CONSTRUCTION REPORT

SHALLOW MARSH RECONSTRUCTION in ALDERGROVE REGIONAL PARK

Submitted to:

Vancouver Aquarium
Metro Vancouver Regional Parks
BC Ministry of Forests, Lands and Natural Resource Operations
BC Conservation Foundation

February 26, 2014

Submitted by:

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BALANCE ECOLOGICAL
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SUMMARY

Vancouver Aquarium and Earth Rangers, in partnership with Metro Vancouver, the BC Ministry of Forests, Lands and Natural Resource Operations and BC Conservation Foundation, reconstructed a historic marsh in Aldergrove Regional Park, British Columbia. The constructed wetland comprises of several shallow ponds adjacent to an ephemeral marsh, and may serve as an introduction site for the endangered Oregon Spotted Frog.

The goals of this project are, through the restoration of a shallow-water marsh wetland habitat on historic agricultural fields, to:

a) Provide recovery habitat for the endangered Oregon Spotted Frog;

b) Enhance general wildlife biodiversity, with a particular focus on Species-at-Risk;

c) Provide outdoor education, stewardship and research opportunities in wetland restoration and species recovery; and

d) Increase our knowledge of marsh restoration techniques.

Construction involved the control of invasive plant species, a re-sculpting of the landscape and the hydrologic restoration of the historic wetland by plugging constructed drainage features, and re-planting with native vegetation. The constructed marsh includes features that promote use by species-at-risk, and features that intend to discourage high-density colonization of the area by invasive wildlife. In addition to providing habitat for native species, the marsh will provide stewardship opportunities, research opportunities and education opportunities for the general public, elementary schools, high schools, colleges and universities in the Lower Mainland of British Columbia.

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1 Background

Vancouver Aquarium and Earth Rangers, in partnership with Metro Vancouver, the BC Ministry of Forests, Lands and Natural Resource Operations and BC Conservation Foundation, reconstructed a historic marsh in Aldergrove Regional Park, British Columbia. The constructed wetland comprises of several shallow ponds adjacent to an ephemeral marsh, and may serve as an introduction site for the endangered Oregon Spotted Frog.

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a) Provide recovery habitat for the endangered Oregon Spotted Frog;

b) Enhance general wildlife biodiversity, with a particular focus on Species-at-Risk;

c) Provide outdoor education, stewardship and research opportunities in wetland restoration and species recovery; and

d) Increase our knowledge of marsh restoration techniques.

2 Personnel and Construction Timeline

Planning, Design and Implementation phases of this project spanned two years, from February 2012 to March 2014. Concept planning began in February 2012 with the Vancouver Aquarium and the BC Ministry of Forests, Lands and Natural Resources in a search for an appropriate location. Pre-construction site monitoring, design proposals and permitting were conducted in partnership with the landowner, Metro Vancouver, from July 2012 – June 2013. Construction was scheduled August and September of 2013 to take advantage of the driest summer months.

Four major phases of construction spanned from June 2013 to April 2014. Work was directed by Balance Ecological, contracted to the Vancouver Aquarium, BC Ministry of Forests, Lands and Natural Resource Operations, and BC Conservation Foundation.

Table 1. Contractors and Personnel

Task	Company	Personnel
Project Management	Balance Ecological	Monica M Pearson, R.P.Bio Aleesha Switzer (UFV) Marin Patenaude (Wilders Nest Farm)
Site Preparation	Will Unruh Farms	Ron Unruh
Site Preparation	Whatcom Custom Work	JP Sidhu
Equipment Operator	George Flath Construction	George Flath / Marvin Wheeler
Planting	Fraser Valley Watershed Coalition	Natashia Cox Rachel Drennan
Planting	Lower Mainland Green Team	Leda Salatian
Planting	Matsqui AFSAR crew	Robin Clark / Duane Hoskith

Table 2. Timeline of habitat construction activities at Aldergrove Regional Park shallow wetland reconstruction in 2013-2014.

