RURAL FLUSH

HARNESSING MULTIFUNCTIONAL CONSTRUCTED WETLANDS TO PLAY A WINNING HAND IN BLUE RIVER, OR

A terminal project for a Master in Landscape Architecture

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ABSTRACT

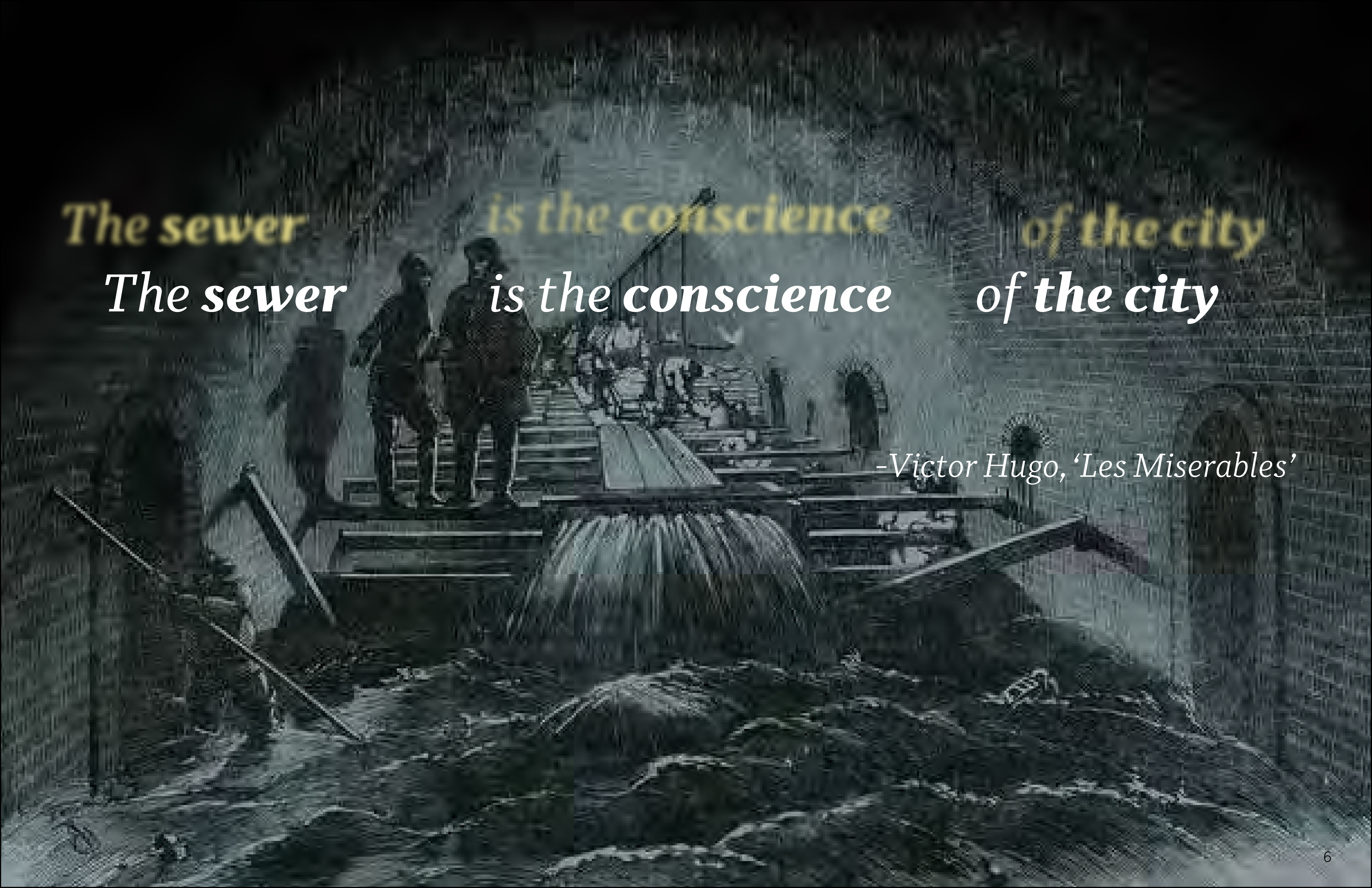
This project applies a new model for rural wastewater treatment in Blue River, an unincorporated community in Lane County, Oregon. Blue River's destruction in the 2020 Holiday Farm Fire created both a legal imperative to modernize the community's sanitation and an opportunity to rethink rural wastewater treatment. The model combines basic mechanical primary treatment with extensive secondary treatment by constructed wetlands. Replacing mechanical secondary treatment processes with constructed wetlands considerably reduces the operating costs of centralized sanitation, lowering a critical barrier to treating wastewater offsite in low-population areas of the United States. Constructed wetlands additionally restore threatened habitats and provide recreational opportunities, making them dynamic community assets. The efficacy of treatment wetlands have been widely demonstrated in research and practice worldwide, and are beginning to be adapted in the United States. Landscape architects are uniquely suited to act as 'aesthetic ambassadors' for this intervention, which can provide a sustainable and affordable model for rural wastewater treatment.

CONTENTS

0 PREAMBLE

The Stakes of Sanitation

Welcome to “Rural Flush,” a proposal for new, post-Holiday Farm Fire wastewater treatment practices for Blue River, Oregon.



The sewer is the conscience of the city

The ***sewer*** *is the* ***conscience*** *of* ***the city***

-Victor Hugo, 'Les Miserables'

In Victor Hugo's 1862 novel Les Miserables, he engages in a long digression which didn't make it into the more famous musical. His subject? The Parisian sewers.

'The sewer is the conscience of the city...each thing bears its true form, or at least, its definitive form...A sewer is a cynic. It tells everything."

This author agrees wholeheartedly with Hugo; adequately managing our wastewater is a critical moral charge in which we should be enthusiastically engaged.

Wastewater treatment contributes immediately to the water cycle in which we all participate. Adequate wastewater treatment is directly related to our own drinking water quality, as well as to the health and stability of some of Oregon’s most beloved assets; our magnificent rivers.

CLEAN WATER ACT

- Enacted 1972
- *Major amendments*
  1977
  1987
  2014
  2018

- Governs the water quality of *"all waters with a continous surface connection to navigable bodies of water"*

- Regulates point-source pollution in the United States

Richard Nixon signing Clean Water Act

Wastewater treatment in the United States is regulated by the 1972 Clean Water Act, and individual states' specific interpretations/enforcement of that Act.


CENTRALIZED
MUNICIPAL
TREATMENT


ONSITE SEWAGE
DISPOSAL -
SEPTIC TANK AND
DRAINFIELD

To meet the clean water standards associated with the Clean Water Act, American sanitation is largely managed by two means. Almost all cities use centralized municipal Wastewater Treatment Plants; residents of rural, unincorporated communities – like Blue River, OR – use On-Site Sewage systems – typically, a septic tank and drainfield.


BLUE RIVER
(CASCADE)
LIBRARY
BLUE RIVER, OREGON
CONSTRUCTED
WETLANDS
FOR WASTEWATER
TREATMENT

Rural Flush proposes an alternative strategy specifically targeted for rural, unincorporated communities; a system mixing both mechanical treatment and constructed treatment wetlands.

This project explores a possible application of that system in Blue River, Oregon – an unincorporated community in eastern Lane County, where the Blue River converges with the McKenzie River – the river from which we in Eugene draw our drinking water. The Holiday Farm Fire essentially destroyed Blue River in 2020, providing both an imperative for an upgraded sanitation system, and an opportunity for innovation.

I'll provide uick overview of conventional wastewater treatment is provided, comparing centralized municipal systems and onsite sewage disposal.

I'll introduce Blue River, a McKenzie river community devastated by the 2020 Holiday Farm Fire. I'll contextualize the local wastewater treatment problems, and the post-fire 'silver lining' opportunity that Blue River has here is to implement more modern and sustainable wastewater treatment practices. I'll also generally discuss my engagement at Blue River and discuss the character and needs of the community in the post-Fire context.

After that, I'll go through some critical design decisions I made based on my research of treatment wetlands. I'll explain and examine common types of treatment wetlands, discuss best practices associated with successful treatment wetlands and lay out the most relevant design conclusions.

I'll introduce my design, which is a mixed proposal, providing primary treatment conventionally, and secondary treatment via constructed treatment wetlands which will double as a public park. This proposal introduces a significant green infrastructure intervention to provide a sustainable and multifunctional solution to Blue River's longstanding wastewater problem.

A final discussion section will briefly evaluate the design on the merits of its stated goals, before considering the realities of using this system as a new model of sustainable wastewater treatment in rural, unincorporated contexts.

1 INTRODUCTION

American Wastewater Treatment: Current Practice, Outcomes and Alternatives

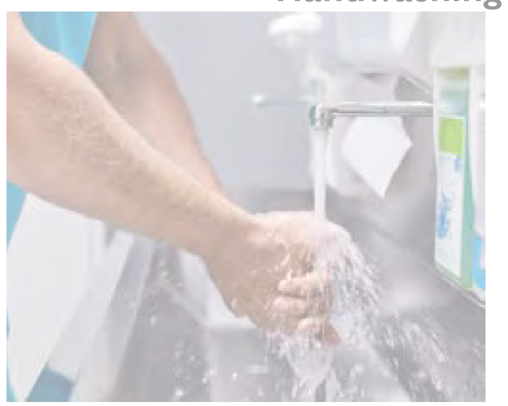
I’d like to quickly define the wastewater being targeted in this project.

CATEGORIZING WASTEWATER

SEWAGE | NON-SEWAGE

GREYWATER

Handwashing



Bathing

Laundry

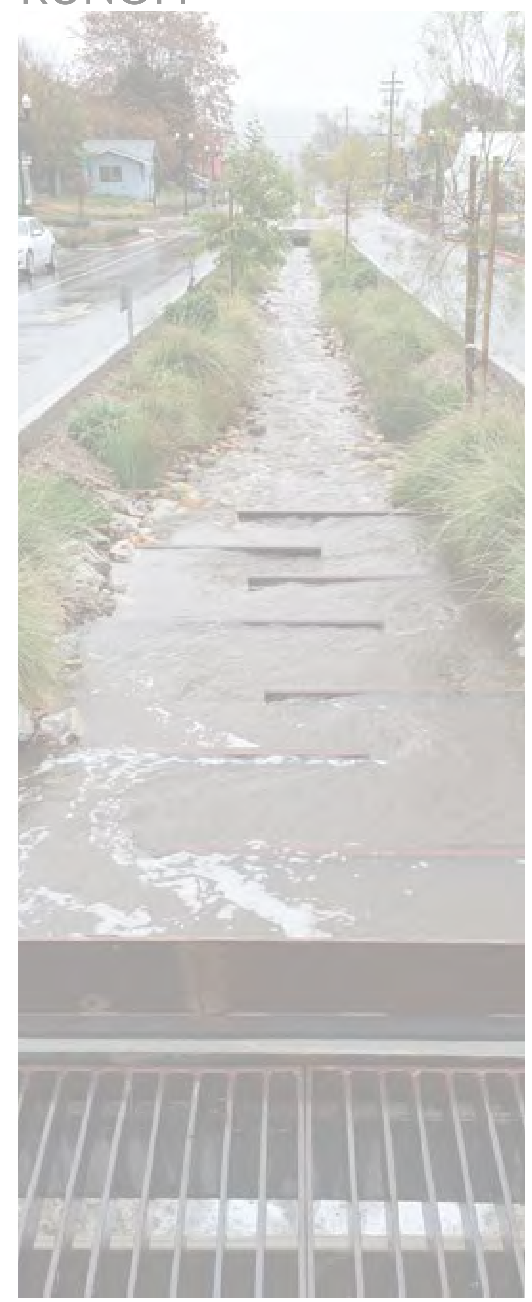
BLACKWATER

Food Waste

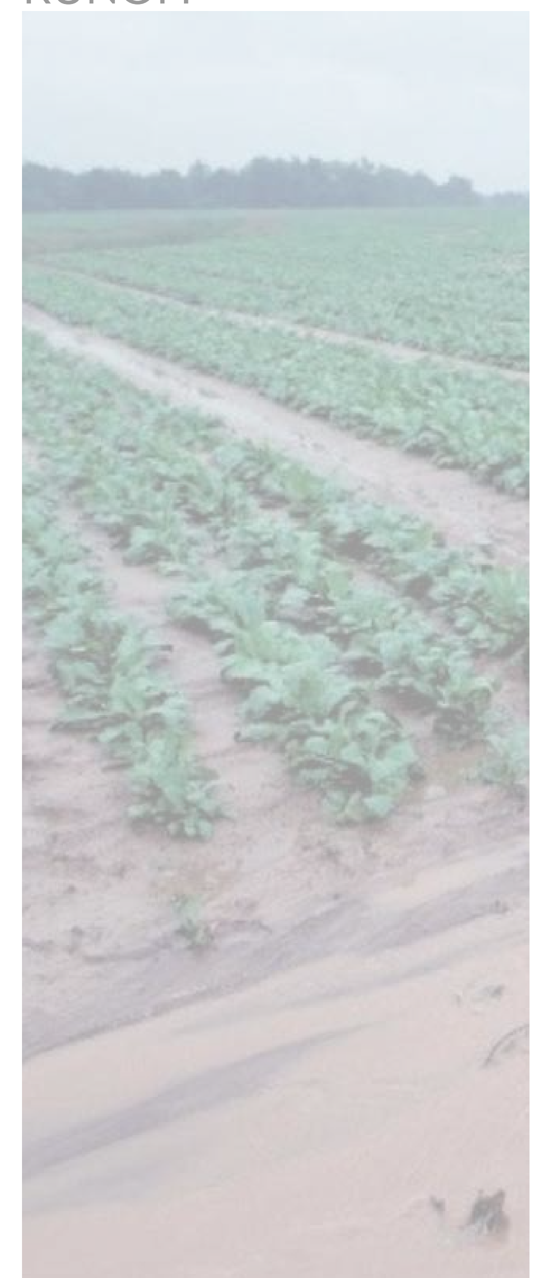
Urine

Feces

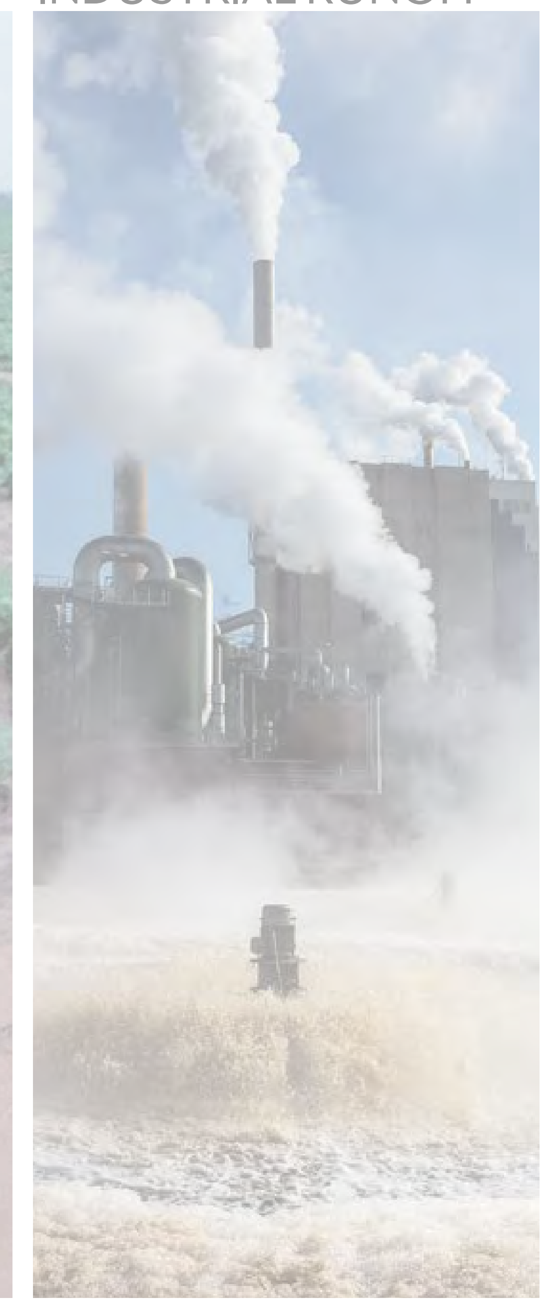
STORMWATER RUNOFF



AGRICULTURAL RUNOFF



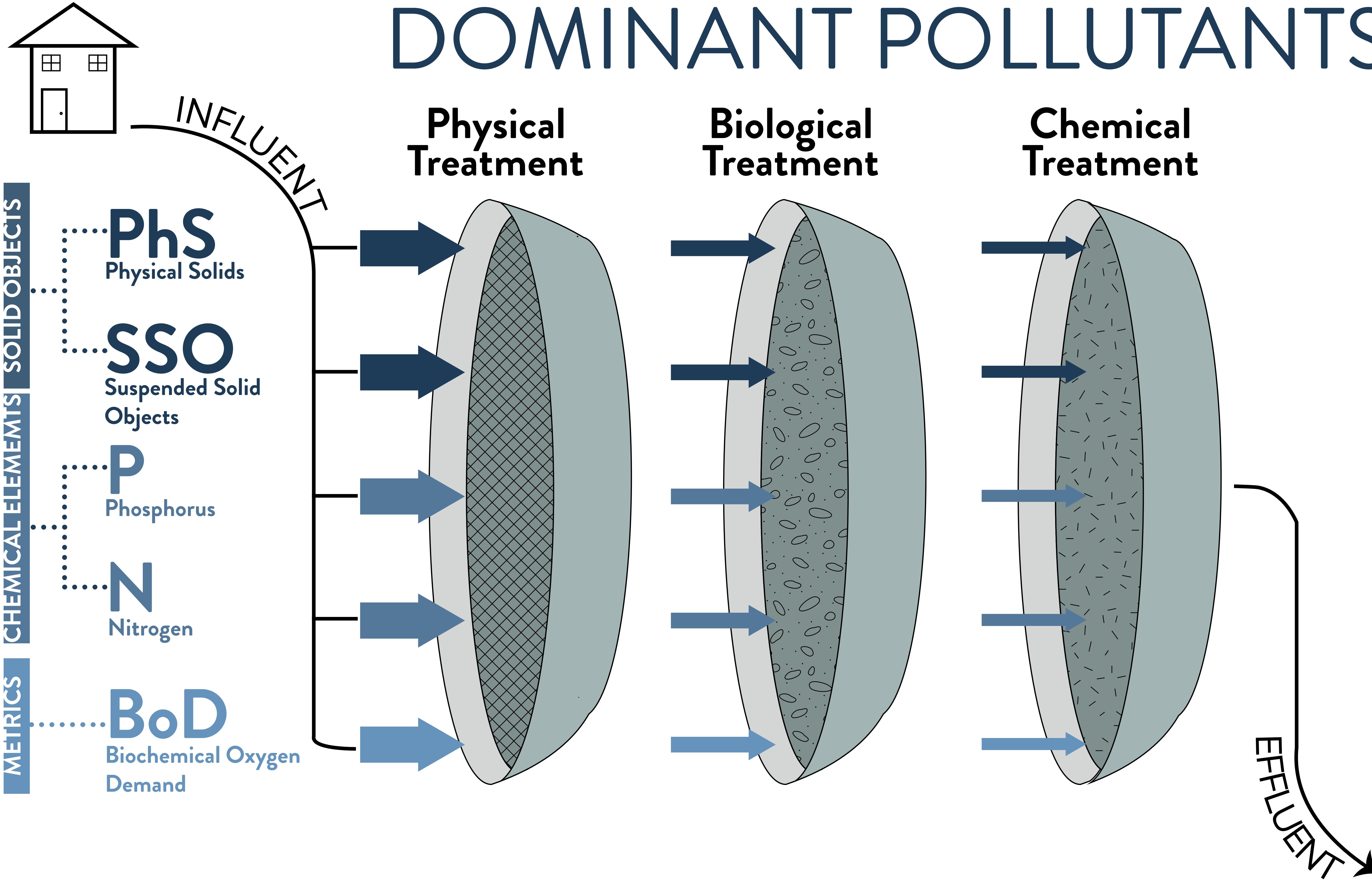
FACTORY & INDUSTRIAL RUNOFF



Wastewater can be first categorized as either sewage - wastewater from domestic dwellings - or non-sewage - which includes stormwater, agricultural and industrial runoff.

