaded previous monitoring data, so that you are able to quickly relocate patches at the site.

Monitoring protocol:

- Locate patch of *D. leucophaeum*.
- Thoroughly survey area, marking every flowering individual that is found with a pin flag. Once all individuals are located, search the perimeter of the patch (~5 meters) thoroughly for additional plants.
- GPS the boundary of the patch.
- If recording the number of flowers/fruits, do so while collecting flags. It is often helpful to have one person examining the plant and one person recording the data. Collect the flag once you have finished recording the reproductive data.
- If not recording reproductive data, simply collect all flags within the patch and then count the flags to get a total number of flowering individuals.
- Record the patch name/number, total number of individuals, reproductive data (if collected), name of data collectors, date the data was collected, and any additional notes of interest about the population or its habitat.
- It is helpful to enter patch count in GPS unit in the field, if you have equipment that allows you to do this. Otherwise, you can populate the shapefile attributes table in the office.
- Repeat with the next patch.
- As restoration and augmentation efforts progress, once you have recorded data for all known extant patches, spend time walking through areas with appropriate habitat not known to contain *D. leucophaeum* just to see if there is any recruitment outside of the known patches.