	Dates	Task	Location	Equipment	Personnel
	Control of Invasive Species				
July	11– 13	Site preparation – Mowing and Haying. 94 bales removed	Site prep zone	John Deere 5525	Unruh Farms
August	18	Site preparation – Herbicide application	West field / South east field	Kubota L3800	Whatcom Farms
	30	Site preparation – Herbicide application	East field (north)	Kubota L3800	Whatcom Farms
	31	Site preparation – disc (6 passes)	East field (all)	John Deere 5525 + domries disc	Unruh Farms
	Habitat Complexing and Feature Construction				
	21 - 23	Grass removal / berm construction	West field	Hitachi 150 with thumb / Hitachi 200 Long Reach	George Flath Construction
	25 – 31	Grass removal / berm construction / channel infilling	West field	Hitachi 150 with thumb / Hitachi 200 Long Reach	George Flath Construction
Sept	2 – 6	Feature construction + woody debris placement / Berm construction	West field / East field	Hitachi 150 with thumb / Hitachi 200 Long Reach	George Flath Construction
	8 – 14	Habitat complexing, feature construction + woody debris placement	Central channel / East ponds	Hitachi 150 with thumb / Hitachi 200 Long Reach	George Flath Construction
	15 – 21	Habitat complexing, feature construction + woody debris placement	North ponds / berms	Hitachi 150 with thumb / Hitachi 200 Long Reach	George Flath Construction
	Hydrologic restoration				
	15 – 21	Overflow construction + berm refinement	Trail network	Hitachi 150 with thumb / Hitachi 200 Long Reach	George Flath Construction
	Revegetation				
October					
	10	Weirs breached to drain for planting	South weirs	Hand Tools	Balance Ecological
	13 – 15	Plant layout – potted plants (#)	All	Hand Tools	Balance Ecological
	15 – 19	Planting – potted plants & willow whips	All	Hand Tools	FVWC Crews
	21 – 24	Planting aquatic plugs & willow whips	All	Hand Tools	Balance Ecological
Nov	6	Weir reconstruction. Drain pile installation.	South-west weir	Hand Tools	Balance Ecological
March	1 – 30	Plant aquatic plugs / additional shrubs as available	All	Hand Tools	Balance Ecological

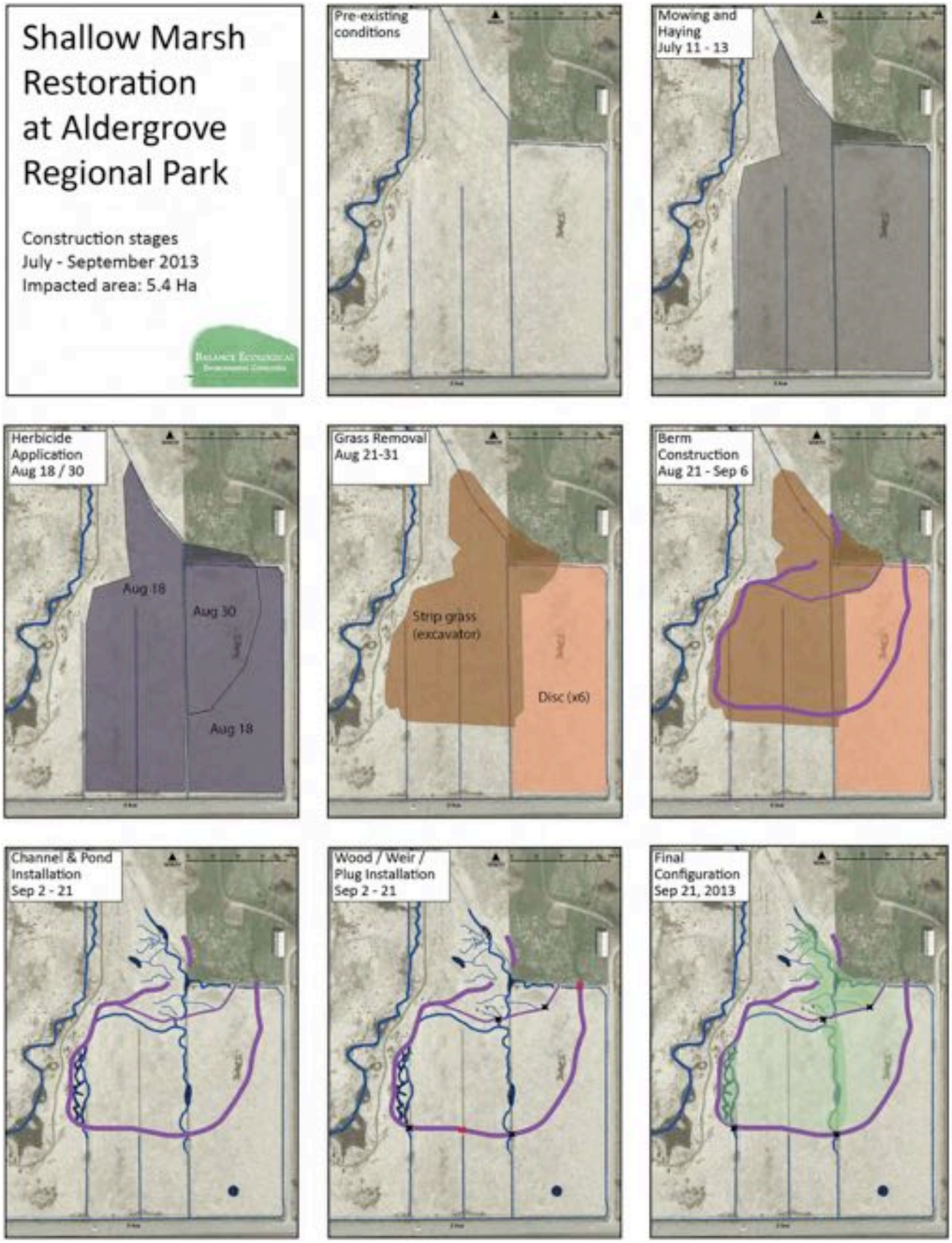


Figure 1. Construction phases of the marsh at Aldergrove Regional Park from July - September 2013.