This project is concerned with point-source sewage – including greywater, which includes handwashing and bathing water. But we’re really concerned with blackwater, which includes water mixed with raw food waste and our toilet flushes – urine and feces.

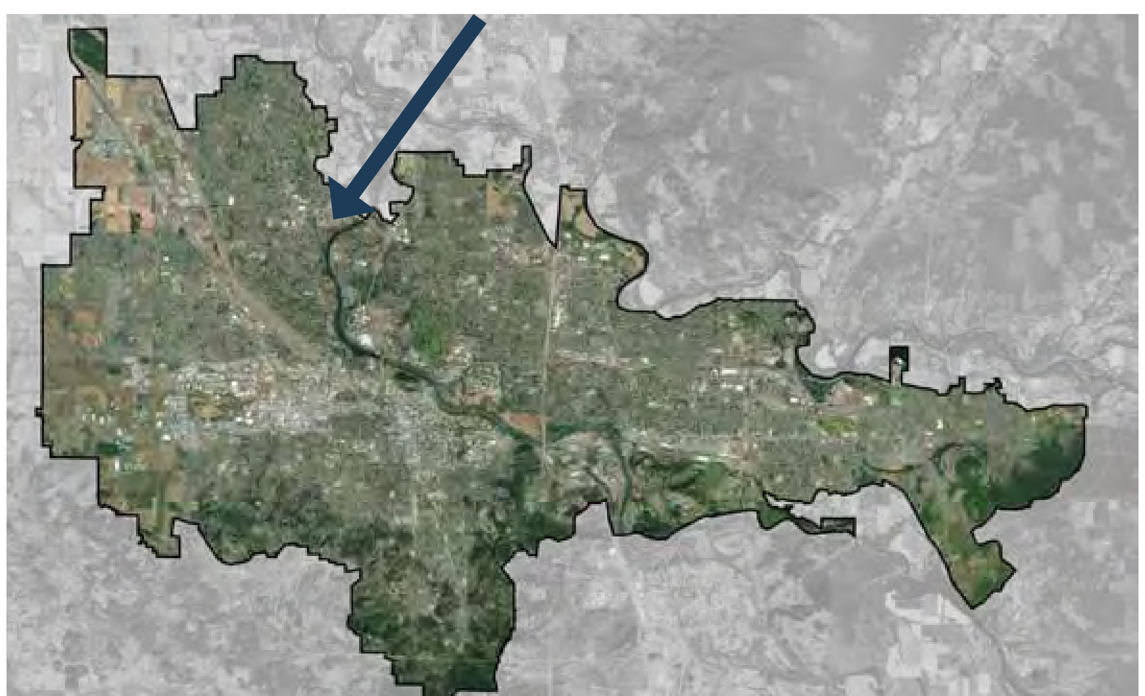
DOMINANT POLLUTANTS



Certain dominant contaminants are found in domestic wastewater, and treatment strategies must address all of them to treat wastewater safely.

In some way or another, wastewater treatment is conventionally achieved by the following fundamental processes; a form of physical treatment, a biological treatment facilitated by various biota, and chemical treatments.

CENTRALIZED TREATMENT



TREATMENT FACILITY **FAST FACTS**

Receives influent from
49 pump stations
across Eugene and Springfield

Typical daily flow load
35 Million Gallons Per Day

Capacity
190 Million Gallons Per Day

Removal
Over 97.5 % of Pollutants

If you live in Eugene or Springfield, your wastewater is likely is treated by the Municipal Wastewater Management Commission (MWMC) treatment facility.

CENTRALIZED TREATMENT

4 - Aeration Ponds
Water is passed into large aeration basins, where it is mechanically oxygenated, promoting the growth of bacteria which absorb some of the remaining organic contaminants.

5 - Secondary Clarifiers
A second set of clarifiers settles the bacteria generated during the aeration process; these same bacteria are returned to the aeration ponds to be reused.

6 - Tertiary screening
Additional fine particulate screening is conducted.

7 - Disinfection
Chlorine is added to the wastewater as a final stage of contaminant removal. The chlorine is then removed from the treated wastewater, which is now called effluent.

3 - Primary Treatment
Large circular clarifiers separate and settle smaller solids. The settled solids are pumped to anaerobic digesters and converted to 'biosolids.'

2 - Preliminary Treatment
Bar screens and grit chambers filter out any large solid objects such as rocks, sticks & gravel.

1 - Influent Pump Station
Pipelines distribute from 49 smaller area pump stations to central MWMC pump station.

8 - Discharge
Effluent is discharged directly into the Willamette River

A many-stepped mechanical process treats 'Influent' from the Eugene and Springfield area. After treatment, the 'effluent' is discharged into the Willamette River. This discharge is permitted because this effluent meets Department of Environmental Quality standards. About 80% of American households treat their domestic wastewater this way – often very successfully in terms of treatment, but with a high footprint facility with a significant carbon footprint both in construction, operation and maintenance.

ON-SITE TREATMENT

In small, unincorporated communities like Blue River, Oregon, residents have utilized onsite wastewater treatment systems, treating the water in their own 'backyard.' This almost always takes the form of a septic tank and drainfield, which also performs a physical, biological and chemical treatment, of a different character.

ON-SITE TREATMENT

1 - Distribution from House
Sewage is piped direcltly from home to on-site septic tank

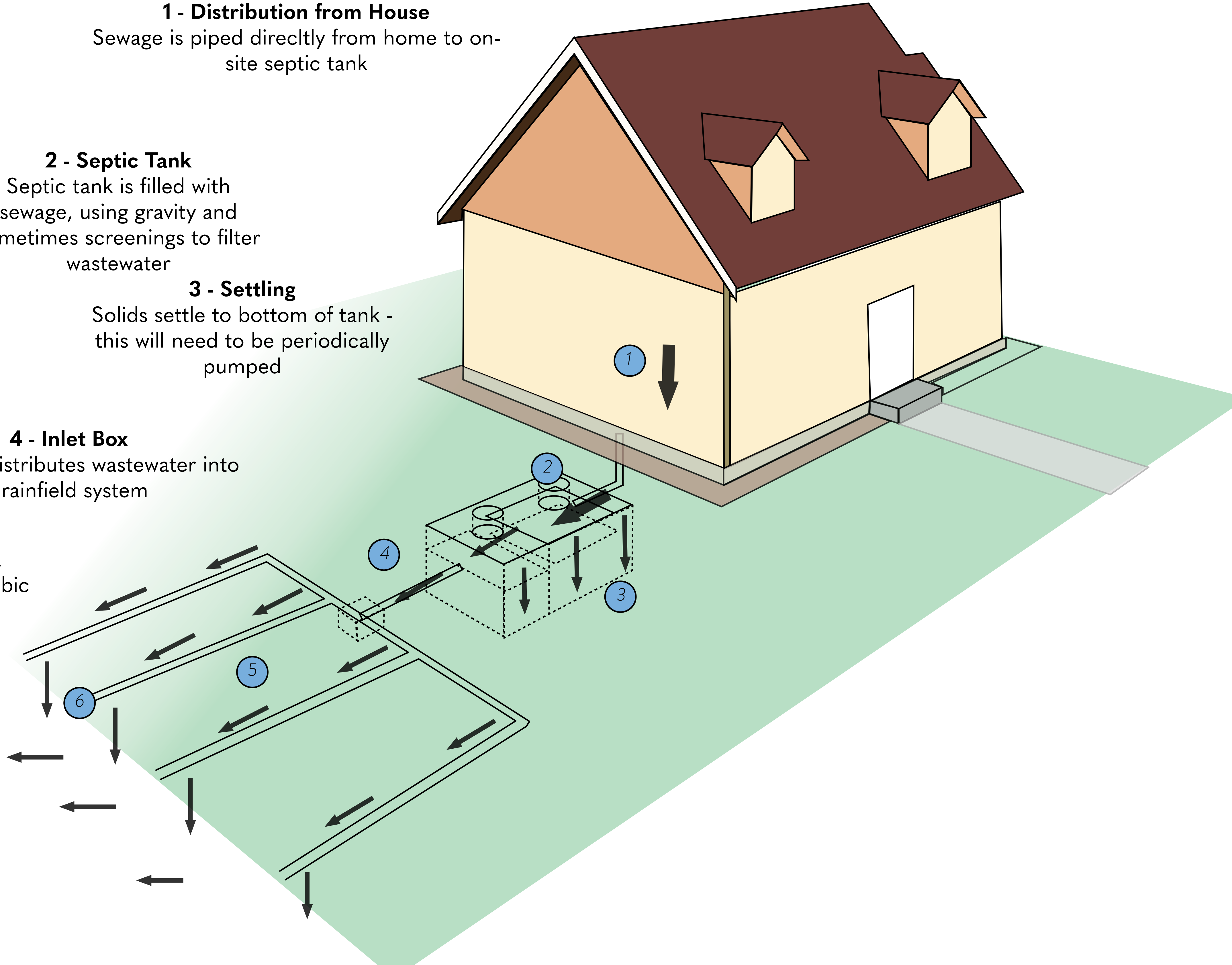
2 - Septic Tank
Septic tank is filled with sewage, using gravity and sometimes screenings to filter wastewater

3 - Settling
Solids settle to bottom of tank - this will need to be periodically pumped

4 - Inlet Box
Inlet box distributes wastewater into drainfield system

5 - Drainfield
Influent passes through gravel bed via perforated pipes for physical and anaerobic filtration

6 - Drain to Groundwater
Ostensibly treated, the effluent can 'safely' pass to aquifer, groundwater, and potentially free water systems



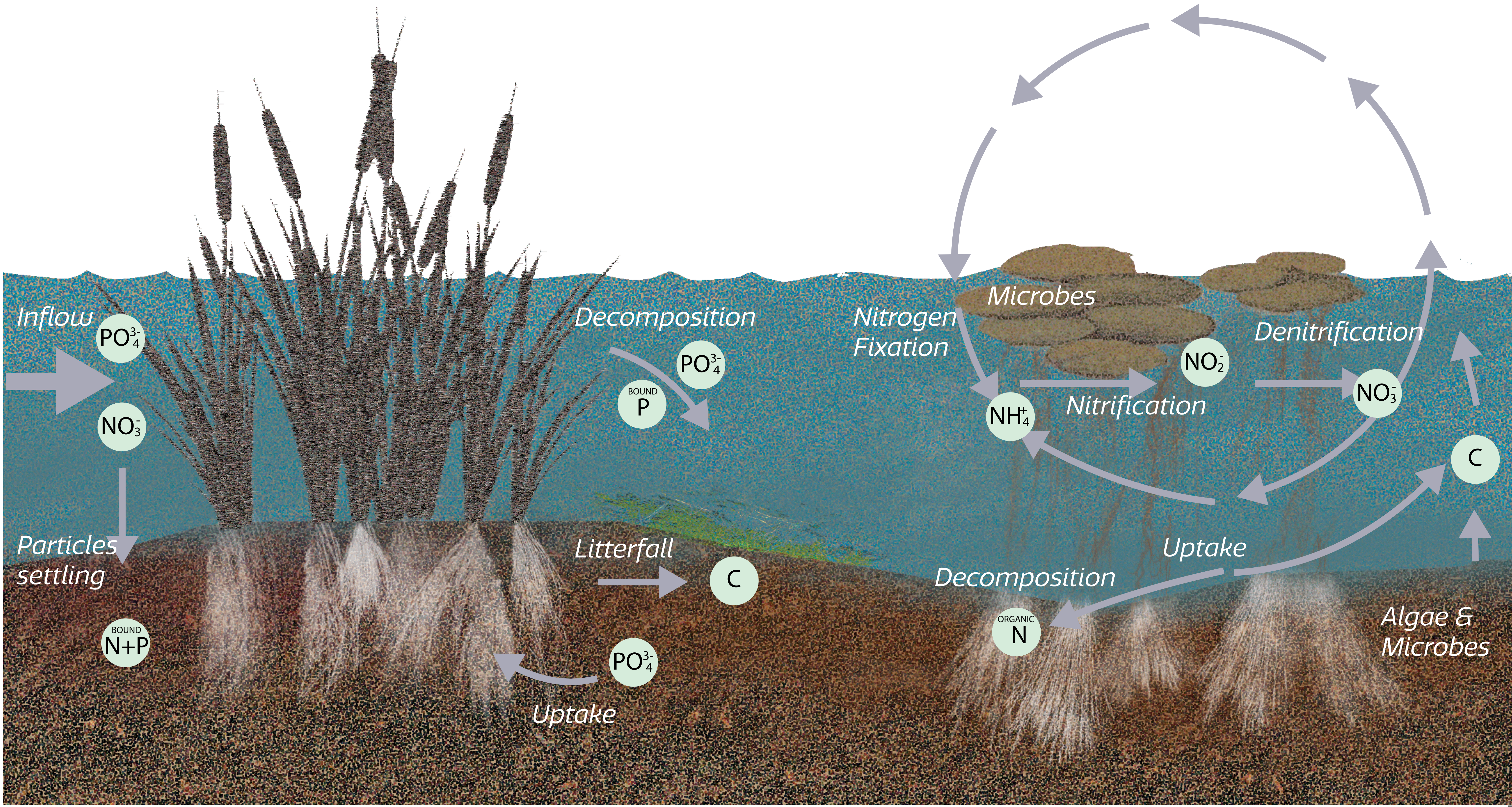
The wastewater is piped from homes to a septic tank, where the physical solids settle to the bottom. The screened wastewater is then piped to a drainfield, where biological and chemical treatment is performed as the influent passes through soil and biota. Ostensibly, the wastewater is adequately treated by the time it reaches the groundwater.

Use of these systems are almost always directly tied to a resident's distance from municipal development. Traditionally, it has been considered prohibitively costly to operate and maintain centralized facilities at the rural, unincorporated scale. It's a large up-front cost to install lengthy pipelines for just one or two homes; and the substantial construction and maintenance costs associated with these centralized facilities would be imposed on a small tax base.

TREATMENT WETLANDS

I am proposing treatment wetlands as an alternate infrastructure option. Treatment wetlands are operationally affordable, they replace grey infrastructure with green infrastructure, and have proven effective at treating wastewater.

TREATMENT PROCESS



As influent passes through the rhizosphere and substrate zones of wetlands, pollutants are naturally filtered or biochemically transformed. These naturally-occurring interactions between living plant matter, detritus, influent, sunlight, and substrate can be harnessed in artificially engineered wetlands to remove wastewater pollutants.

MULTIFUNCTIONAL BENEFITS

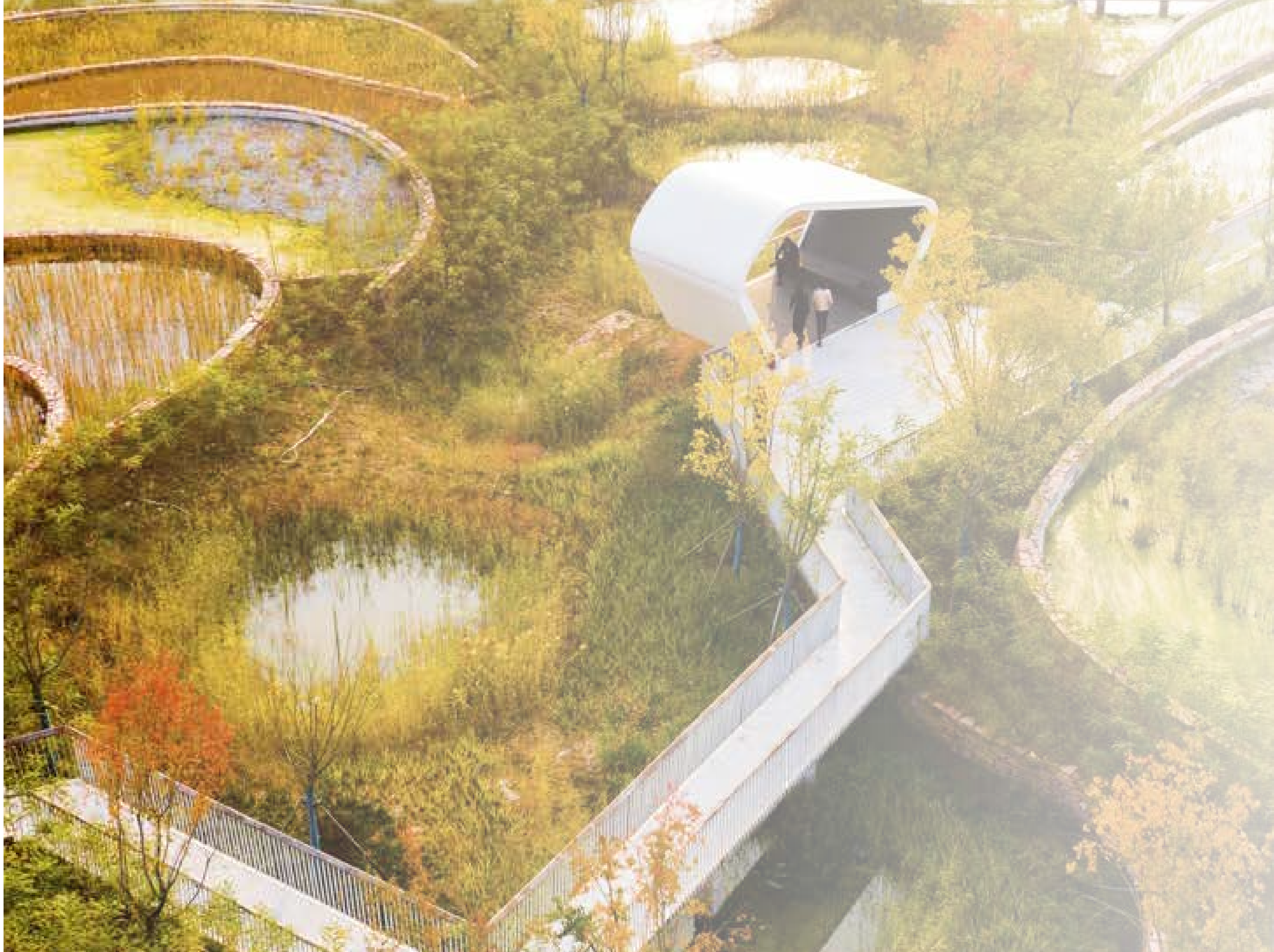
Public Access

Educational Opportunities

Ecological Restoration

Wetlands additionally have the capacity to provide many multifunctional benefits to the communities they serve. And, when executed well by discerning landscape architects, they can be very beautiful.

PRECEDENT



Handan Water Purification Terraces

Location: Handan, Hebei, China

Designer: Turenscape

Wetland Types Hybrid of oxidation ponds, surface flow wetlands, horizontal submerged wetlands and vertical submerged wetlands

Capacity: 1.35 million gallons per day

Multifunctional Benefits
- Restoration of former brownfield site
- Creation of new public and open space
- Experimental site with strong research
- opportunities

This experimental precedent in China (with Turenscape's distinctive style), uses a hybrid mix of different wetland types to provide secondary cleansing of pre-treated wastewater on a series of cascading terraces which double as a beautiful public park.

PRECEDENT

Sidwell Friends Middle School

Location: Washington, DC

Designer: Andropogon Associates

Wetland Types:
Surface Flow
Treatment Wetlands

Capacity: 375,000 gallons per year

Multifunctional Benefits

- Saves sewage and treatment bills by treating all wastewater and 65% of stormwater on site
- Strong education component for students
- Reuse: treated wastewater is used for onsite toilet flushing

A courtyard redesign at Sidwell Friends Middle School transformed a previously bare-lawn court into a treatment wetland which decontaminates and reuses all of the school's wastewater and more than half of its stormwater. This reduces operating costs and provides onsite educational benefits for the students.

PRECEDENT

Crooked River Wetlands Complex

Location: Prineville, OR

Wetland Typology: Hybrid of free water surface and vertical & horizontal subsurface flow

Capacity: 2 million gallons per day

Multifunctional Benefits
- Expands Prineville's treatment by 400%
- Restores natural riparian flow to Crooked River
- Creation of new public and open space

Some recently constructed wetland precedents are closer to home, including Prineville's Crooked River Wetlands Complex, which was finished in 2017 and provides secondary wastewater cleansing while providing acres of critical wetland habitat restoration.

PRECEDENT

Redmond Wetlands Complex

Location: Redmond, OR

Designer: Walker Macy

Wetland Typology Hybrid of oxidation ponds, surface flow wetlands, and horizontal submerged wetlands

Capacity: 4.6 million gallons per day

Multifunctional Benefits
- Meets Immediate Need for Treatment Capacity
- Restoration of Wildlife
- Habitat
- Creation of new public open space

The City of Redmond's need for expanded wastewater treatment capacity has prompted this under-construction project, designed by Walker Macy.

These precedents provide a sampling of the benefits of the most thoughtful and carefully-designed constructed wetlands. Besides treating wastewater successfully, can provide public access to nature; they restore critical habitat; and they can provide opportunities for public education on both wetland ecosystems and sustainable wastewater treatment.

2 SITE: BLUE RIVER, OR

Constructed treatment wetlands are the key intervention of Rural Flush. The site of Rural Flush is Blue River, OR.

BLUE RIVER, OR

Blue River is an unincorporated community in Eastern Lane County which used to have a population of about 850 people and which now has a population of closer to 250.

Blue River shares a name with a river, flowing down from Blue River Reservoir a few miles north; the downtown core is across from Highway 126, between the Blue River and the McKenzie River. The main town circulation route is Blue River Drive, rather than Highway 126. Most of the housing was historically located in the downtown core and along Blue River Drive. On the western side of the community is the McKenzie Community School, a K-12 for residents of Blue River and other McKenzie Valley communities. Blue River is also home to the McKenzie Valley Track. Finally, the community has recently had the Three Sisters Meadow, formerly the site of a lumber mill, made available to them.

BLUE RIVER, OR

1895
Samuel Sparks & family
settle land
just east of Blue River

1902
Sparks Family lays out
Blue River downtown core

1924
Blue River
Mining District Closes

1975
Blue River
Library Built
(not founded!)

2020
Holiday Farm Fire

FUTURE
Innovative
Wastewater
Treatment?

Like many communities in the McKenzie River Valley, Blue River's development as a population center was intimately tied with mining and logging practices. After a robust but somewhat short-lived mining rush, much of Blue River's 20th century identity was defined by the timber industry; and many of the residents are still part of multi-generational logging families.

Blue River's most robust economic days may be behind it – this is no longer an affluent population. Blue River is nevertheless a valuable, distinctive and resilient community whose residents have taken care to enshrine and steward their legacy.

'Blue River is pretty much a total loss'

- Oregon Register-Guard, September 12, 2020

That resilience has proven incredibly valuable since 2020, when Blue River was largely destroyed by the 2020 Holiday Farm Fire.

‘Destroyed’ is not an overstatement. This was the single hardest-hit community in the Holiday Farm Fire. Residents that I’ve spoken to up there have told me truly harrowing stories – they used the school and the track as their protected zones. Residents huddled in the middle of the track while the fire raged around them. The destruction was sudden and near-total.

The only silver lining to a tragedy like the Holiday Farm Fire is the opportunity to improve the community in rebuilding it. Indeed, Blue River, along with Lane County Special Projects and a number of consultants, is taking the opportunity (and some emergency funding) to implement a long-desired upgrade to Blue River’s sanitation – which was, prior to the fire, achieved with backyard septic tanks and drainfields.

BLUE RIVER WASTEWATER

2012
Dyer Engineering conducts wastewater facilities assessment and provides facility upgrades; finds 20% of septic systems to be failing.

20% FAILING SEPTIC SYSTEMS

2015-16
Hatfield Fellows and RCAC produces Blue River Downtown Redevelopment and Wastewater Roadmap

2020
Holiday Farm Fire

95% TOWN DESTROYED

2021
Oregon State Legislation Approves Emergency Funding for Wildfire-Impacted Communities

October 2022
Oregon Department of Land Conservation and Development produces Future Buildout Scenario for Blue River Rural Community

December 2022
Three Sisters Property Donated to McKenzie Community Land Trust

16 ACRE PARCEL DONATED

April 2023
Lane County conducts draft zoning and community drainfield feasibility study for community feedback

January 2024
HDR Engineering and Lane County produce final Community Feasibility Study - which includes the very solution being implemented at Blue River this summer

Many of the community's septic systems are failing or would no longer meet permitting standards. The price of replacing an onsite wastewater system is borne by the resident, and the upfront cost is significant. But beyond that, septic systems and drainfields, no matter how sophisticated, may be illegal, as they pollute groundwater, and potentially the McKenzie River.

MCKENZIE RIVER

NATIONALLY
FAMOUS
SPORT FISHING

The risks of a polluted McKenzie are especially acute for Blue River. After the decline of logging, much of the vitality of this and other unincorporated communities along the McKenzie River is dependent on the health of McKenzie River, nationally renowned as a sport-fishing destination.

Additionally, the McKenzie River is the source of Eugene and Springfield's drinking water.

MCKENZIE RIVER - PROTECTIONS

OAR 340-041-0350

The Three Basin Rule: Clackamas, McKenzie (above RM 15) & the North Santiam

(1) In order to preserve or improve the existing high quality water for municipal water supplies, recreation, and preservation of aquatic life, new or increased waste discharges must be prohibited, except as provided by this rule, to the waters of:

- **(a)** The Clackamas River Subbasin;
- **(b)** The McKenzie River Subbasin above the Hayden Bridge (river mile 15);
- **(c)** The North Santiam River Subbasin.

0

EFFLUENT DISCHARGE PERMITTED

The McKenzie River's value is legally codified by the Three Basin Rule, which explicitly prohibits point-source pollution of any kind into certain tributaries of the Willamette River. This upper stretch of the McKenzie River is among these tributaries. This prevents any sort of centralized effluent discharge into the McKenzie, and it provides for stringent regulation of onsite sewage systems.

Blue River is attempting to upgrade its sanitation within this complex legal framework. But just two years after the fire, another major inflection occurred which provides a potential solution for another significant wastewater treatment problem - that of space.

In 2022, the McKenzie Community Land Trust was the donor recipient of a 16 acre parcel of land called the Three Sisters Meadow.

THREE SISTERS PARCEL

Jones Sisters: Kathy, Becky & Jody

The meadow is named not for the nearby Cascades, but for the Three Jones Sisters, whose family established and owned the local Seneca sawmill that used to be on this site. They have a respected legacy as community stewards in Blue River and that legacy was permanently cemented when, as they were selling to Sierra Pacific, they donated this 16-acre parcel to the McKenzie Community Land Trust – explicitly placing the land in the hands of Blue River's residents. This is a remarkable opportunity for this rebuilding community.

CURRENT CONDITIONS

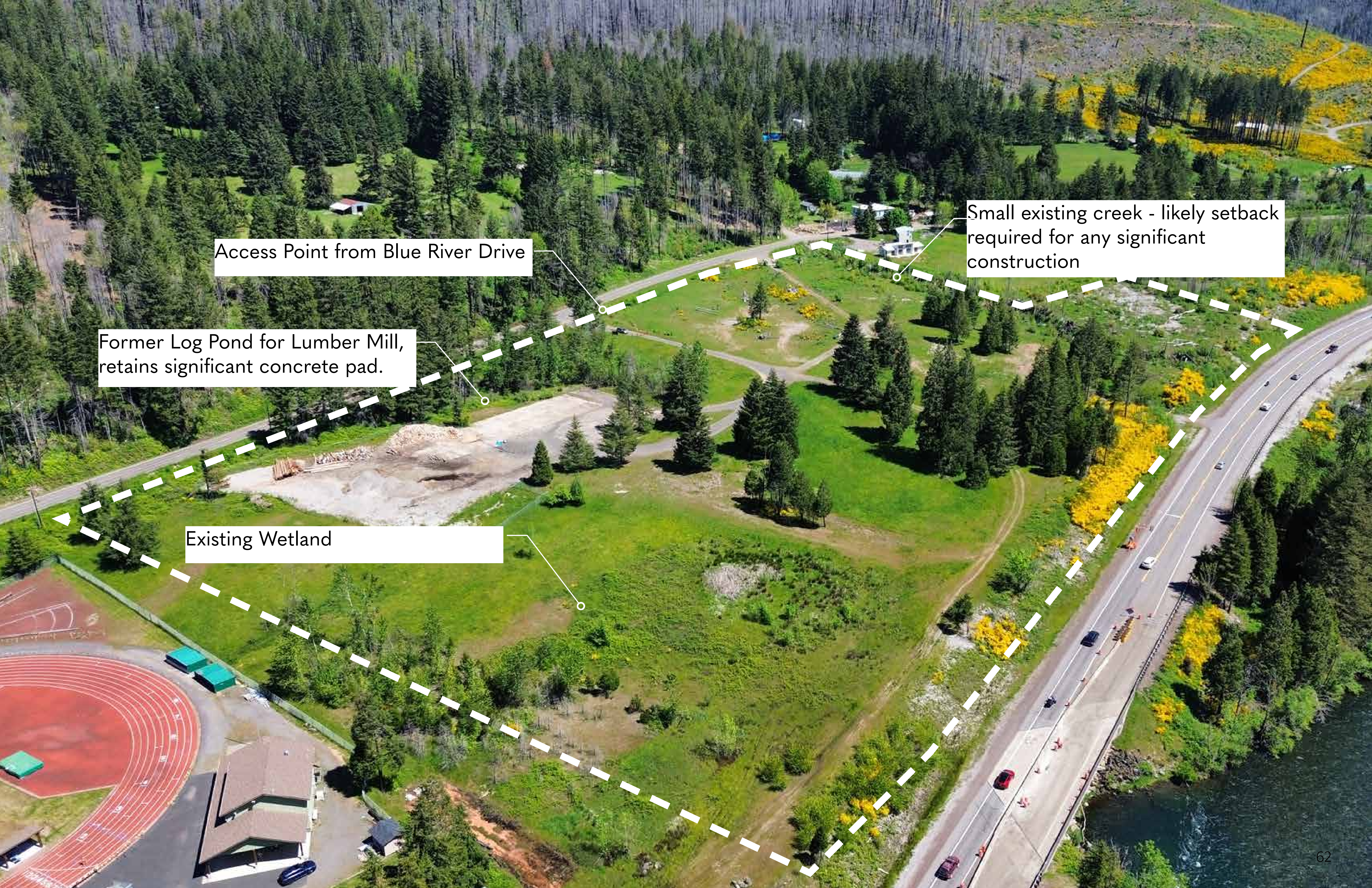
1 Former Log Pond for Lumber Mill, retains significant concrete pad.

2 Existing Wetland

3 Small existing creek - 100' setback on either side

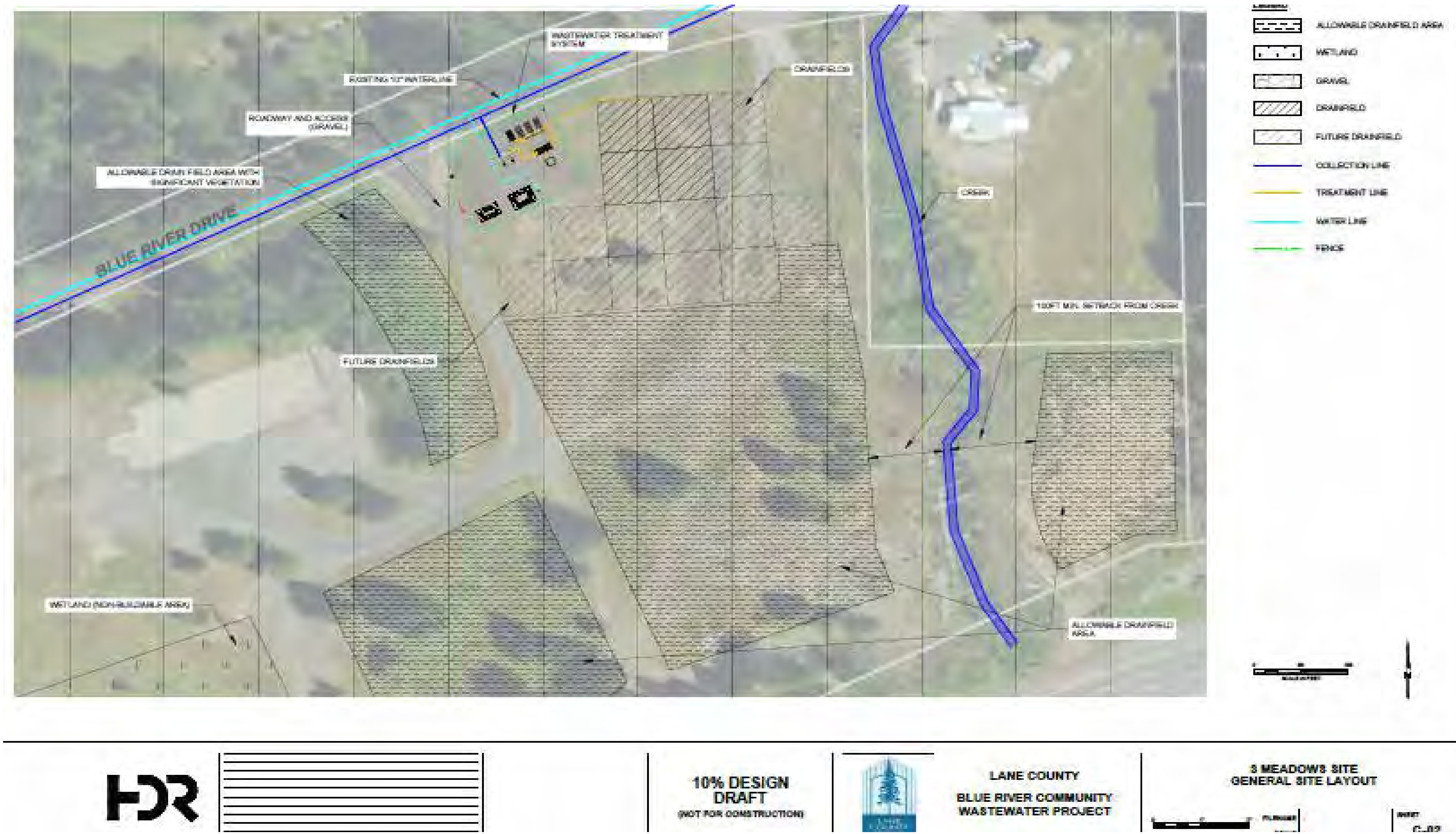
4 Access Point from Blue River Drive

There is access to the site from Blue River Drive, and an informal path a little east of Blue River drive. It's a gently sloping meadow with a small creek running N-S through the site along part of its eastern boundary, which would require a 100' setback on both sides. There's also an existing wetland zone along the southwest corner of the site.


Access Point from Blue River Drive
Small existing creek - likely setback required for any significant construction
Former Log Pond for Lumber Mill, retains significant concrete pad.
Existing Wetland

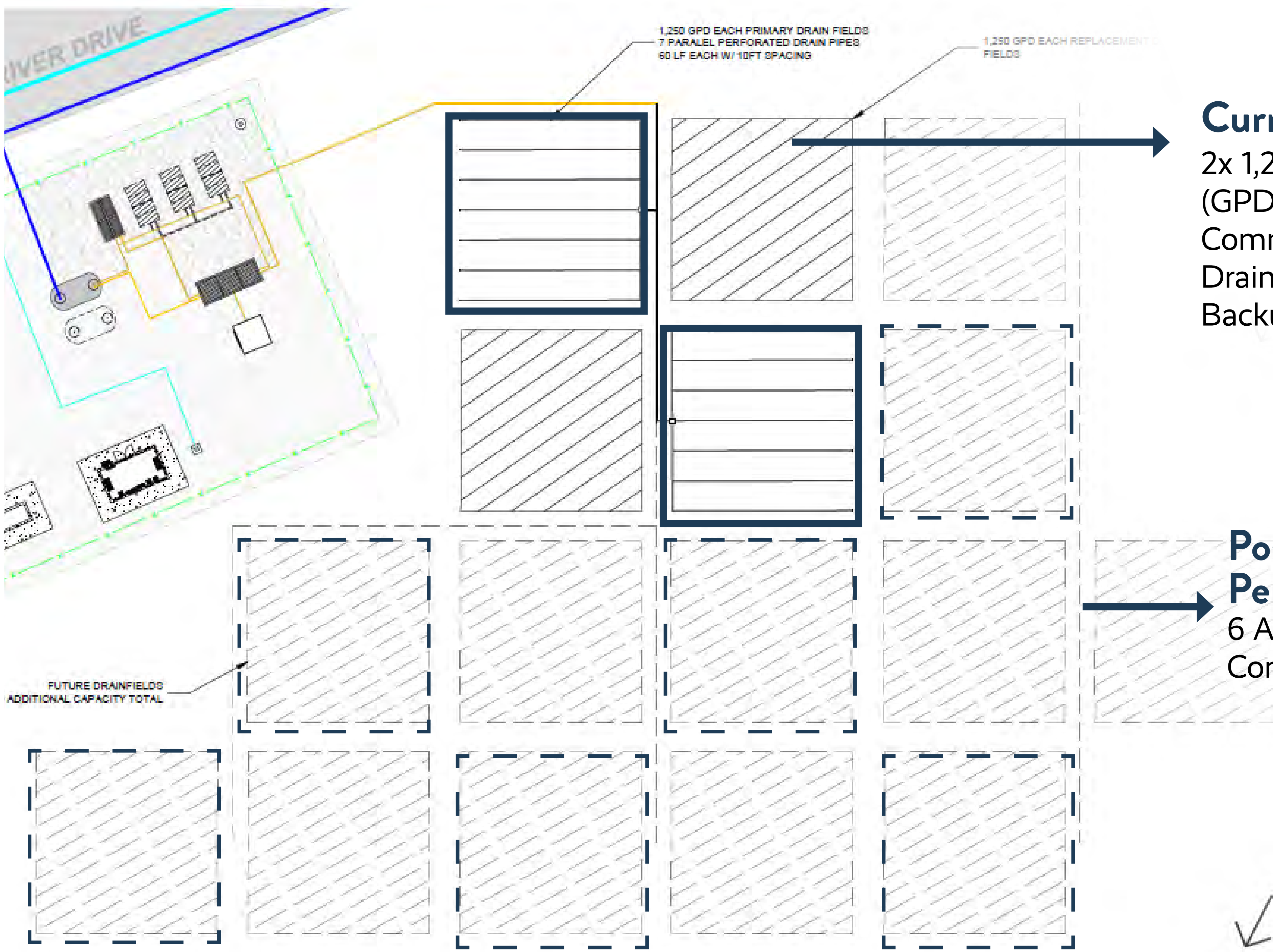
These elements are seen a little more clearly in this photograph.

PLANNED SOLUTION



Blue River, Lane County, and various consulting partners have been researching modernizations to Blue River's wastewater treatment for over 10 years. In February 2024, at a meeting I attended, Lane Special Projects unveiled their solution – a community drainfield located on the Three Sisters Meadow.