3 Control of Invasive Species: June – August 2013

Reed canary grass was dominant across the proposed restoration site, and in all surrounding fields. Native plants present were limited to stinging nettle and a few planted willows at the east edge of the field. Several cottonwood trees had also been planted at the south end of the main drainage ditch. Reed canary grass is a hardy, early to leaf plant species that easily outcompetes native vegetation in shallow wetlands. Controlling reed canary grass is a multi-step process requiring: 1) killing / removal of existing plants and rhizomes; 2) exhausting the seed bank; 3) active restoration (re-seeding); 4) prevention of re-invasion; and 5) continued monitoring and follow-up treatments. Destruction of the root mass is most important to prevent re-infestation of the site and is most effectively performed through chemical control.

The drained, flat nature of the project site allowed us to use chemical control methods, as the ground was dry and firm enough to accommodate farm equipment and waterways were dry in late summer. Final control treatments varied across the fields, and will provide an indication of which treatments were more or less effective. In preparation for herbicide application, the entire field was mowed in early July, then raked and hayed to remove grass biomass that presented a potential fire hazard.

Grass regrowth was treated with a glyphosate-based herbicide (Roundup WeatherMax® formulation). Unfortunately, chemical control was not performed to design standards due to administrative and logistic delays. Permits were delayed due to a change in administrative structures within Metro Vancouver, resulting in a late start on mowing (July rather than June). Additionally, the size of the project (5 Ha) was too small to be an attractive work opportunity for commercial custom spray operators, and was delayed several times as contractors postponed application in favour of larger projects. Finally, a local farmer performed the application using smaller equipment that was more expensive (time consuming) to operate, had a higher margin of error in spray (missed patches), and too late to allow for resprouting and reapplication before construction work could begin. Herbicide was applied once with a boom sprayer across the field west of Central Ditch and the southern portion of the east field on August 18, and on the northern portion of the east field on August 30 (Figure 1).

Grass was stripped from the surface of the west field as well as the 'ponds' area and used to build berms for water control structures. Stripping involved removing the growth and a shallow portion of roots and topsoil. The east field was not stripped of grass but disced with a rotator disc 6 times to break up the grass mat and soil. Berms built of grass will settle over the first two years post-construction, and will require re-grading and smoothing to develop a walking trail.

Figure 2. Site preparation to control reed canary grass prior to wetland construction at Aldergrove Regional Park in 2013.

4 Habitat Complexing and Feature Construction: Aug – Sept 2013

The constructed habitat contains a variety of zones and habitat features that target Oregon Spotted Frog, Northern Red-legged Frog and attempt to exclude American Bullfrog by design. The features also provide for avian and invertebrate biodiversity. Habitat features at multiple scales create an abundance of variance for an abundance of life. Micro-features incorporate a variety of depth and shallows, a rough finish to increase surface area of soils, and differing densities and combinations of plants and woody debris.

Focal species were targeted with the following habitat features:

Oregon Spotted Frog (*Rana pretiosa*):

- shallow marsh areas for breeding, rearing and foraging;
- summer refuge pools for low water survival and foraging;
- coarse woody debris in pools and within flowing water for winter survival;
- hardhack 'islands' to provide refuge in summer and provide overwintering structures in the winter.

Northern Red-Legged Frog (*Rana aurora*):

- coarse woody debris in ponds for breeding;
- shallow marsh areas for rearing and foraging.

American Bullfrog (*Rana catesbeiana*):

- shallow marsh areas less desirable to bullfrogs may discourage presence;
- complexity in deep areas provided by coarse woody debris, hardhack islands and brush piles may discourage bullfrog presence.

Great Blue Heron (*Ardea herodias*):

- shallow marsh habitat for foraging.

General avian biodiversity:

- shallow marsh habitat for foraging;
- tall woody debris for perching / resting;
- short woody debris for perching / resting;
- brush piles for resting / nesting / foraging;
- hummocks for resting / nesting;
- pond habitat for foraging.

General invertebrate biodiversity:

- varied freshwater habitats (sedge / cattail / pond / floating / ephemeral) for dragonfly foraging, laying and rearing;
- brush piles for pollinator breeding;
- coarse woody debris for breeding / foraging.

The constructed project is generally divided into a north Pond zone and south Marsh zone by a constructed berm. A second berm (south berm) constrains a constructed marsh / wet meadow that is bisected into east and west fields by a central drainage channel. The marshes drain to the south across rock weirs in the south berm (a future Loop Trail) into local agricultural drainage ditches. Deep-water refuges access permanent groundwater to ensure wetted habitats remain available for aquatic wildlife year-round.

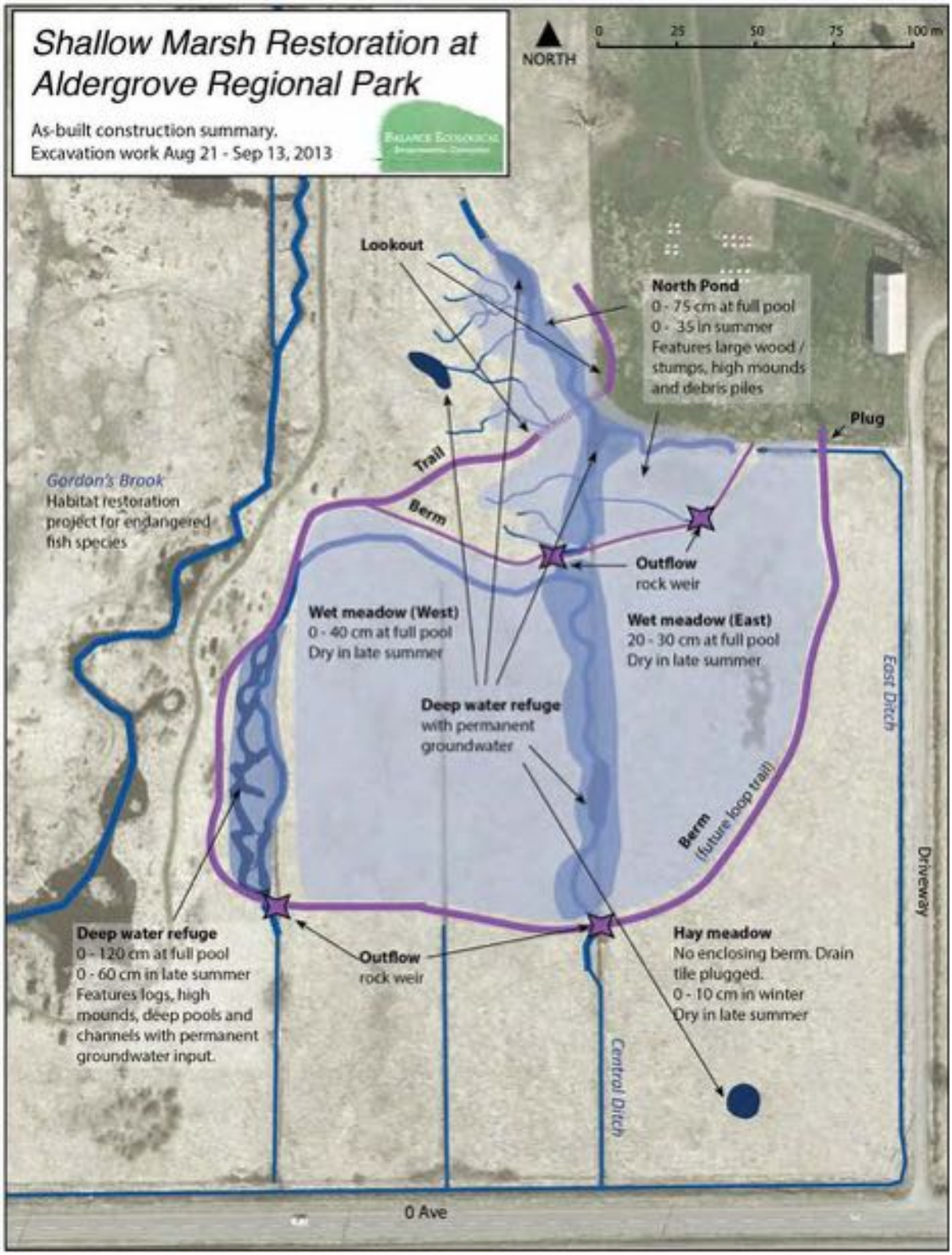


Figure 3. Summary figure of constructed habitat at Aldergrove Regional Park indicating major features.

4.1 North Pond Zone

The Pond zone is complex, with channels, deep pockets, high mounds, and dense placement of coarse woody debris and scrub piles. Topological variation in the ponds reaches 1.5 m from top of mound to adjacent pond invert, with a diversity of sharp vertical edges alongside gentle slopes. Three large (100 m^2) deep water pools and connecting channels were constructed to provide low-water refuges to aquatic fishes and frogs during the late summer months; these ponds were constructed alongside existing shrubby vegetation that provide pre-existing shade and cover structure.

Figure 4. Pre-, during and post-construction images of the north Pond zone.