COMMUNITY DRAINFIELDS



Currently Permitted
2x 1,250 Gallon Per Day (GPD) Community Drainfield + 2 Backup Drainfields

Service Capacity: 8 Homes

Possible Future Permitting
6 Additional 1,250 GPD Community Drainfields

Service Capacity: Additional 24 Homes

They're currently introducing two drainfield plots each capable of treating 2,500 gallons, or the wastewater or 8 homes, per day. As permitting becomes available, they'd like to install more of these plots to support growth.

Even under optimistic permitting circumstances, this approach would only have capacity to service 1/3 of the Blue River homes. Just as seriously, this concentrated groundwater release has a strong chance to pollute the McKenzie River.

ALTERNATIVE

~~THREE SISTERS MEADOW?~~

THREE SISTERS DRAINFIELD?

THREE SISTERS WETLANDS

I have a different idea for the Three Sisters Meadow – to introduce a community-scale treatment wetlands system in association with a high-volume conventional treatment.

3 METHODS - COMMUNITY

Designing for Blue River's Character and Sanitation Needs

A considerable concern, apart from successful wastewater treatment, was ensuring that this project fit into the character and scope of this community in active transition.

ENGAGEMENT

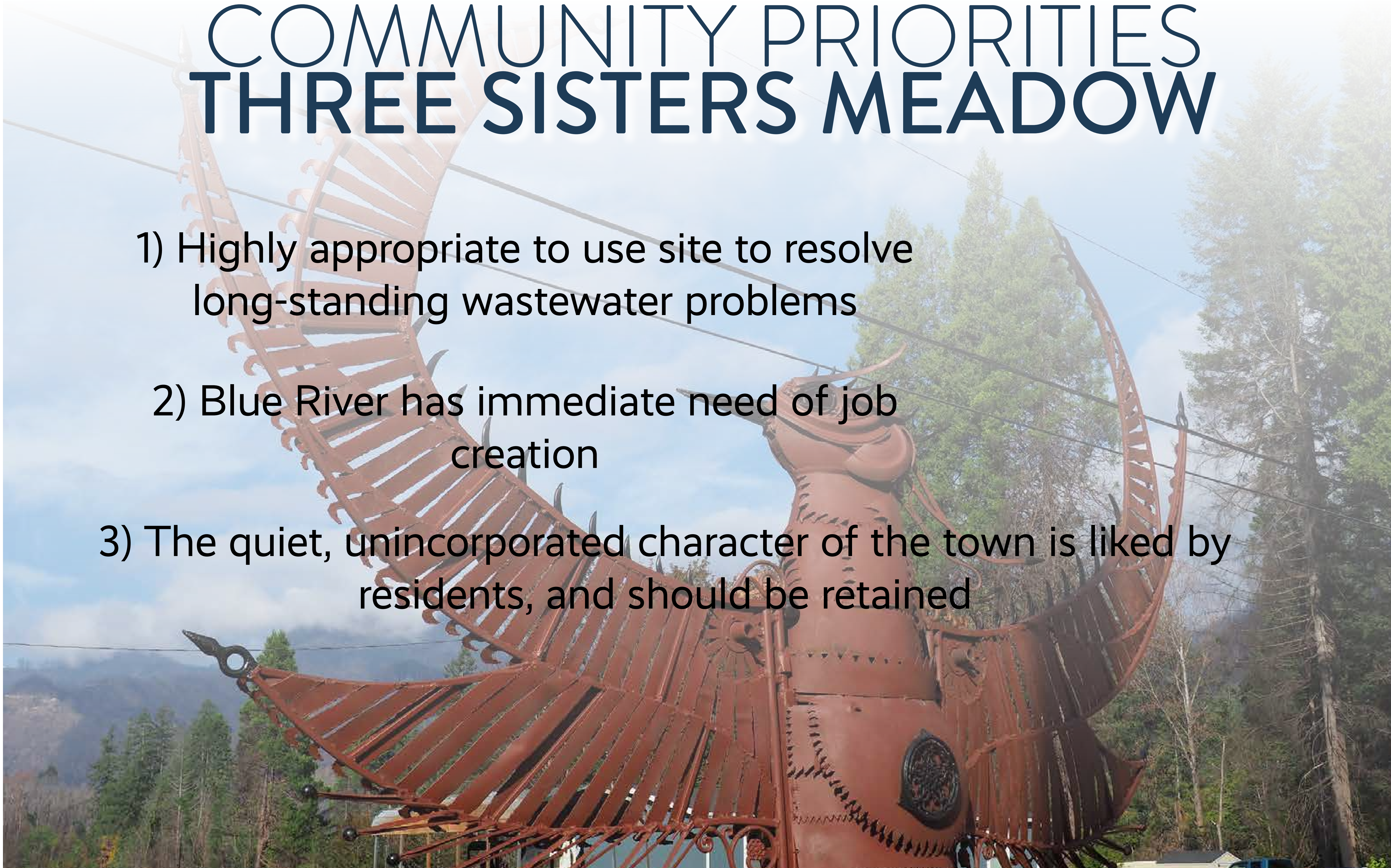
'Viribus' sculpture, constructed by Jud Turner, from reclaimed scrap metal after Holiday Farm Fire

'Viribus is testament to the strength and resilience of the residents of the McKenzie River area'

-From the Artist

I visited Blue River several times and was able to speak to a number of residents, and some of the consultants, about community wastewater treatment, Blue River's history and future, and opportunities for Three Sisters. I was also able to attend one of the community engagement sessions conducted by Lane County and TBG Architects and Planners.

That session had specifically to do with desired uses for the Three Sisters Meadow; what it amounted to was a discussion of what the remaining Blue River residents want their town to look like in the future.



COMMUNITY PRIORITIES
THREE SISTERS MEADOW

1) Highly appropriate to use site to resolve long-standing wastewater problems

2) Blue River has immediate need of job creation

3) The quiet, unincorporated character of the town is liked by residents, and should be retained

I summarize my conclusions from my engagement as follows.

1) The state of community wastewater treatment was a serious problem before the Fire. It is highly appropriate to use both the state grants and the actual Three Sisters site to address this critical infrastructure issue.

2) Blue River, which hasn't fully recovered from the declines of the key industries which made the town a population center, needs jobs to grow. It would be fantastic if the future of Three Sisters could include the possibility of some job creation.

3) The people of Blue River want it to improve without losing its unincorporated character or becoming a tourist trap. Residents of Blue River are there because they like it. Suggestions of any significant level of private development were met with significant trepidation.

ESTIMATING FLOW RATE

SEWAGE FLOW RATE ESTIMATING GUIDE

(Range and Typical are shown in gallons per unit)

Estimates are based on US standards for water usage
sewage strength.

Typical Wastewater Flow Rates from Commercial Sources

Source	Unit	Range	Typ
Airport	Passenger	2-4	
Auto Service Station	Vehicle Served	7-13	
	Employee	9-15	
Bar	Customer	1-5	
	Employee	10-16	
Department Store	Toilet Room	400-600	
	Employee	7-13	
Industrial Building	Employee	7-16	
(Sanitary Waste Only)			
Laundry (Self-Serve)	Machine	450-650	
	Wash	45-55	
Office	Employee	7-16	
Restaurant	Meal	2-4	
Shopping Center	Employee	7-13	
	Parking Space	1-2	

Typical Wastewater Flow Rates from Residential Sources

Source	Unit	Range	Typ
Apartment, High-Rise	Person	35-75	
Low Rise	Person	50-80	
Hotel	Guest	30-55	
Individual Residence			
Typical Home	Person	45-90	
Better Home	Person	60-100	
Luxury Home	Person	75-150	
Older Home	Person	30-60	
Summer Cottage	Person	25-50	
Motel			
with Kitchen	Unit	90-180	
without kitchen	Unit	75-150	
Mobile Home Park	Person	30-50	

Wastewater Flow Estimation Guidelines for Sewer Capacity Certification Requests

Gwinnett County Department of Water Resources

Land Use Category and Facility Type		Annual Average Daily Unit Flow (gpd)	Per Unit	Additional categories t may be required
(Column A)		(Column B)	(Column C)	(Column D)
Commercial Developments (continued)				
Self-storage units		25	per employee (all sh	
Sports/ Fitness Centers	*Bowling*	125	per lane	
		25	per employee	
	Fitness Center	500	per 1000 sq ft	
	Tennis, Soccer, Basketball Facility	10	per person, max ca	
	Gymnasium	500	per 1000 sq ft	
	Skating Rink	5	per person, max ca	
Theater	*Movie*	5	per seat	
	Drive-in	25	per bay	
Vehicle Service/Repair		50	per 1000 sq ft	
		25	per employee	
Warehouse		25	per 1000 sq ft	
		25	per employee (all sh	
Institutional Developments/Community Facilities				
Auditorium/Arena/Concert Hall/Convention Center		10	per person, max ca	
Community Assembly/Banquet Hall		10	per person, max ca	
Educational Facilities	*K-12 school*	20	per student	
		25	per teacher/employ	
	Boarding School/Dormitory	70	per student, residen employee	
	Tutoring Center	100	per 1000 sq ft	
	Day Camp/Daycare Center	20	per student	
		25	per teacher/employ	
	University/College/ Technical School	20	per student	
		25	per employee	
	Laboratory	*	per laboratory class	
Library		100	1000 sq ft	
		25	per employee (all sh	
Museum/Art Center/Visitor Center		2	per patron, max cap	
Pool/Aquatic Center		5	per swimmer, max c	
		25	per employee	
Park/Fairground/Outdoor Assembly		15	per total parking sp	
Sports/Fitness Centers	*Bowling*	125	per lane	
		25	per employee	
	Fitness Center	500	per 1000 sq ft	
	Tennis, Soccer, Basketball Facility	10	per person, max ca	
	Gymnasium	500	per 1000 sq ft	
	Skating Rink	5	per person, max ca	
Transportation Terminal (Airport, bus, train)		5	per passenger	
		25	per employee	
Worship Center		10	per seat, max capac	
Emergency Services	*Fire Station*	70	per firefighter per sh	
	Police Station	25	per employee (all sh	
	Shelters	70	per resident, max ca	
Detention Center		120	per inmate, max cap	
		25	per employee (all sh	

Table I - Flow Projection Based Upon Gallons Per Person Per Day

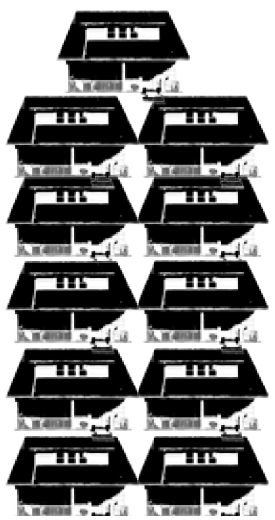
Airports (per passenger)	5
Apartments-multiple family (per resident)	60
Bathhouses and swimming pools	10
Camps:	
Campground with central comfort stations	35
With flush toilets, no showers	25
Day camps (no meals served)	15
Resort camps (night and day) with limited plumbing	50
Luxury camps	100
Cottages and small dwellings with seasonal occupancy	50
Country clubs (per resident member)	100
Country clubs (per non-resident member present)	25
Dwellings:	
Boarding houses	50
additional for non-resident boarders	10
Luxury residences and estates	150
Multiple family dwellings (apartments)	60
Rooming houses	40
Single family dwellings	75-100
Factories (gallons per person, per shift, exclusive of industrial wastes)	35
Hospitals (per bed space)	350
Hotels with private baths (2 persons per room)	60
Hotels without private baths	50
Institutions other than hospitals (per bed space)	125
Laundries, self-service (gallons per wash, i.e., per customer)	50
Mobile home parks (per space)	250
Motels with bath, toilet and kitchen wastes (per bed space)	50
Motels (per bed space)	40
Picnic Parks (toilet wastes only) (per picnicker)	5
Picnic Parks with bathhouses, showers and flush toilets	10
Restaurants (per seat)	25
Restaurants (toilet and kitchen wastes per patron)	10
Restaurants (kitchen wastes per meal served)	3
Restaurants, additional for bars and cocktail lounges	2
Schools:	
Boarding	100
Day, without gyms, cafeterias or showers	15
Day, with gyms, cafeterias and showers	25
Day, with cafeterias, but without gyms or showers	20
Service Stations (per vehicle served)	10

The other chief community concern is designing a facility large enough to meet the needs of a community.

Using wastewater flow estimates derived from multiple best-practice guidelines, I estimated possible Blue River flow demand for multiple growth scenarios.

FLOW RATE - SCENARIOS

SCENARIO 1 - NO CHANGE



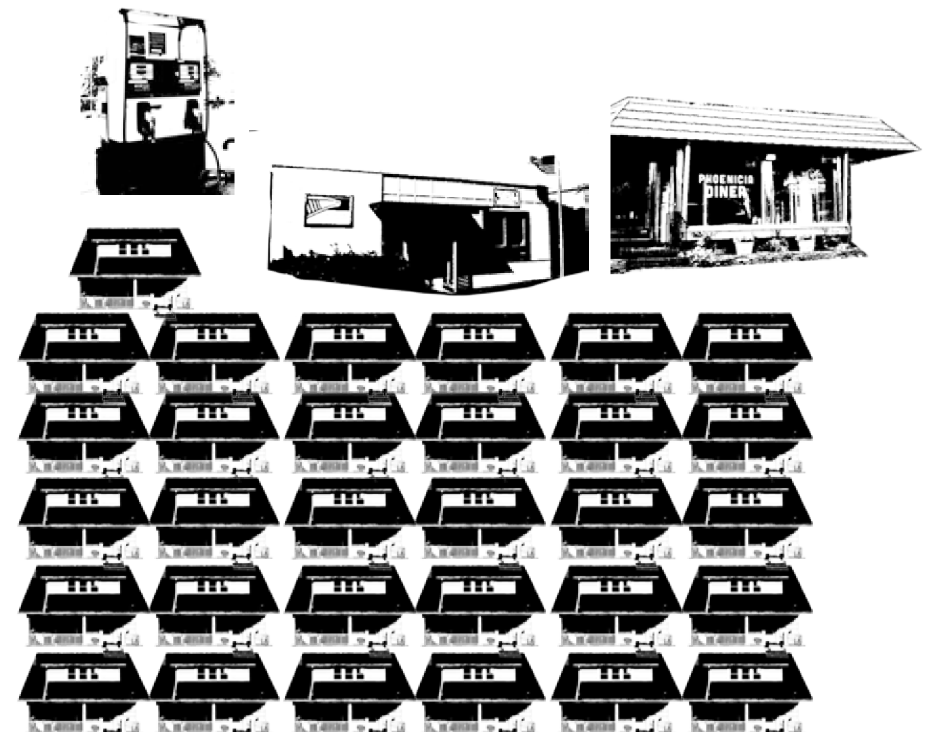
- 110 Households *(# currently connected to water supply)*

28,000 GPD

.09 ACRE-FEET PER DAY

1.26 ACRES

SCENARIO 3 - SIGNIFICANT EXPANSION



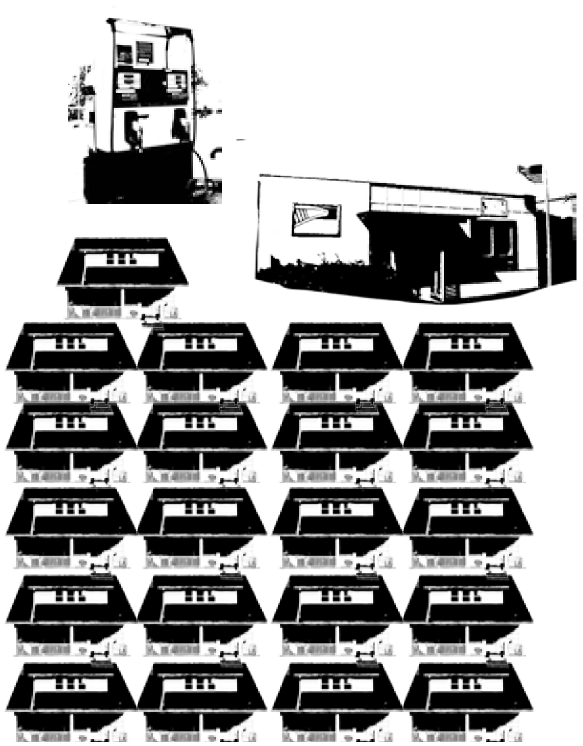
- 300 Single-Family House
- 2-pump gas station
- Post Office
- Restaurant

85,805 GPD

.26 ACRE-FEET PER DAY

3.64 ACRES

SCENARIO 2 - MODEST EXPANSION



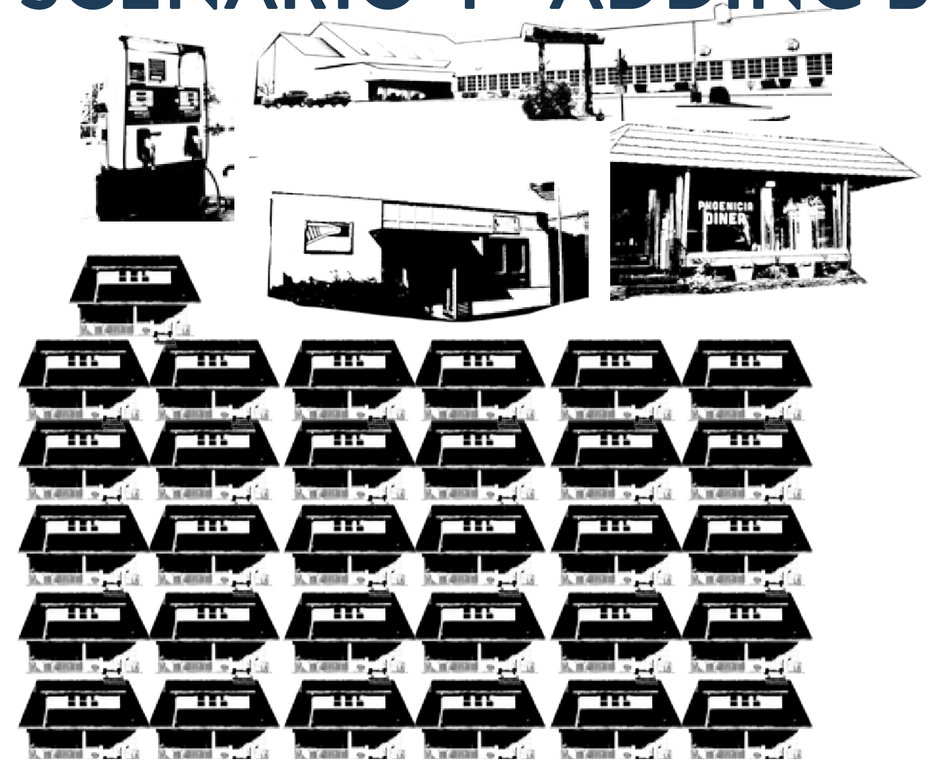
- 200 homes *(aproximate # connected pre-Fire)*
- 2-pump gas station
- Post office

57,600 GPD

.17 ACRE-FEET PER DAY

2.10 ACRES

SCENARIO 4 - ADDING BUSINESSES



- 300 Single Family Houses
- 2-pump gas station
- Post Office
- Urgent Care Center
- Restaurant
- McKenzie River School