4.2 Wet Meadow / Marsh Zone

The Marsh comprises two marsh-meadows divided by a channel with deeper pools and channels bordered by the south berm. Topological variation in the fields is low, with a gradient of 0.4 m from north to south over 100 m. The east field is shallower than the west; it had less disturbance to the ground during construction as vegetation was disced with a tractor rather than stripped with the excavator. Stripping grass with the excavator allowed us to use the material to build berms, and also to increase microtopographic complexity. The field is level enough to accommodate a tractor for maintenance, but rough edges were maintained to provide a diversity of opportunities for naturally colonizing plants and invertebrates. Both fields are designed to flood in winter to a maximum of 40 cm depth, slowly drop water levels through the summer via evapotranspiration, and dry in late summer / early fall to allow for mowing or other invasive grass maintenance activities.

Figure 5. Pre-, during and post-construction images of the wet meadow / marsh zone. This zone was used by birds and odonates before construction was complete, particularly Killdeer and Dowichers.

4.3 Central channel

A central channel bisects the east and west fields, providing deeper habitat opportunities and a conduit for heavy flow in rain events. A straight, narrow agricultural ditch was shallowed, widened and sculpted to increase its meander. The channel does not have a continuous gradient from north to south, but at times shallows to force water over the adjacent fields. Our intention was to give water somewhere to go, but to make it work to get there. Mid-way between the north and south berms is a 100-m^2 deep permanent water refuge pool alongside existing cottonwood trees. Coarse wood was placed at intervals, particularly at the edge of steeper gradients where water will flow continuously in winter months. This is intended to provide overwintering habitat for Oregon Spotted Frog.

Figure 6. Pre, during and post-construction images of central channel bisecting east and west fields. Facing south from berm. A deep water refuge was dug beneath the existing cottonwood trees seen in the photos.

4.4 'The Warren' Refuge

At the west edge of the south marsh is a 0.1 Ha low-water refuge with deep (> 1.5 m deep) channels broken up by islands and coarse woody debris. The woody debris provides refugia in times of low-water and increases complexity to reduce potential bullfrog densities.

Figure 7. Pre, during and post-construction of a complex, deep water refuge with access to permanent groundwater.

4.5 Coarse Woody Debris

Coarse woody debris provides important nutrient cycling opportunities for fungi, bacteria and invertebrates that form the base of the food web, and also provides complex structures that serve as refugia for wildlife. Interactions between stable wood and moving water disrupt flows and increase chaos in the built environment. Coarse wood was incorporated primarily in deep habitats to provide water-wood interactions, refugia for wildlife, complexity to deep sites to reduce bullfrog densities, and to encourage invertebrate development.

Figure 8. Installation of coarse woody debris in the constructed marsh.

5 Hydrologic Restoration: September 2013

Hydrologic restoration required the removal of constructed drainage features (ditches, drain tiles) and reconnection to a permanent water source. One drainage channel in the south west meadow was filled and plugged at the south berm; a drainage channel at the base of the hill at the north end of the project was plugged to force water into the fields; one line of drain tile in the southwest field was identified and plugged with soil; and gravel weirs were constructed in the north and south berms for overflow. Gravel weirs were used in order to maintain a natural, low-impact aesthetic and to allow for easy modification.

The south-west weir is permeated with a 25-cm PVC drainpipe that can be simply altered to drain the wetland to 30 cm below design elevation. Interchangeable PVC pipes are placed in an upright elbow at the upstream end of the drain to increase or gently reduce water levels.

Figure 9. Drain tile uncovered and removed from east field.

Groundwater from the fluvial moraine at the north end of the project was captured and has been redirected to flow across the wetland and through the constructed channels, ensuring some flow-through the summer months. We retained a 'plug' between the most abundant source of groundwater and the main project site to reduce flow through the first summer of the project (2014) and anticipate connecting this source in September 2014.

In the design document we noted that a connection will be made to Gordon's Brook only if necessary to maintain water in the permanent ponds through the summer. Pepin Creek and Gordon's Brook are high in nutrients from upstream agricultural inputs, and would likely result in the rapid recolonization of the ponds and marsh with reed canary grass. In the first winter post-construction, water from Gordon's Brook did redirect through the wetland due to beaver dam activities upstream of the wetland, and flood waters from Gordon's Brook flowed overland into the project site.

Figure 10. Gravel weirs / overflows directly after construction (Left) and directly following a large rain event (right). Weir elevations will be adjusted in 2014 to allow for settling of the disturbed grounds, and may be finalized after several years of monitoring. Weirs 1 and 2 drain the north pond into the marsh; Weir 3 drains from the south-west; Weir 4 drains south the central channel.

6 Revegetation with Native Plant species: October 2013 – April 2014

The wetland was revegetated with native wetland herb, grass, sedge and shrub species known to historically exist in Lower Mainland freshwater marshes. Unfortunately, no reference sites with native communities were known to remain in the Lower Mainland that could provide information on appropriate vegetation. Plant selection considered the likelihood of a historic presence in the Lower Mainland, structural suitability for the target species, and availability of materials. All plants were special-ordered one year in advance in order to allow the nursery to source, plant and grow the stock for the project.

Aquatic plugs were planted in the fall (October / November) or in the Spring (March / April) dependent on their growth form. Hardy, late-season herbs that maintained foliage through the fall were planted in the fall, and early perennials that had already senesced were held back for planting in the spring.

Table 3. Aquatics planted in the restoration project. USDA wetland status is indicated in brackets: OBL: Obligate wetland; FACW: Facultative wetland; FAC: Facultative.

AQUATIC PLANTS			
PLUGS - FALL 2013			
Latin Name	**Common Name**	**size**	**#**
Carex aquatalis	WATER SEDGE (OBL)	plug	414
Carex densa	DENSE SEDGE (OBL)	plug	3640
Eleocharis palustris	COMMON SPIKE-RUSH (OBL)	plug	1000
Glyceria elata	TALL MANNAGRASS (OBL)	plug	1340
Juncus accumInatus	TAPERTIP RUSH (OBL)	plug	393
Juncus effuscus	COMMON RUSH (FACW)	plug	1500
Juncus patens	SPREADING RUSH (FACW)	plug	1000
Juncus supinformis	HAIRYLEAF RUSH (OBL)	plug	450
Juncus tenuis	POVERTY RUSH (FAC)	plug	1000
Typhya latifolia	CATTAIL (OBL)	plug	25
PLUGS - SPRING 2013			
Carex martensii	MERTIN'S SEDGE (FAC)	plug	900
Carex obnupta	SLOUGH SEDGE (OBL)	plug	1000
Carex stipata	AWLFRUIT SEDGE (OBL)	plug	450
Oenanthe sarmentosa	PACIFIC WATER PARSLEY (OBL)	plug	300
Scirpus accutus	HARDSTEM BULLRUSH (OBL)	plug	1000
Scirpis mIrcroparpus	PANICLED BULLRUSH (OBL)	plug	1200
Scirpus veridis	SOFTSTEM BULLRUSH (OBL)	plug	500
Veronica americana	AMERICAN SPEEDWELL (OBL)	plug	1000
		TOTAL	**17112**
POTTED AQUATICS			
Carex densa	DENSE SEDGE (OBL)	1gal	60
Carex mertensii	MERTIN'S SEDGE (FAC)	1gal	23
Carex obnupta	SLOUGH SEDGE (OBL)	1gal	113
Eleocharis palustris	COMMON SPIKE-RUSH (OBL)	1gal	13
Glyceria elata	TALL MANAGRASS (OBL)	1gal	52
Juncus patens	SPREADING RUSH (OBL)	1gal	90
Scirpus acutus	HARD-STEM BULLRUSH (OBL)	1gal	70
Scirpus mIrcrocarpus	PANICLED BULLRUSH (OBL)	1gal	83
Scirpus veridis	SOFTSTEM BULLRUSH (OBL)	1gal	11
		TOTAL	**515**

Aquatics were planted with reference to the design water elevation: obligate wetland plants (OBL – hydrophytes that almost always occur in wetlands) were planted 0-20 cm below design high water elevation; facultative wetland (FACW – hydrophytes that usually occur in wetlands but may occur in non-wetlands) plants were planted 0-10 cm below design high water elevation; and facultative plants (FAC – hydrophytes that occur in wetlands and non-wetlands) were planted 0-10 cm above design high water elevation.

Many of the aquatic plugs planted in the fall were affected by periods of deep cold in the winter and were heaved out of the ground by the expansion of ice in the soil. Plugs above the water line appeared most affected. All were replanted, then heaved out a second time, and replanted again in the spring. Future projects will plant aquatic plugs in the spring months only.

To create a 'barrier' around the wetland to reduce seed dispersal of reed-canary grass, a thicket of willows, hardhack and dogwood was planted at the north-west edge of the project between Gordon's Brook and the project site. Approximately 500 willow whips were cut from an adjacent willow farm to supplement potted materials.

Table 4. Native shrubs and trees planted in Fall 2013.

SHRUBS			
Latin Name	**Common Name**	**size**	**#**
Andromeda polifolia	BOG ROSEMARY	1gal	20
Cornus sericea	RED-OSIER DOGWOOD	2gal	50
Myrica gale	SWEET GALE	2gal	50
Rosa nootkatensis	NOOTKA ROSE	2gal	50
Rosa woodsii	WOODS ROSE	2gal	50
Salix lusiandra	PACIFIC WILLOW	1gal	50
Salix scouleriana	SCOULER'S WILLOW	1gal	50
Salix hookeriana	HOOKER'S WILLOW	1gal	50
Sambucus racemosa	RED ELDERBERRY	2gal	25
Spiraea douglasii	HARDHACK	2gal	100
Symphoricarpus alba	SNOWBERRY	2 gal	50
		TOTAL	**545**
HARDHACK / AQUATIC COMBINATION			
Spirea / C. densa	HARDHACK / DENSE SEDGE	1gal	85
Spirea / G. elata	HARDHACK / TALL MANNAGRASS	1 gal	115
		TOTAL	**200**
TREES			
Latin Name	**Common Name**	**size**	**#**
Betula papyrifera	PAPER BIRCH	5gal	20
Crataegus douglasii	PACIFIC DOGWOOD	2gal	20
Crataegus douglasii	BLACK HAWTHORN	5gal	20
Fraxinus latifolia	OREGON ASH	5gal	15
Malus fusca	PACIFIC CRABAPPLE	5gal	20
		TOTAL	**95**