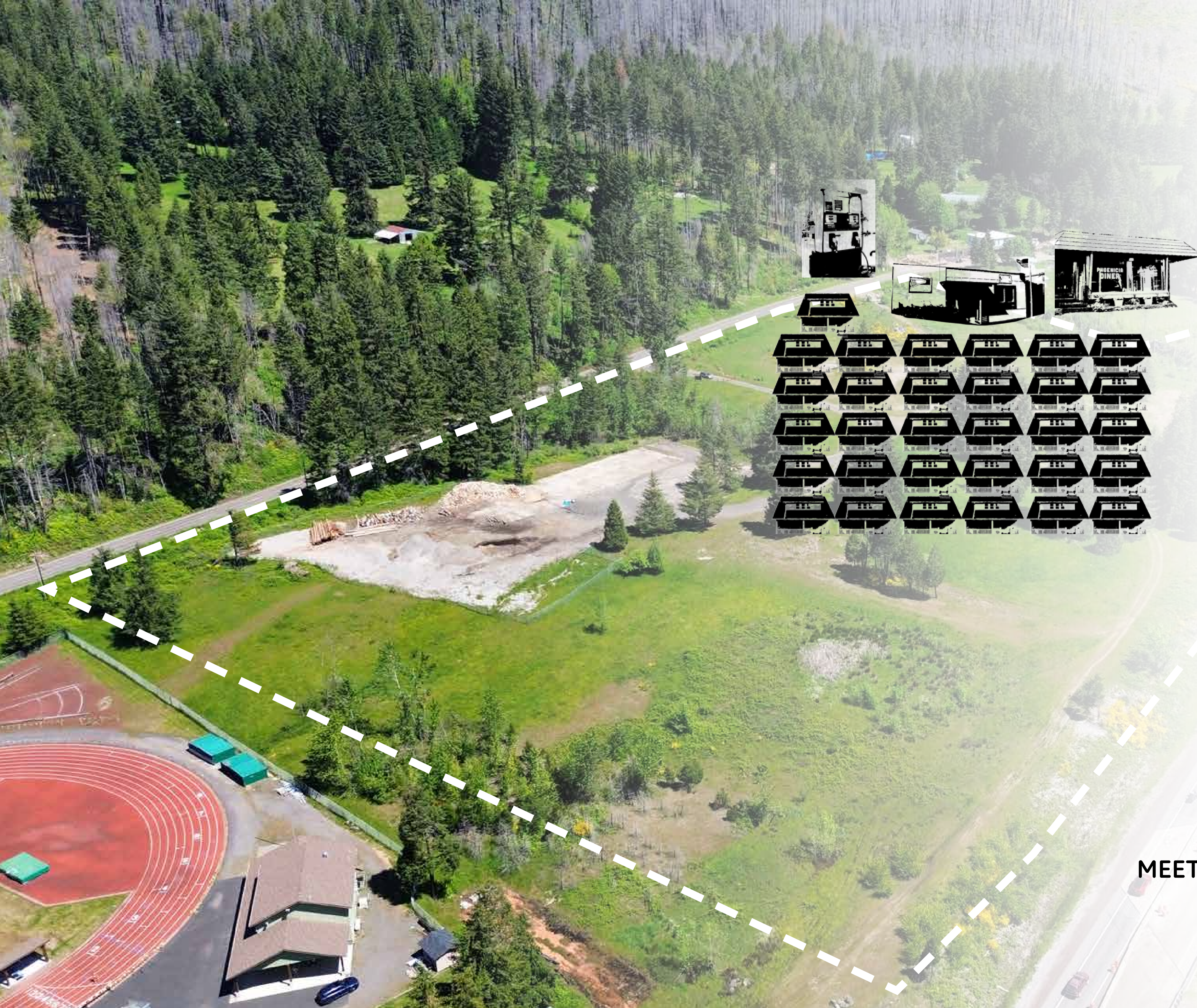
108,097 GPD

.32 ACRE-FEET PER DAY

4.62 ACRES

To give Blue River some flexibility in its growth prospects over coming years, I planned for a more ambitious growth scenarios – settling on Scenario 3, with extensive housing growth, and a post office, a restaurant and a gas station (these are among the businesses lost in the fire).

I calculated, from these development scenarios, a Gallons Per Day estimate. As these wetlands will typically require 1' of water depth, Gallons Per Day can be expressed as taking up 'Acre-Feet' Per Day. Estimating for a detention time of 14 days, to ensure treatment efficacy, I concluded that Scenario 3 would require at least 3.64 acres of active wetland treatment space.



- 300 Single-Family House
- 2-pump gas station
- Post Office
- Restaurant

85,805
GPD

.26
ACRE-FEET
PER DAY

3.64
ACRES

16 ACRE PARCEL

‘ROYAL FLUSH’ RESERVES 4.27 ACRES FOR WASTEWATER TREATMENT

TREATMENT CAPACITY OF 104,065 GALLONS PER DAY

MEETS SCENARIO 3 DEMAND OF 85,805 GPD WITH 40% REDUNDANCY

Under that scenario, I calculated that Blue River could produce a little over 85,000 gallons of wastewater a day – and happily, there is more than enough space at the Three Sisters Meadow to treat that wastewater with a detention period of 14 days.

Despite Blue River's somewhat uncertain growth possibilities, I decided that it was important to plan for as much as the site could accommodate. Critical infrastructure such as wastewater treatment should not plan for the bare minimum, but with redundancy and adaptability. For human dignity and environmentally sustainable sanitation practice, this is worth the cost.

4 METHODS - TREATMENT

Designing for Successful Wastewater Treatment

The ability of wetlands to successfully treat these pollutants under highly controlled circumstances is well-documented; this has been extensively researched since the 1950s around the world, and the United States is slowly moving towards adopting this method. Following this research, I'm employing the following best practice guidelines in this design.

TREATMENT WETLANDS
BEST PRACTICE

PRE-TREATMENT

DETENTION TIME

HYBRID SYSTEMS

1) Treatment wetlands require some level of physical primary treatment – and the more rigorous, the better the wastewater treatment outcomes.

2) Detention time is essential – the longer the wastewater spends traversing the treatment wetlands, the better the treatment results.

3) Hybrid systems – which combine multiple, distinct treatment cells using different forms of treatment wetlands – are most effective at treating those most common wastewater pollutants. Because these forms largely define what the wetland cells at Three Sisters will look like, they're worth quickly examining one at a time.

BEST PRACTICE
HYBRID OF WETLAND TYPES

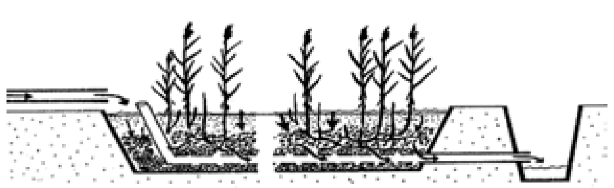
SURFACE FLOW
(SF)

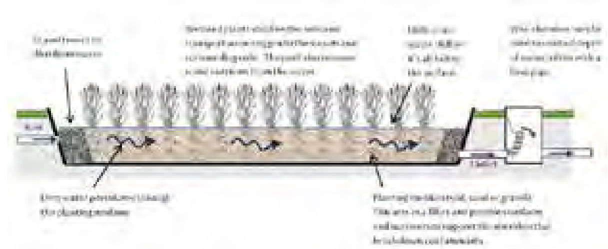
SUBSURFACE FLOW
(SSF)

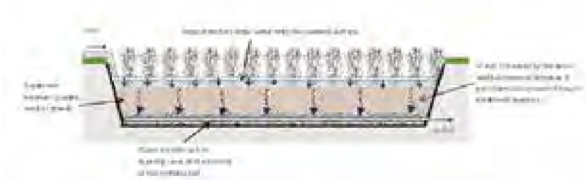
HORIZONTAL
SSF

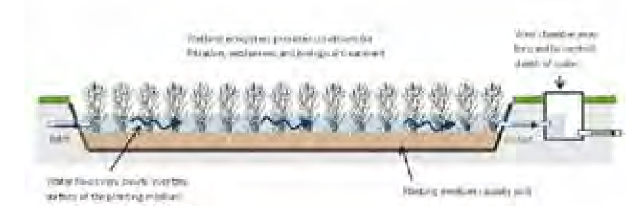
VERTICAL
SSF

FREE WATER
SURFACE FLOW
(FWS)



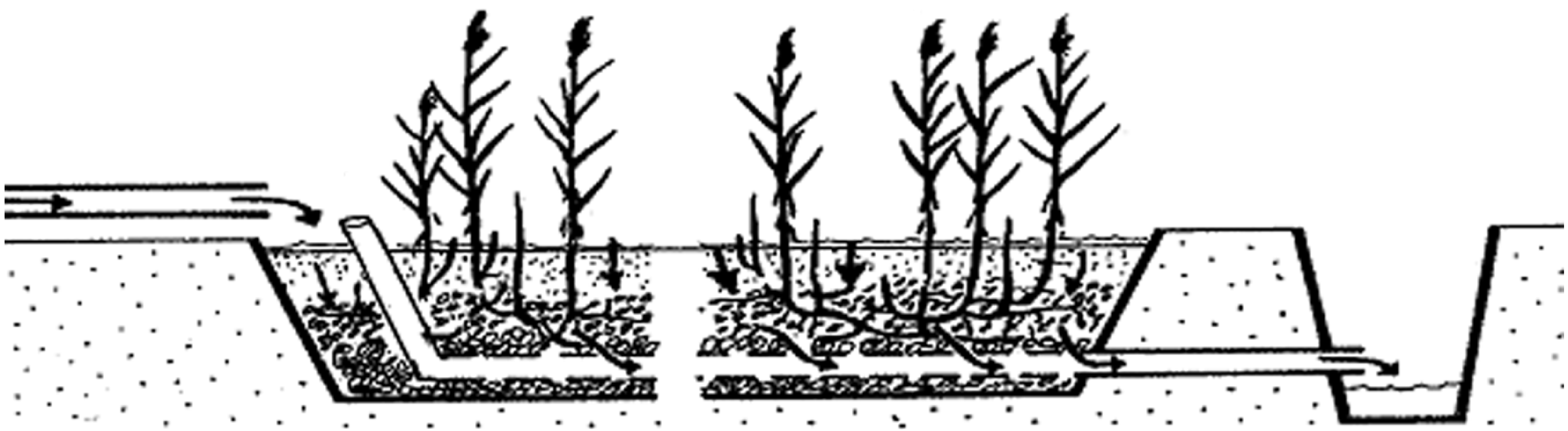






Because these forms largely define what the wetland cells at Three Sisters will look like, they're worth quickly examining one at a time.

SURFACE FLOW



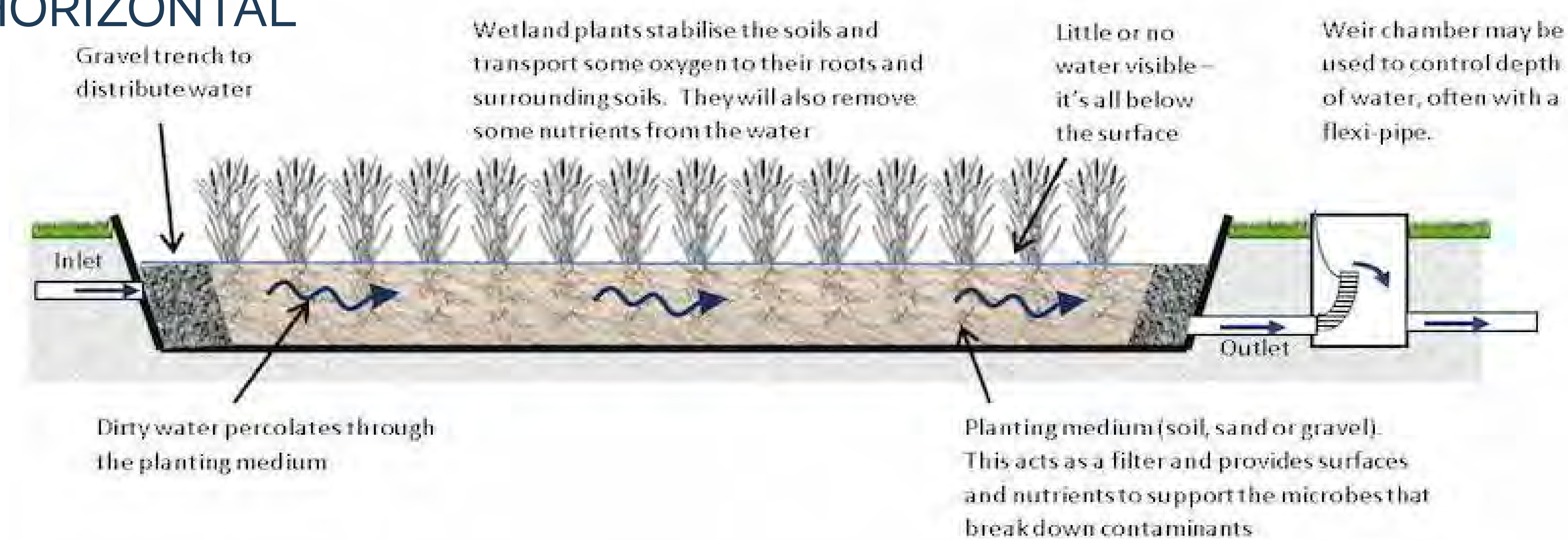
Adapted from Vymazal, 2007

Surface Flow Wetlands (SF Wetlands) are the most similar to what we might think of as ‘natural’ wetlands.

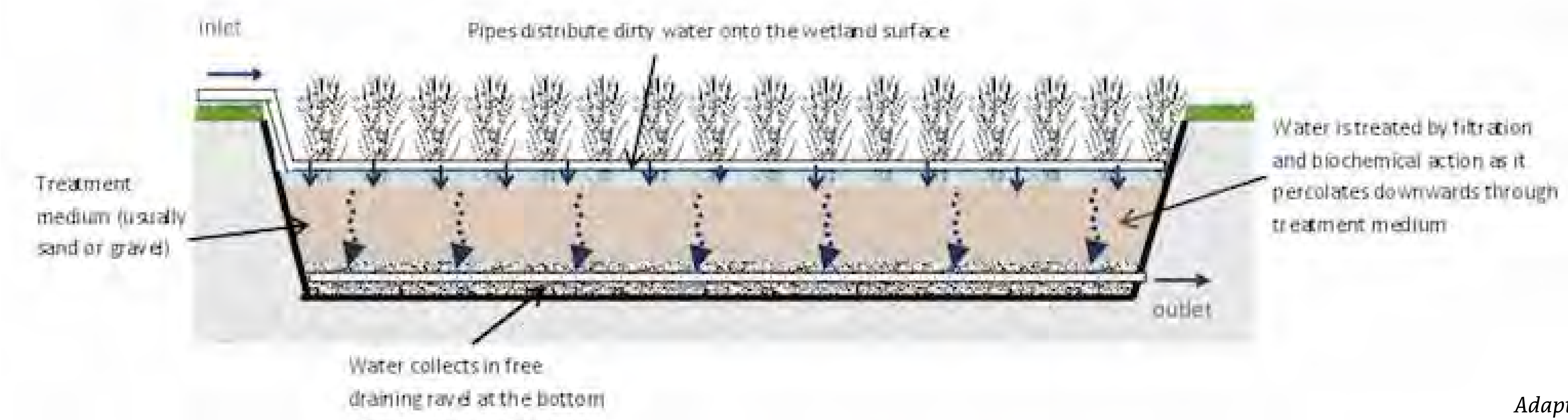
Water passes above ground in what’s supposed to be a slow flow through a landscape populated with emergent growth wetland plants which can tolerate, and indeed thrive, in 12-18” of standing water.

SUBSURFACE FLOW

HORIZONTAL



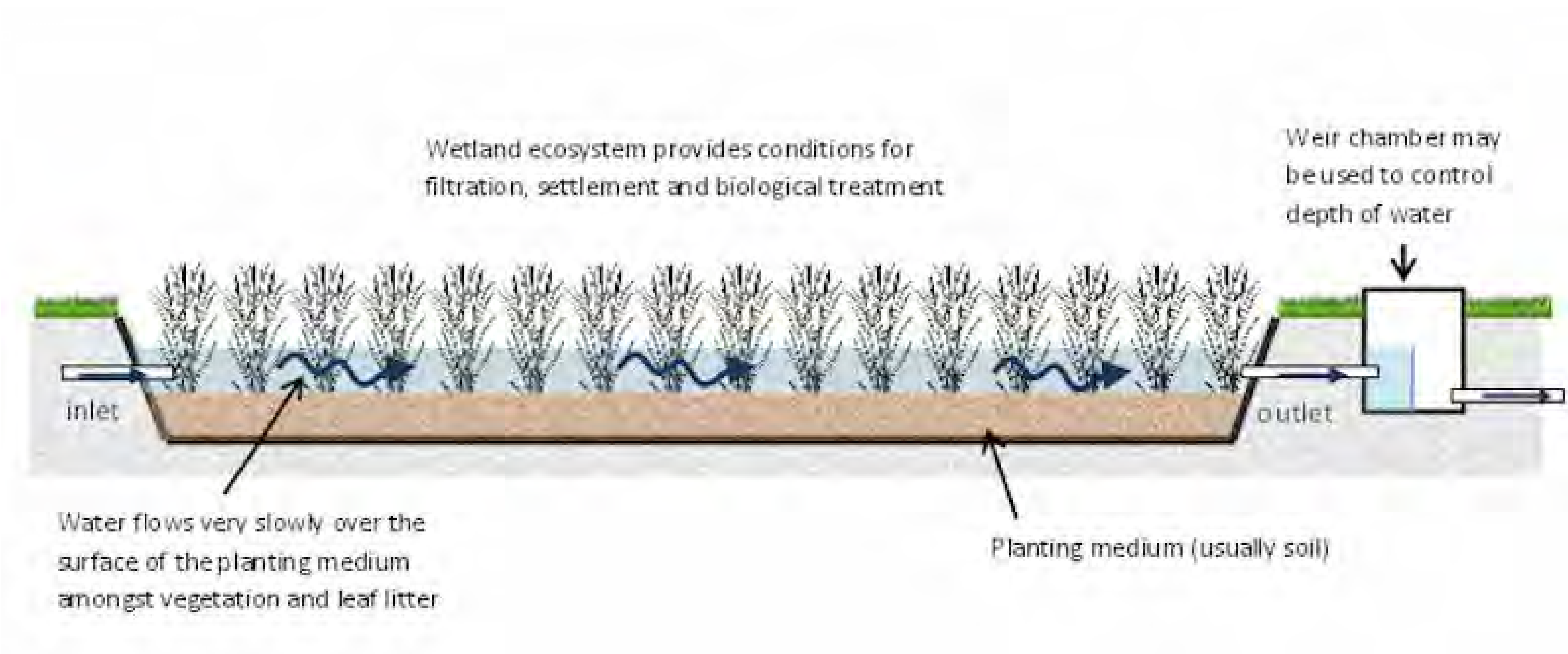
VERTICAL



Adapted from Vymazal, 2007

Subsurface flow wetlands, or SSF wetlands, have the water passing below ground through some sort of permeable media which is also planted before passing through an outflow. There are two sub-variations on this type; horizontal flow, where the inlet is graded only slightly above the outlet, and vertical flow, where the water passes both horizontally and vertically to the outflow.

OPEN WATER SURFACE FLOW



Adapted from Vymazal, 2007

The third type is open water surface flow. It's much deeper than the surface-flow wetlands and has floating rather than emergent plants.

BEST PRACTICE

PRE-TREATMENT

DETENTION TIME

HYBRID SYSTEMS

SIZE MATTERS!

And again, because of the different treatment mechanisms in each of these types, it is best to install hybrid wetlands with multiple cells, in different sequences, which utilize these different forms.

A common theme here is that size matters - wastewater treatment by this method requires a substantial footprint (again - the Three Sisters Meadow donation was a wonderful gift to this community).