Hardhack-aquatic combinations were hardhack and aquatic herbs planted in the same pot, and combined to form hardhack 'islands'. Each island was made up of a grouping (3-4 bags) of these combinations 'planted' in burlap sacks with a soil base, and staked around a wooden stake in the

wetland. These islands were placed in the deeper areas of the wetland to create living complex woody structures in the maturing wetland.

Figure 11. Construction and placement of 'Hardhack combo islands'. Hardhack and aquatic plants are potted together in a burlap sack 1/3 full of soil. The sacks are placed in the wetland at depths of 20-30 cm to form 'islands' for multispecies habitat.

7 Public Engagement

Volunteer events to plant aquatic plants, shrubs and trees provided opportunities to connect the public with nature and involve them directly in habitat and species recovery. Volunteer events reduced labour costs, and provided an effective venue for connecting local residents with nature. Partnerships with existing non-government organizations that organize stewardship events increased the reach of the project. As of the end of 2013, 88 volunteer participants contributed 336 hours of labour to the project. This includes 60 children from BirchGrove Elementary School, who joined us for a morning of planting and discussions about species at risk. Additional support for volunteer plantings and recovery was provided by the Fraser Valley Watershed Coalition, the Lower Mainland Green Team, Pepin Brook Streamkeepers, BC Ministry of Forests Lands and Natural Resource Operations, Environment Canada and the Government of Canada's Aboriginal Fund for Species at Risk.

Figure 12. Volunteers out planting the wetland, including school children, community members, and BC Forests, Lands and Natural Resource Operations staff in October 2013.

8 Next Steps

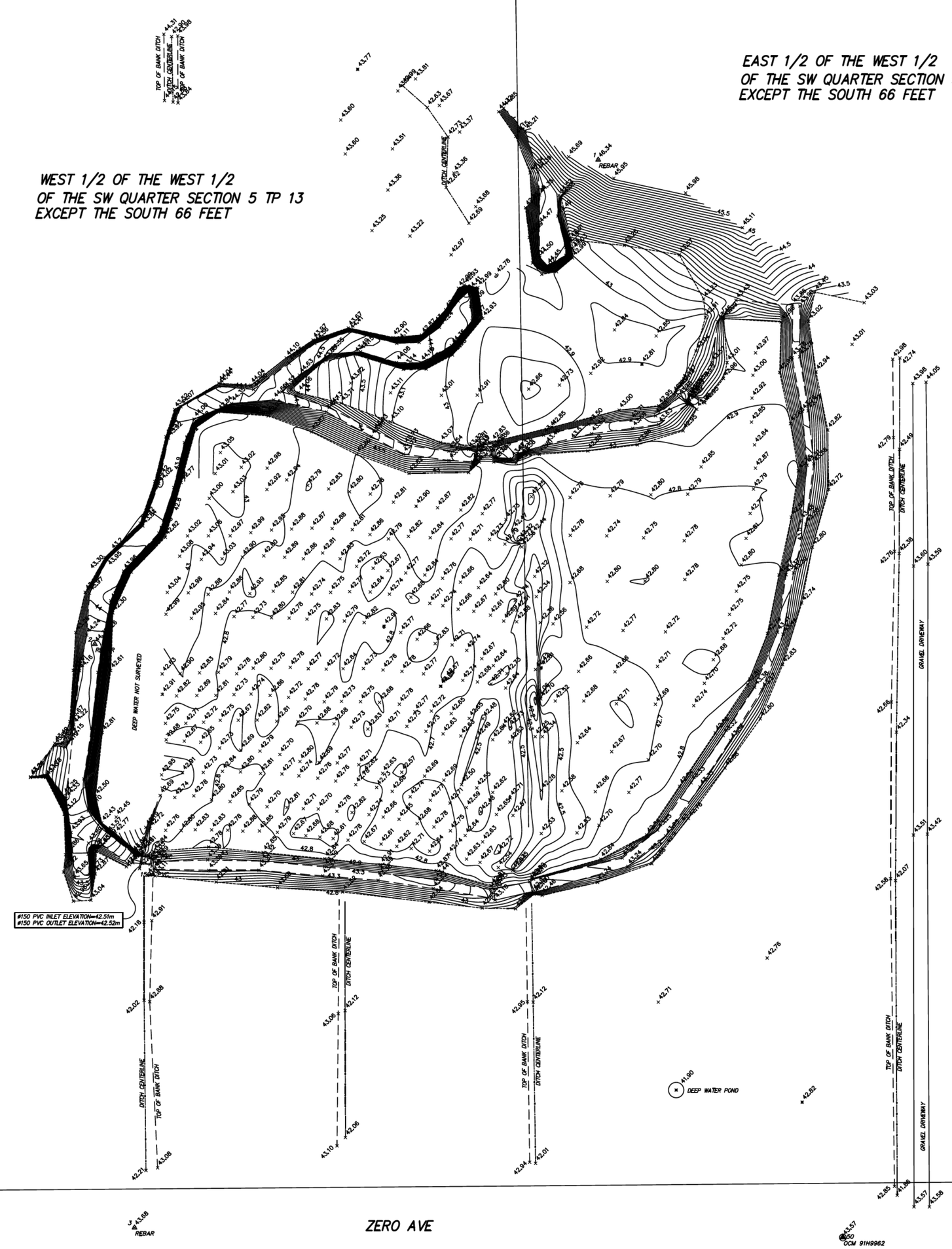
Final phases of installation will continue through 2014, including the installation of additional plants, monitoring and adjustments of water levels, and additional works to increase groundwater flows and finalize heights of weirs. The constructed wetland will require monitoring and maintenance, however as the final outcomes are uncertain, an adaptive management approach that accepts several potential futures and management plans must be considered (Table 5).

Post-construction habitat monitoring began in Fall 2013 and will continue for at least four years following construction. The monitoring plan will inform management recommendations dependent on hydrological and revegetation outcomes. A final decision on whether or not the habitat is suitable for introduction of Oregon Spotted Frogs in the future will depend on the information gathered.

Table 5. Adaptive management planning structure.

Potential Futures & Adaptive Management Plan	Post-construction vegetation establishment		
	A: Preferred outcome • Widespread native plant growth. • Patchy reed canary grass growth.	**B: Acceptable outcome** • Widespread reed canary grass in ephemeral marsh. • Ponds primarily populated with native emergent species.	**C: Undesirable outcome** • Widespread reed canary grass in ephemeral marsh. • Widespread grass in / around ponds. Few native species.
Post-construction hydrologic regime **2. Wetter than design:** • Ephemeral marsh stays wetted throughout year. • Ponds > 40 cm deep in summer.	**2A:** Reduce outlet height. If necessary divert some flow to remnant ditchs or Gordon's Brook.	**2B:** Reduce outlet height. If necessary divert some flow to remnant ditchs or Gordon's Brook.	**2C:** Reduce outlet height. If necessary divert some flow to remnant ditchs or Gordon's Brook.
1. As per design: • Ephemeral marsh floods Oct - June. Dries out mid- late summer. • Ponds retain permanent water.	**1A:** Patch reed canary grass removal. Manual and chemical as needed. Add native plants and re-seed if available.	**1B:** Annual mowing of ephemeral wetland in late summer. Add native plants and re-seed if available.	**1C:** Annual mowing of ephemeral marsh in late summer. Patch reed canary grass treatment in ponds. 'Grass-breakers" volunteer events. Invasive plant excavation if available.
3. Drier than design: • Ephemeral marsh dries in early spring. • Ponds dry in late summer.	**3A:** Increase outlet height. Avoid connection to Gordon's brook to reduce risk of reed canary grass re-establishment.	**3B:** Increase outlet height. If necessary, connect to Gordon's Brook for additional water source.	**3C:** a. Largescale mow and reed canary grass treatment / spray in late summer*. b. Increase outlet height. (*budget-dependent)

LEGAL FROM CITY BASE MAPS



Legend:

- Survey Control Monument
- Tree (Tbal At Point Of Entry Into The Ground)
- Ground Elevation
- Catch Basin
- Ditch (Creek)
- Edge Of Asphalt
- Fire Hydrant
- Guy Wire
- Inspection Chamber
- Lawn Drain
- Lamp Standard
- Manhole
- Power Pole
- Power Pole With Light
- Water Valve
- Sign
- Gas Valve
- Gas Meter

Terra Pacific
Land Surveying Ltd.
#119 - 19292 60th Avenue, Surrey, B.C. V3S 3N2
Ph. 604-533-0904 Fax. 604-533-0904

Client: Monica Pearson	Drawing Title: Survey Plan Of Pepin Marsh Wetland 27347 0 Avenue Langley BC	Certified Correct This 13th Day Of January 2014	Notes: Contours Are at 0.1m Interval	Benchmark Notes: Elevations Are Geodetic Referred to Monument: 91H9962 Monument Elevation: 43.566m Located At: 27347 0 Avenue	Scale: 1:500
Project: Pepin Marsh Wetland 27347 0 Ave Langley BC					Date: 1/13/2014
					File: 13-522.dwg

1 Of 1