PLANT CHOICE

EMERGENT PLANTS

Typha angustifolia

Juncus patens

Cladium mariscus

Iris pseudacorca

Phragmites australis

Phalaris arundinacea

Typha latifolia

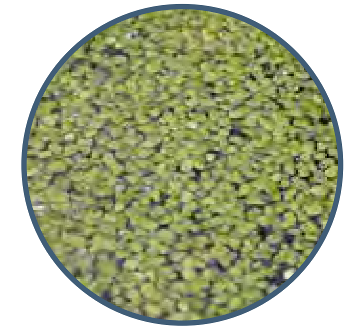
Zizania aquatica

Glycerica oxidentalis

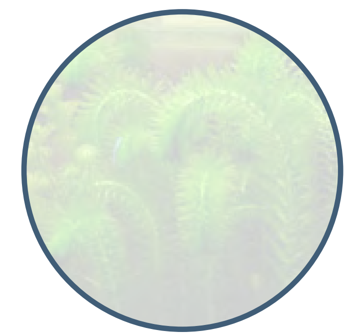
Juncus oxymeris

AQUATIC PLANTS

Lemna minor



Elodea densa



Spirodela polyrrhiza

Sagittaria latifolia

Sagittaria cuneata

Elodea canadensis

Finally, I wanted to choose a primary list of treatment plants which both demonstrated strong treatment efficacy, and which were suitable for this region. Specific plant genus have been repeatedly tested for successful treatment; however, it was important to refine those to native plants. Effort was additionally taken to provide plants that would look distinctive when massed; plant lists for the surrounding areas were made to suit a diverse wetland and riparian ecosystem.

5 DESIGN - THREE SISTERS TREATMENT WETLANDS

With that, I present – the Three Sisters Treatment Plant and Wetlands master plan.

MASTER PLAN

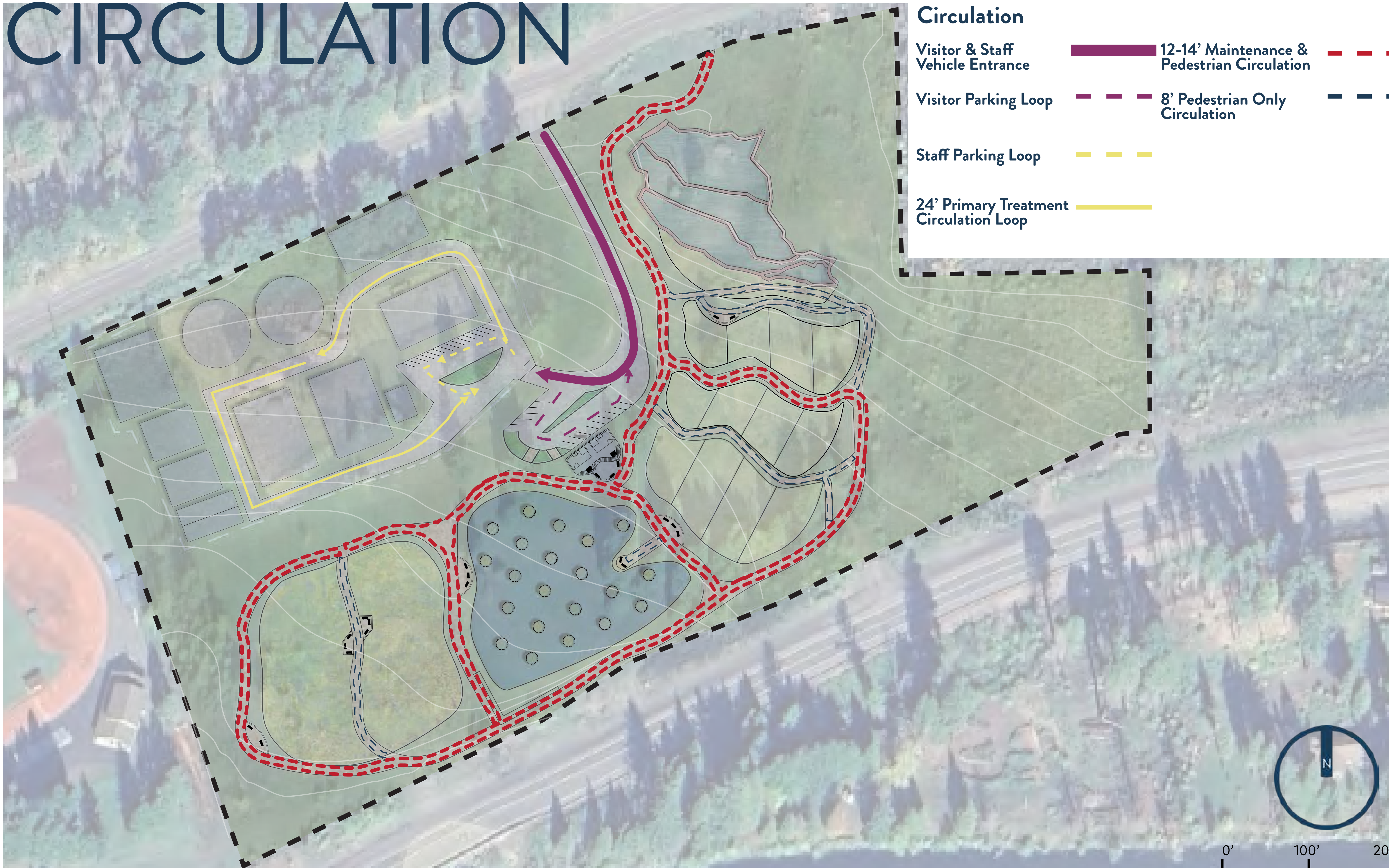
TREATMENT STAFF PARKING
VISITOR PARKING
COMFORT STATION
OXIDATION FOUNTAIN
SUBSURFACE FLOW CELL 1
SUBSURFACE FLOW CELL 2
SUBSURFACE FLOW CELL 3
OPEN WATER SURFACE FLOW CELL
SURFACE FLOW CELL
N
0'
100'
200'

The first and most important way to understand this design is to understand how it treats wastewater.

TREATMENT ZONES

This proposal divides Three Sisters into two areas – primary treatment, and wetland treatment. The primary treatment zone is closed to the public; the wetland treatment areas double as a public recreation and educational area.

CIRCULATION



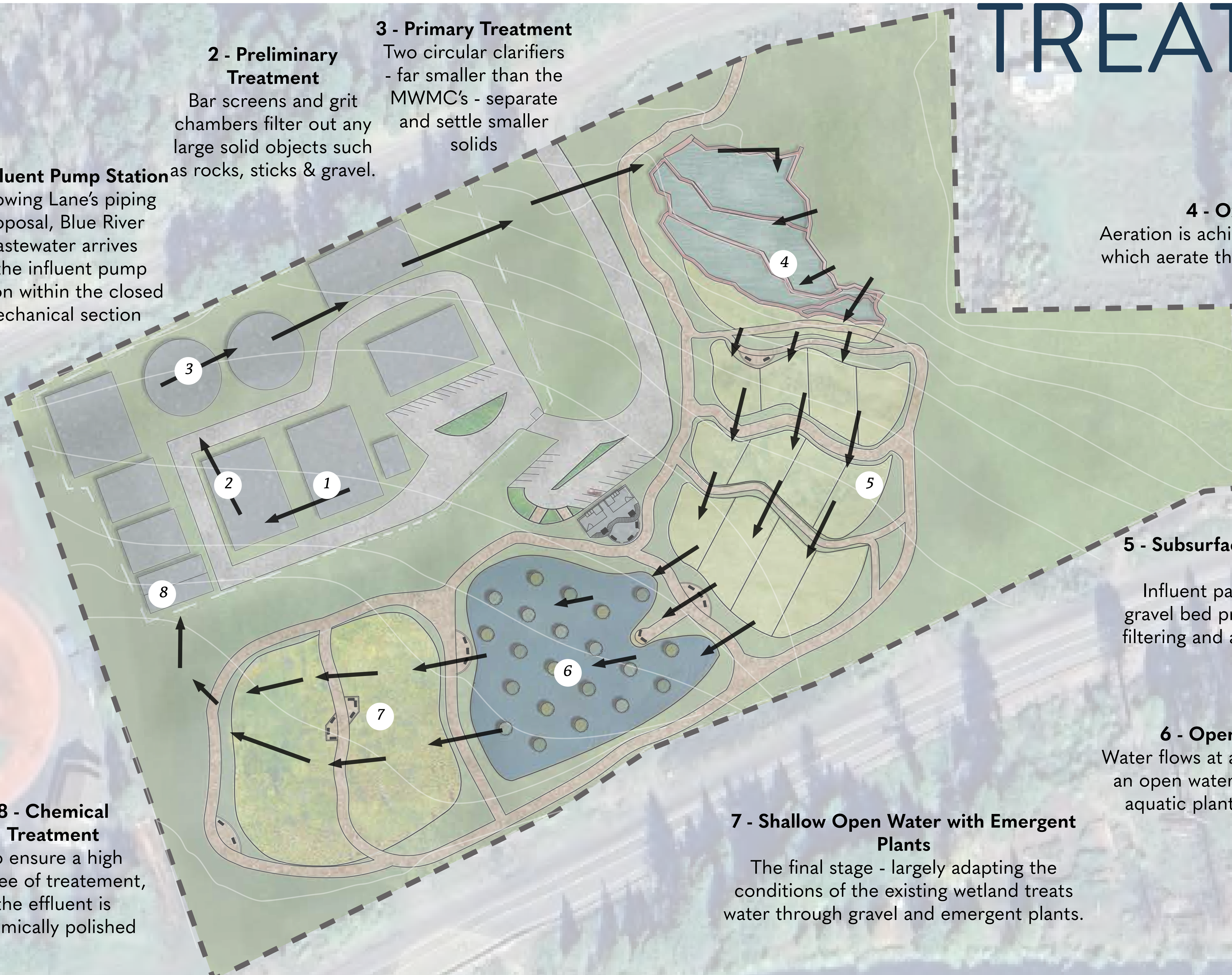
Visitors and workers enter the site from the same entrance that now exists. Wastewater plant staff move through a gated area to the primary treatment zone – visitors loop through the parking lot. There's also a pedestrian entrance available from the existing signature north of Blue River drive, but there isn't contiguous access to the rest of the site; on my own principle of being careful with possible drinking water, I have really tried to honor the creek setback.

TREATMENT

1 - Influent Pump Station
Following Lane's piping proposal, Blue River wastewater arrives at the influent pump station within the closed mechanical section

2 - Preliminary Treatment
Bar screens and grit chambers filter out any large solid objects such as rocks, sticks & gravel.

3 - Primary Treatment
Two circular clarifiers - far smaller than the MWMC's - separate and settle smaller solids



4 - Oxidation Pond
Aeration is achieved through two ponds which aerate through a cascading water feature

5 - Subsurface Flow Treatment Wetland - 3 Zones
Influent passes through an underground gravel bed promoting anaerobic interactions filtering and absorbing further contaminants.

6 - Open Water Surface Pond
Water flows at a slight vertical grade through an open water surface pond populated by aquatic plants, both floating and purely submergent.

7 - Shallow Open Water with Emergent Plants
The final stage - largely adapting the conditions of the existing wetland treats water through gravel and emergent plants.

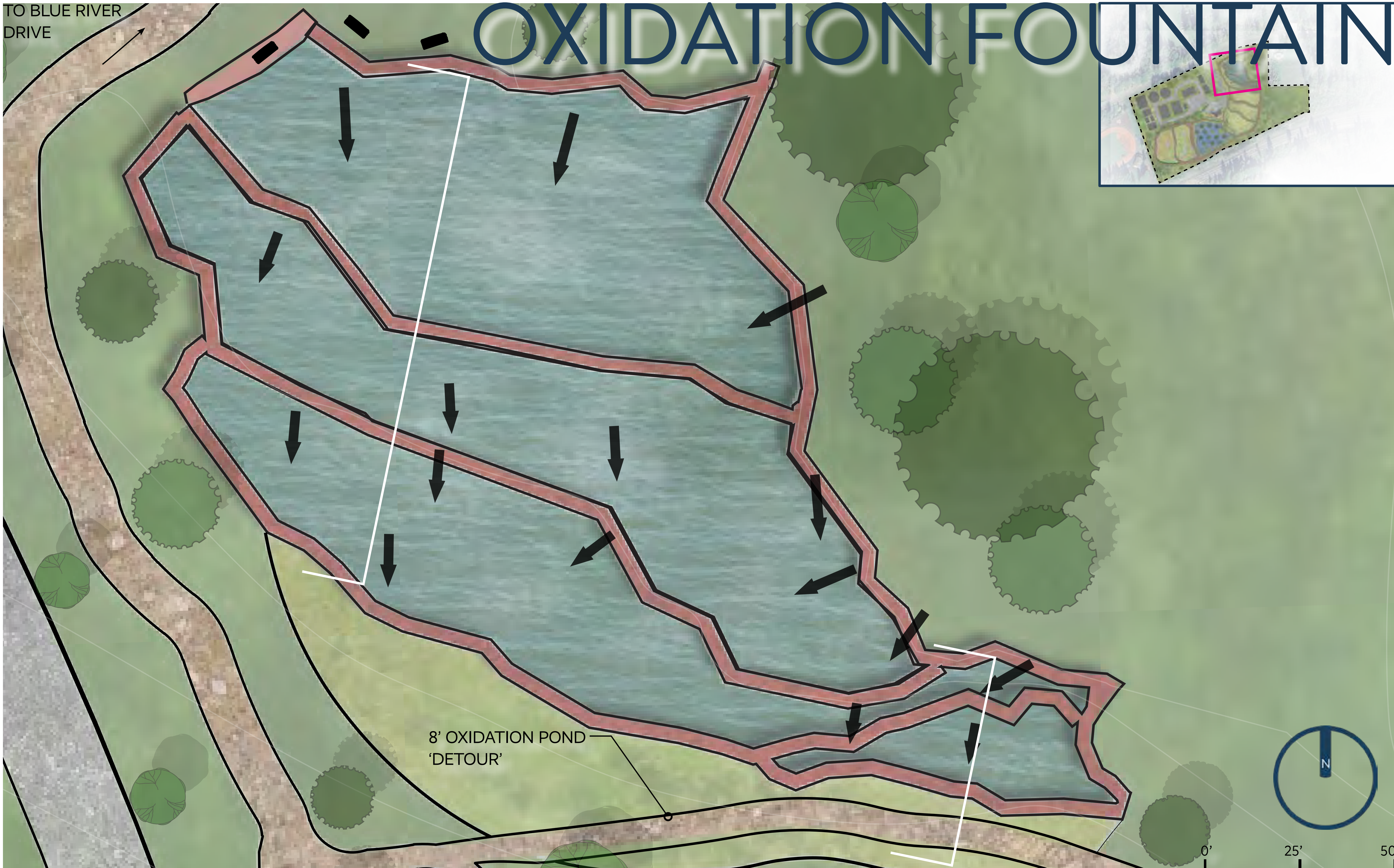
8 - Chemical Treatment
To ensure a high degree of treatement, the effluent is chemically polished

We’re going to visit the rest of the site by continuing to follow the path of the water as it moves through the site.

PRIMARY TREATMENT

One of the first decisions I made was to reserve a substantial area for appropriate primary treatment – and because there was already a huge concrete pad on this part of the site, I decided it was best to put it here. This is necessary to treat wastewater to a sufficient level. This area includes more modest versions of most primary treatment infrastructure – which I won't talk about because that's not my job. But there's parking for staff, and 24' service road.

OXIDATION FOUNTAIN

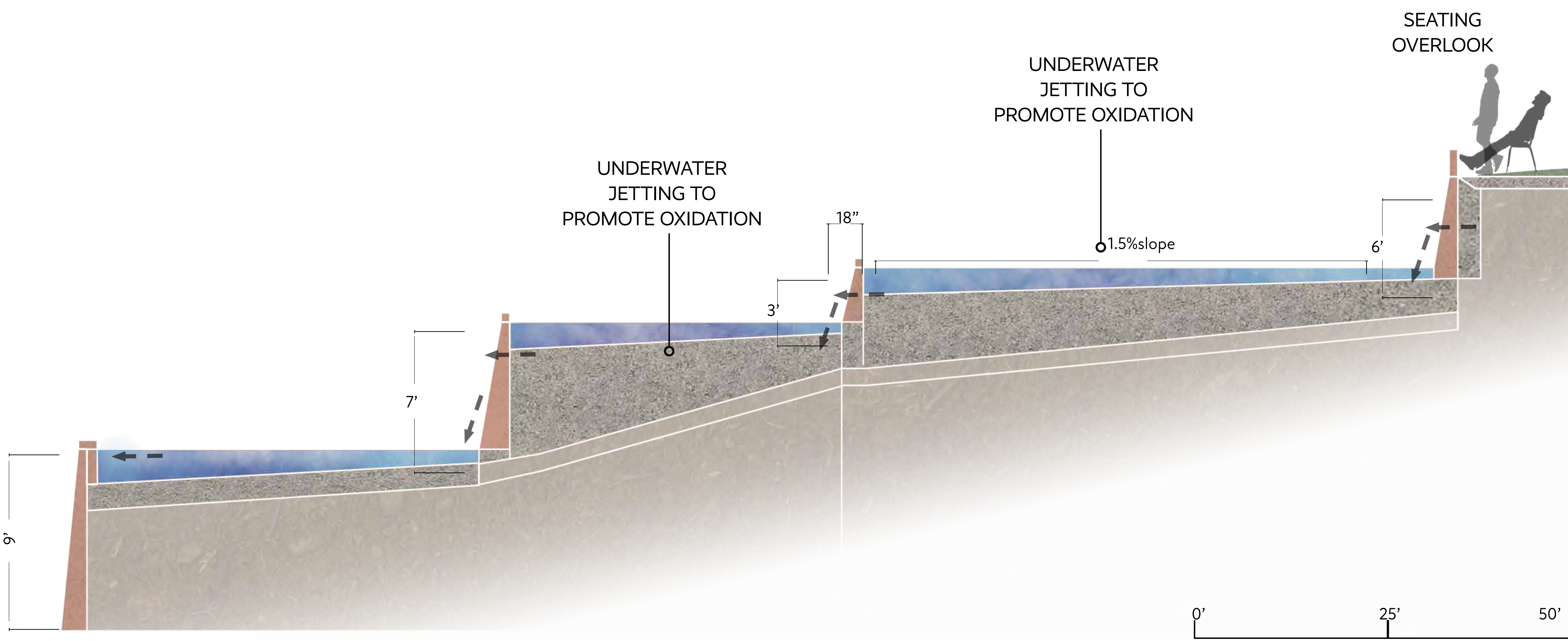


The pretreated influent is aerated through a large, multitiered cascading fountain structure which transitions, on the final plummeting terrace, to emergent wetland planting.

Most of the aeration effect is achieved with gravity, but there is gentle jetting to ensure that the process is thorough. I considered suggesting basalt for these columns; but to ensure stability and customization for the infrastructure needs, I ended up suggesting a stained concrete, like the Keller fountain.

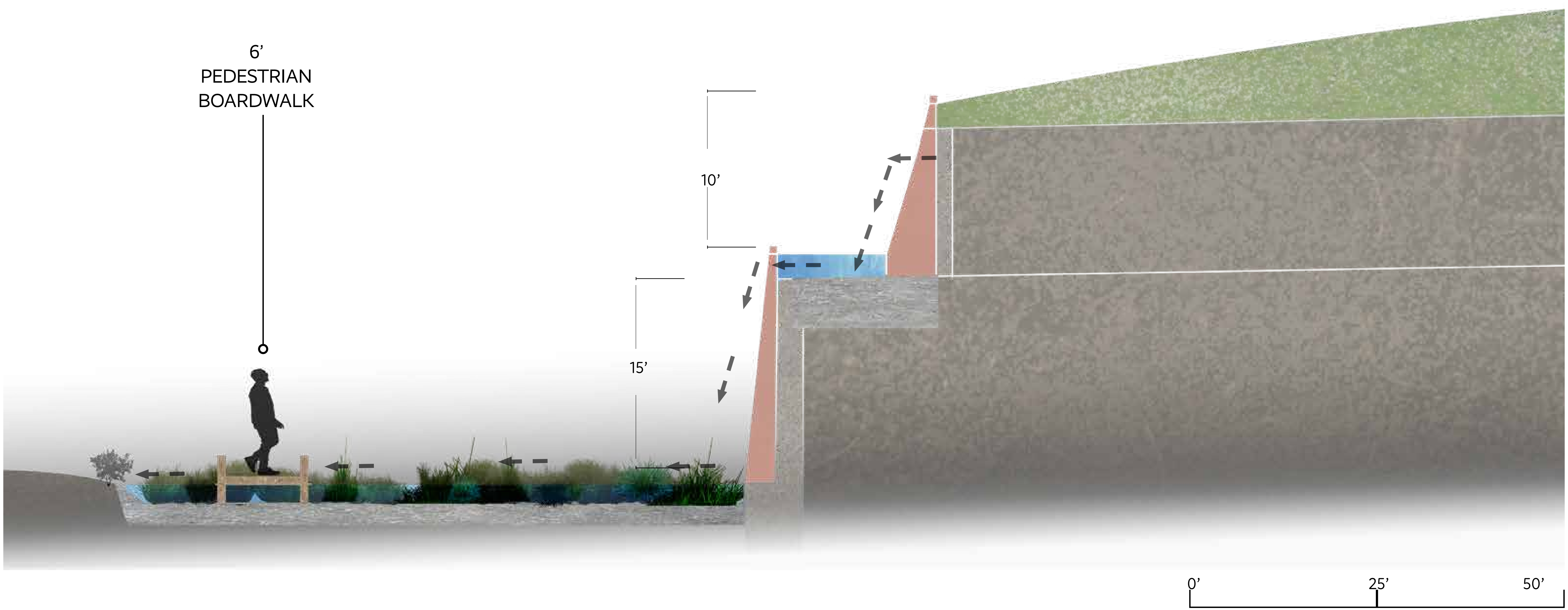
OXIDATION FOUNTAIN SECTION - CASCADE FALL

2X VERTICAL EXAGGERATION



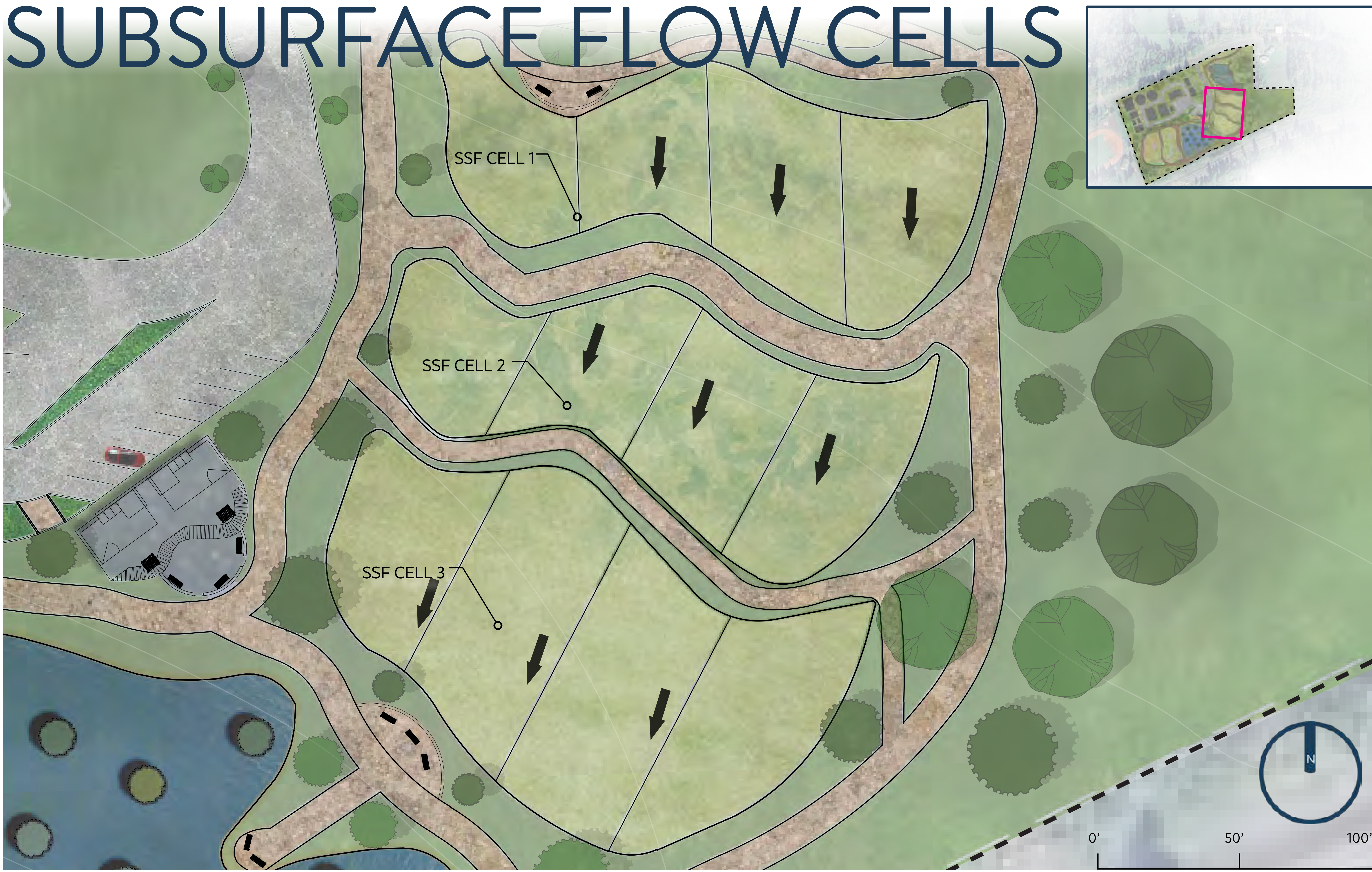
These sections illustrate the variety in the fountain – both dropping 25'...

OXIDATION FOUNTAIN
SECTION - HIGH FALL



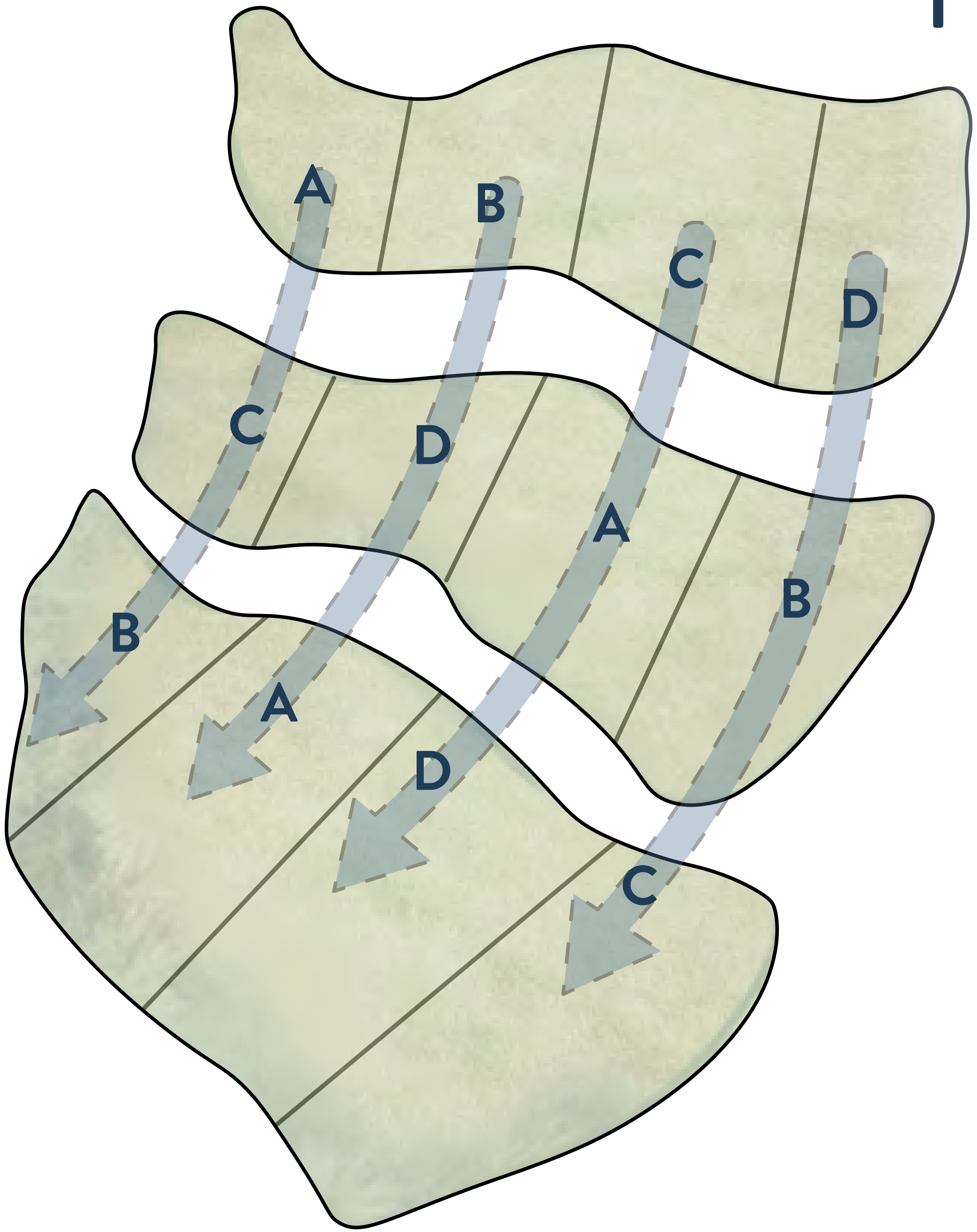
...but in very different ways.

SUBSURFACE FLOW CELLS



The influent now passes through a series of cascading Subsurface Flow Wetlands. These are divided into three terraces. The first two incorporate Vertical subsurface flow design – in part because I am still managing some grade change here - and the final one is a Horizontal subsurface flow wetland.

TREATMENT PATHS

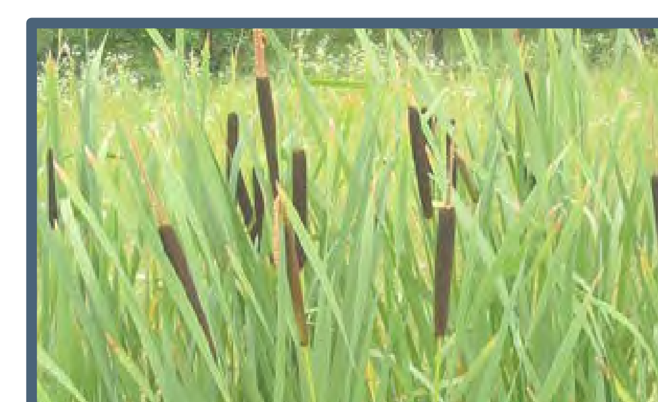


Plant A
Slough Sedge
Carex obnuta

Plant B
Western Mannagrass
Glyceria occidentalis

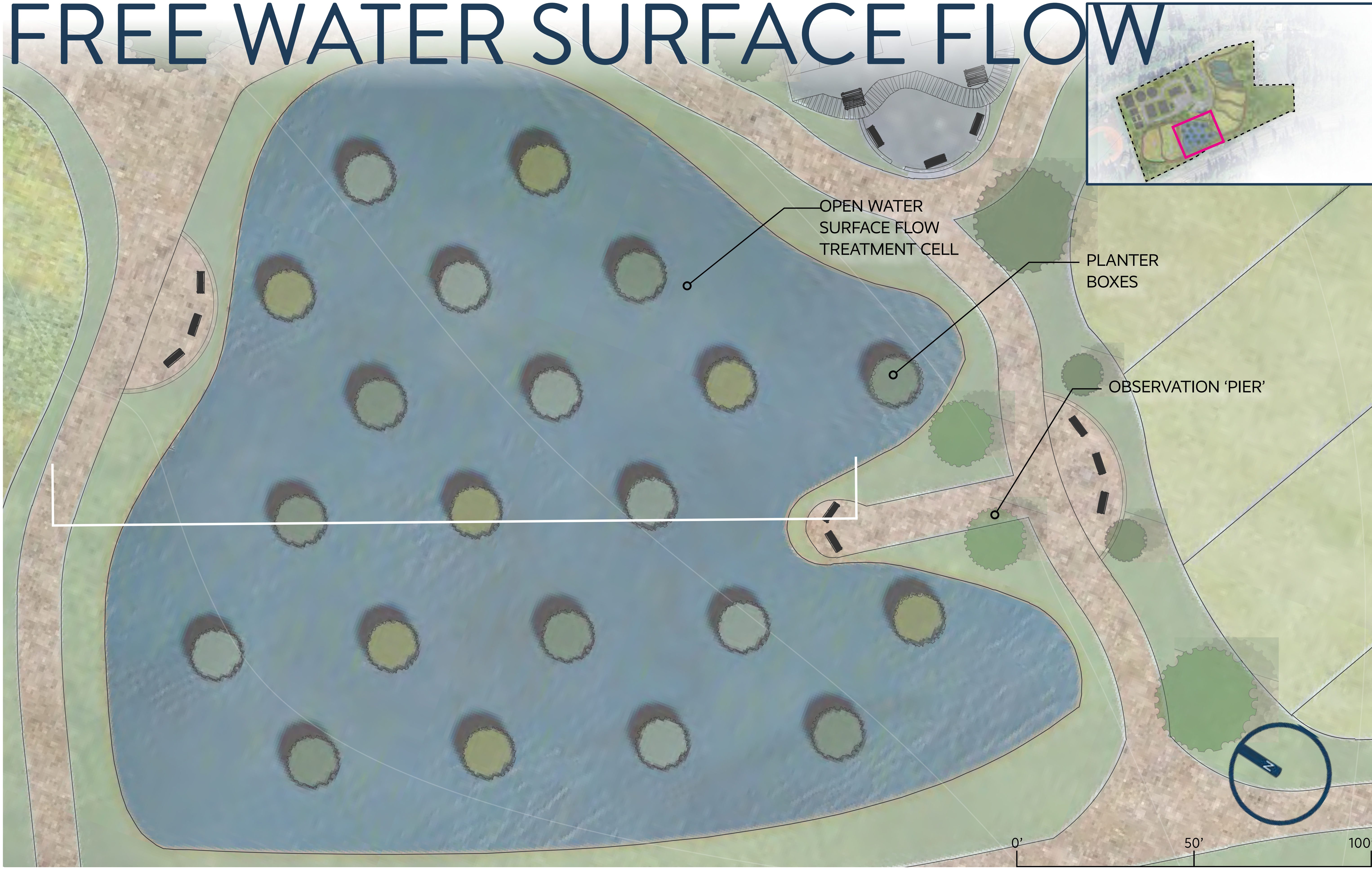
Plant C
Soft-Stem Bulrush
Scirpus tabernaemontani

Plant D
Broadleaf Cattail
Typha latifolia



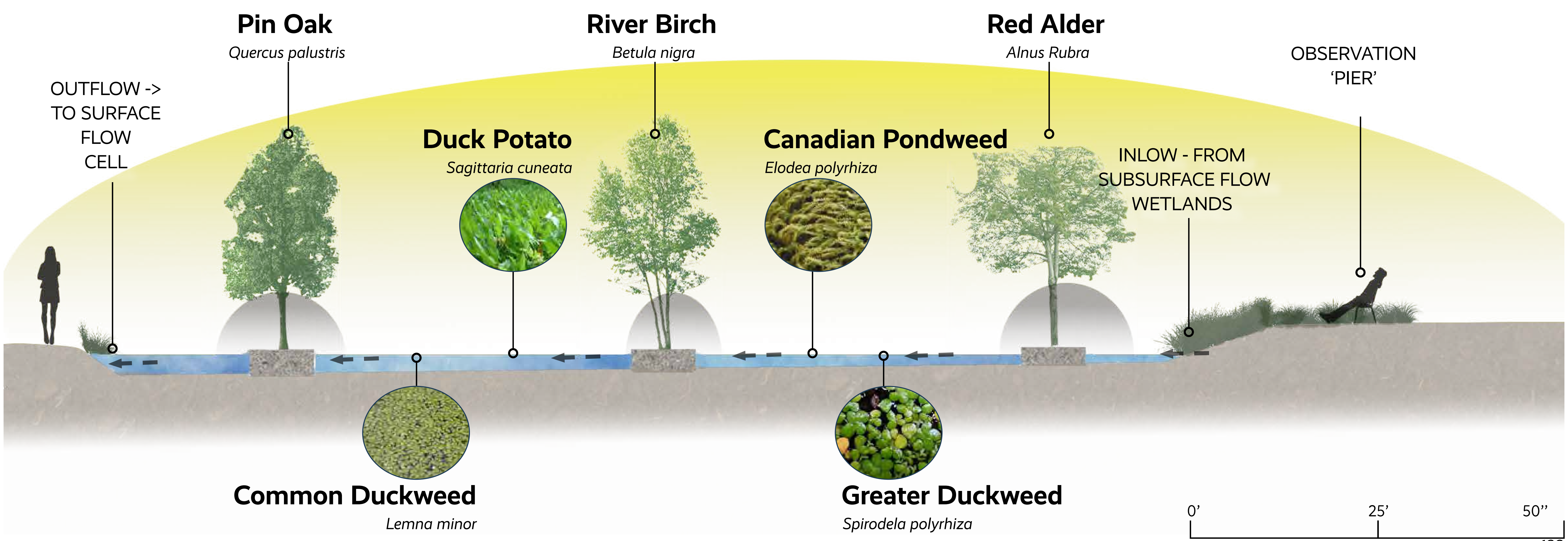
Each of these 3 terraces is planted with one of the same four emergent plants – but it’s in a different order each the four flow paths. The divided influent will pass through the three different combinations of emergent. The mix of horizontal and vertical flow types, and the diversity of plant types is done primarily to ensure as much systemic variety as possible, per Takeaway 2.

FREE WATER SURFACE FLOW



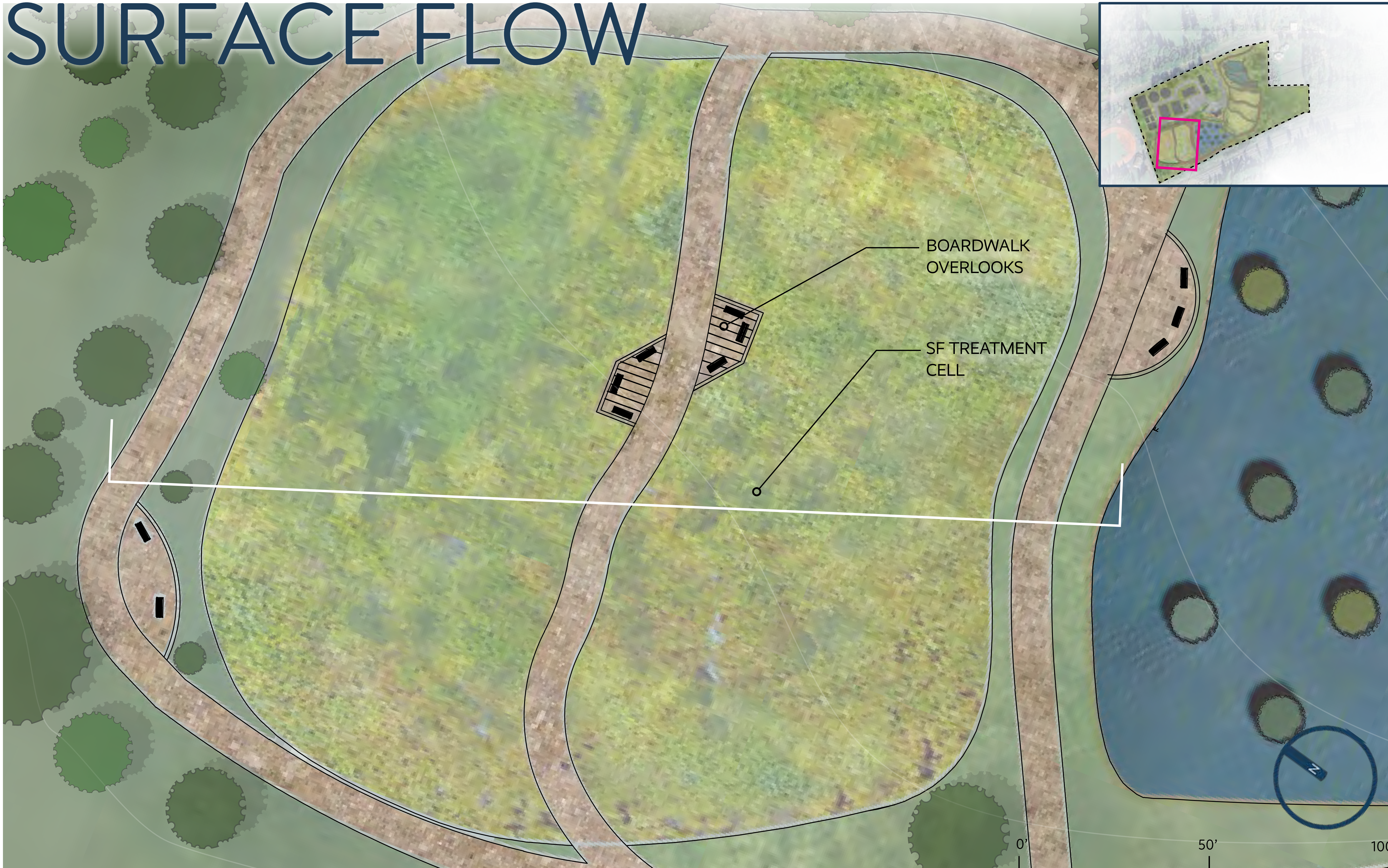
The next main treatment station is a large open water surface pond, with aquatic plants like Duckweeds and Pondweed providing the rhizomic zone. There are also, in planter boxes, shade trees embedded in the water.

FREE WATER SURFACE SECTION



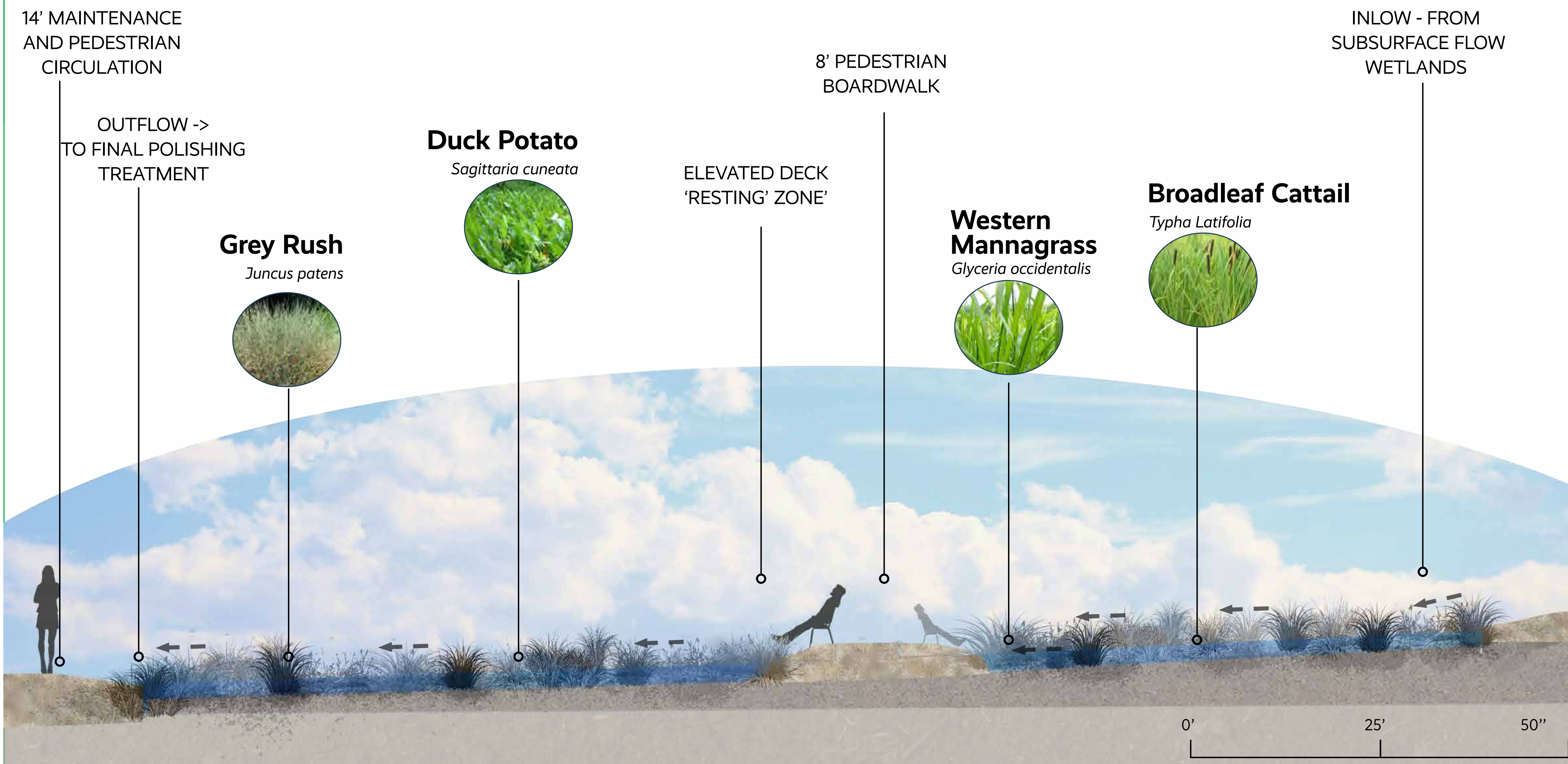
A typical open water surface pond experiences heavy sun exposure – a good thing, for the treatment process, but posing both risks to eutrophication and in raising the temperature of the water beyond river-safe levels. These planters, lined with shade trees, are the design intervention I've taken to prevent that. This particular intervention takes a lot of inspiration from Dan Kiley's Fountain Place in Dallas, Texas.

SURFACE FLOW



The final wetland treatment cell is a surface flow wetland with emergent plants. This is a fairly straightforward surface flow wetland populated largely with Western Cattails and Western Manna Grass.

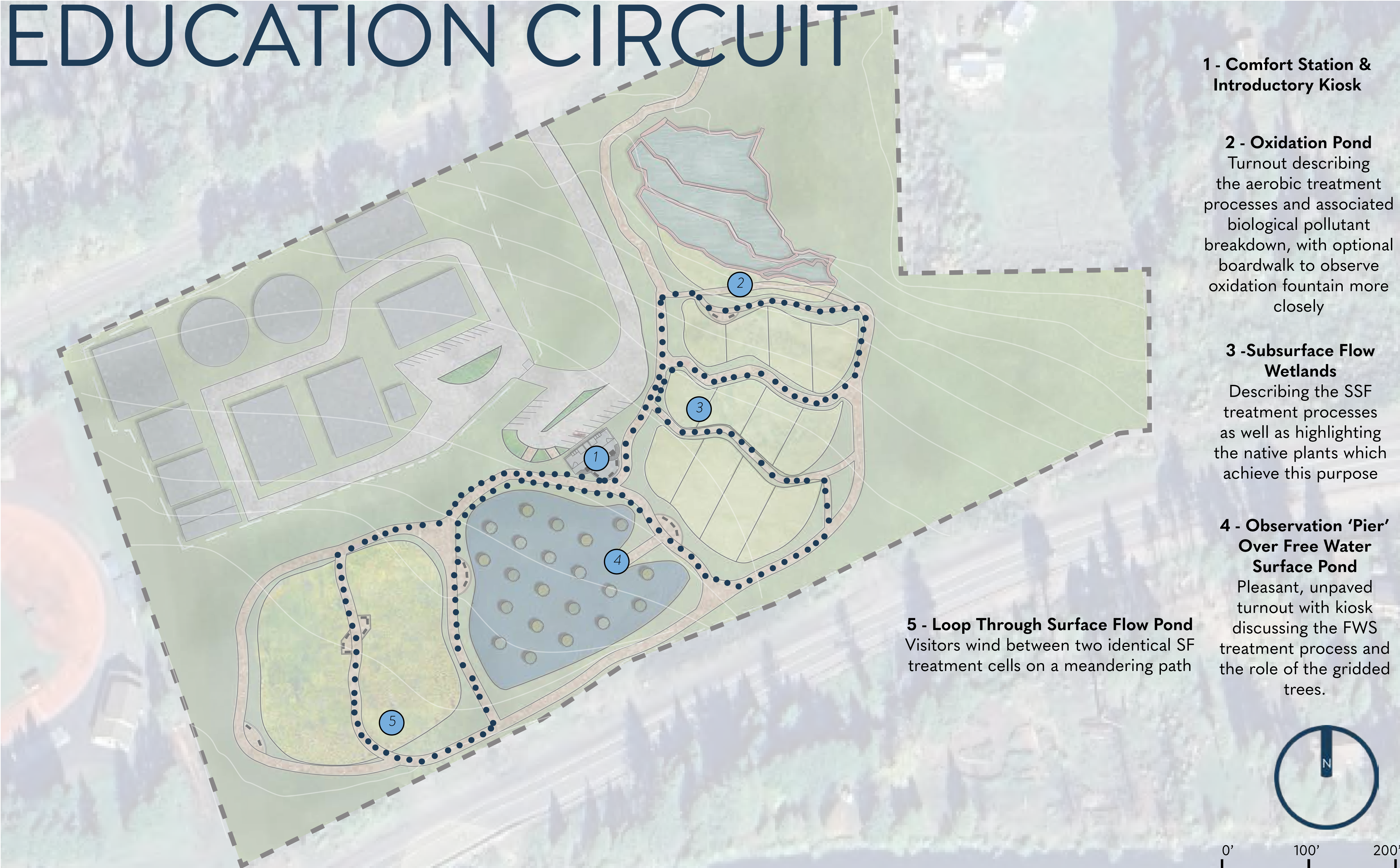
SECTION - SURFACE FLOW



The final wetland treatment cell is a surface flow wetland with emergent plants. This is a fairly straightforward surface flow wetland populated largely with Western Cattails and Western Manna Grass.

In the middle of the pond, pullouts with benches are provided for respite, education and enjoyment.

EDUCATION CIRCUIT



1 - Comfort Station & Introductory Kiosk

2 - Oxidation Pond
Turnout describing the aerobic treatment processes and associated biological pollutant breakdown, with optional boardwalk to observe oxidation fountain more closely

3 -Subsurface Flow Wetlands
Describing the SSF treatment processes as well as highlighting the native plants which achieve this purpose

4 - Observation 'Pier' Over Free Water Surface Pond
Pleasant, unpaved turnout with kiosk discussing the FWS treatment process and the role of the gridded trees.

5 - Loop Through Surface Flow Pond
Visitors wind between two identical SF treatment cells on a meandering path

That's the path of the water – this is my suggested path for the human visitor.

Visitors arriving by car will be greeted with a comfort station and a small picnic area with simple aggregate paving and a few introductory kiosks, and will then be free to proceed through the park. I've tried to provide options – but I've also suggested a tour through the most dynamic parts of the site – which would be accompanied by educational kiosks on the key treatment ponts.

Visitors can pass across the middle section of the tiered aeration pond. Visitors can also access the pond from the top of the site; there's no further access to the rest of the wetlands beyond that, though it is contiguous with the pedestrian-only access point from Blue River Drive. The accessible path takes viewers on an elevated boardwalk over one of the layers of the multi-step aeration pond.

From here, I suggest a winding tour through the vertical and horizontal subsurface flow grasses. This circulation is intended to have strong hide and reveal elements; winding through the different massed plant types gives a sense of proportion and progression, as well as increased visual interest.

Visitors should then take an out and back (or a lengthy respite) to the pier near the pond, where they can see both the aquatic treatment plants and take in the gridded shade trees in the summer.

Finally, visitors should loop through the Surface Flow wetland along the elevated boardwalk, pausing if they like, before circling back to the comfort station area and returning to which part of the park they enjoyed the most. The Three Sisters Treatment Wetlands is a pleasant, dynamic and accessible nature park, as well as a functional treatment wetland.

6 DISCUSSION

A Future for American Rural Wastewater Treatment?

My proposed intervention could treat Blue River's wastewater, reducing the pollutants previously discussed to levels safe for discharge to the McKenzie River.

This proposal also accomplishes the chief multifunctional benefits associated with constructed wetlands.


Public Access
Educational Opportunities
Ecological Restoration

It replaces much of a former mill site with a wetland ecosystem. The current vacant site has some fine native tree specimens and a substantial wetland footprint – but it's also heavily threatened by invasive blackberry and scotch broom. The Three Sisters Wetland would replace most of this with a wetland ecosystem of native plants, whose success would be assisted by the active maintenance regime associated with this system.

This is an easily accessible outdoor experience for any resident or visitor, attractively diversifying Blue River's amenities.

Finally, the location of the Three Sisters site near the McKenzie School affords educational opportunities for students (in addition to residents and visitors) about this sustainable sanitation practice; as well as perhaps instilling a genuine interest and civic pride in sustainable wastewater management.

Goal 1: Improve community wastewater treatment outcomes

YES

Wastewaster treatment is the primary function of this facility

Goal 2: Provide jobs and economic opportunity for Blue River residents

YES

Conventional treatment aspect of facility provides a number of jobs across different sectors and education/background levels

Goal 3: Preserve quiet, unincorporated, relatively undeveloped character of Blue River

YES

This proposal doesn't include any private development and maintains a rural character

I'd also like to address my stated goals for the Blue River community – apart from the wastewater situation, which this obviously addresses.

This does provide job creation, as well as an attraction that can support other Blue River businesses. The jobs associated with the mechanical treatment facilities – which will vary across different sectors and training levels – can help support Blue River's growth going forward (as does, of course, the wastewater treatment)

Finally, this provides the aforementioned raft of multifunctional benefits to Blue River without meaningfully detracting from its rural character.

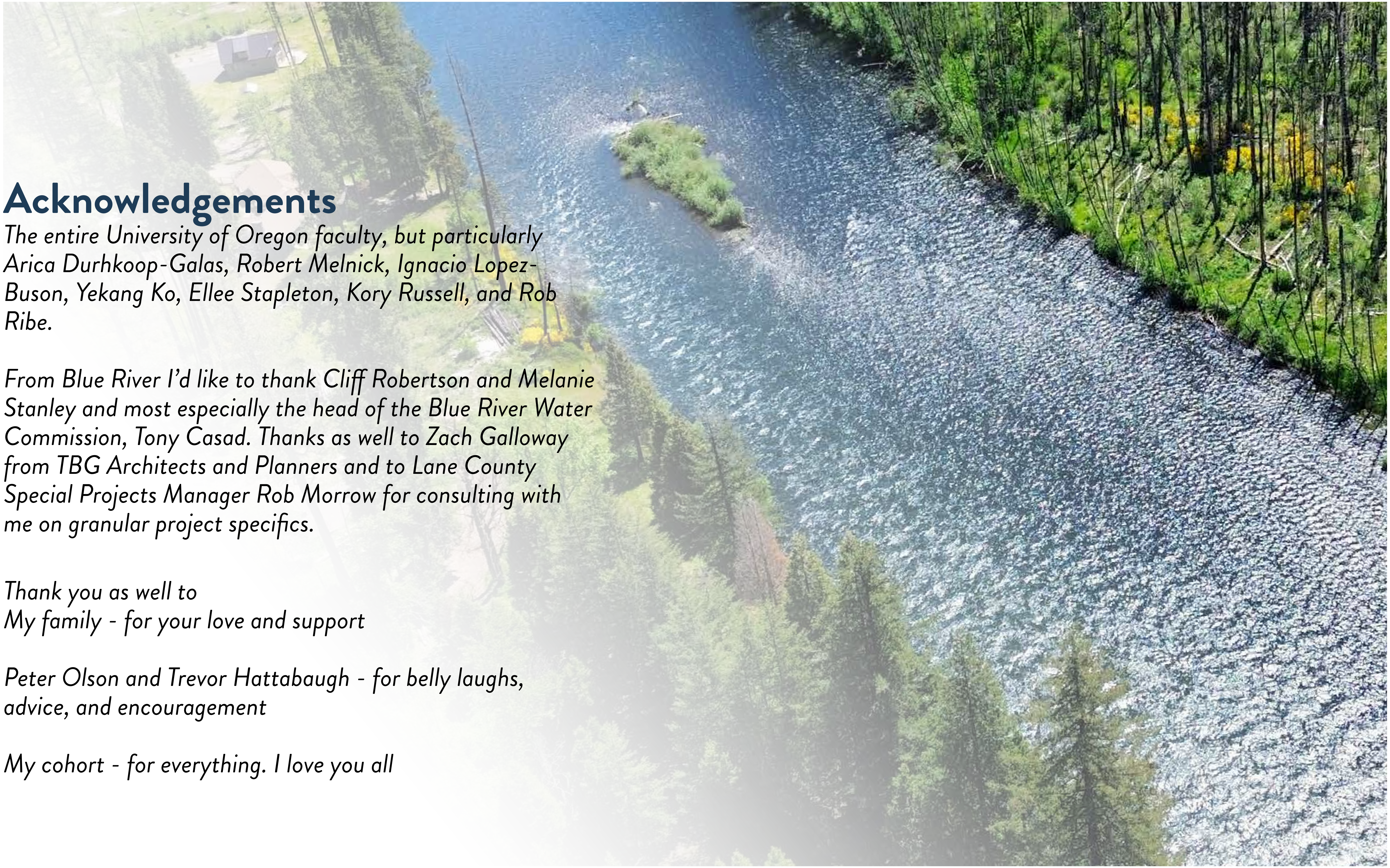
A Future for Rural American Wastewater Treatment?

Given current Clean Water Act regulations, this intervention, at this site, can't be permitted. As such, Blue River's realistic option – the one that will be constructed this summer, is instead just a large community drainfield at Three Sisters. Despite the affordability and current legality of this intervention, it only accounts for a small part of Blue River's population, and it will likely contaminate the McKenzie River at some level.

But if the popularity of treatment wetlands continues to grow – and if certain ongoing legislative efforts to modify the Clean Water Act to explicitly permit and fund green infrastructure treatment practice are ultimately successful – it's possible to imagine mixed infrastructure treatment facilities like this being constructed in the future.

The treatment of wastewater via constructed wetlands – with the possibility of discharge – could represent a more sustainable and preferable social, economic and environmental outcome for Blue River's wastewater treatment. This provides Blue River with the sustainable sewage management (and associated human dignity) which we all deserve; moreover, it provides the infrastructure framework for the community to grow – or not! – at an organic rate.

Green infrastructure, and the work of landscape architects, can be suited to this sort of intervention even at this rural scale; and speculative projects, like the kind I've been permitted to engage in as a student here, can act as ambassadors for speculative futures.



Acknowledgements

The entire University of Oregon faculty, but particularly Arica Durhkoop-Galas, Robert Melnick, Ignacio Lopez-Buson, Yekang Ko, Ellee Stapleton, Kory Russell, and Rob Ribe.

From Blue River I'd like to thank Cliff Robertson and Melanie Stanley and most especially the head of the Blue River Water Commission, Tony Casad. Thanks as well to Zach Galloway from TBG Architects and Planners and to Lane County Special Projects Manager Rob Morrow for consulting with me on granular project specifics.

Thank you as well to
My family - for your love and support

Peter Olson and Trevor Hattabaugh - for belly laughs, advice, and encouragement

My cohort - for everything. I love you all

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