Optimizing Nutrient Removal in Wastewater Treatment Ponds

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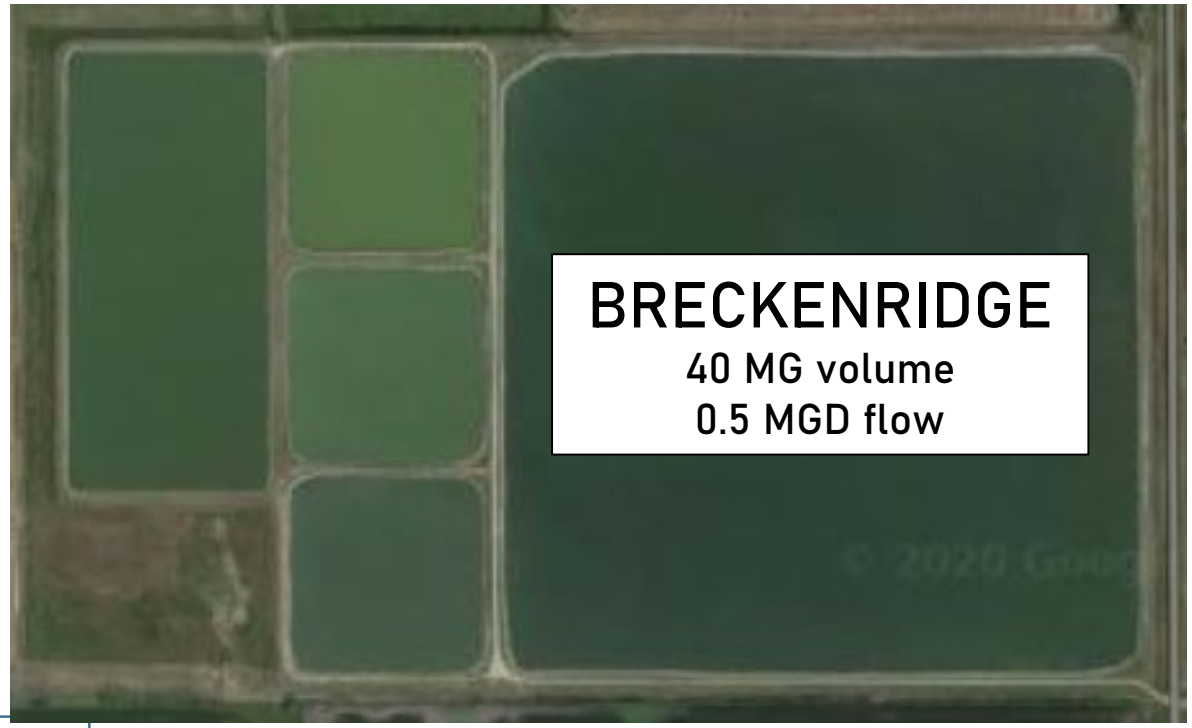
Project Sites

Treat wastewater from the community by removing nitrogen and phosphorus.



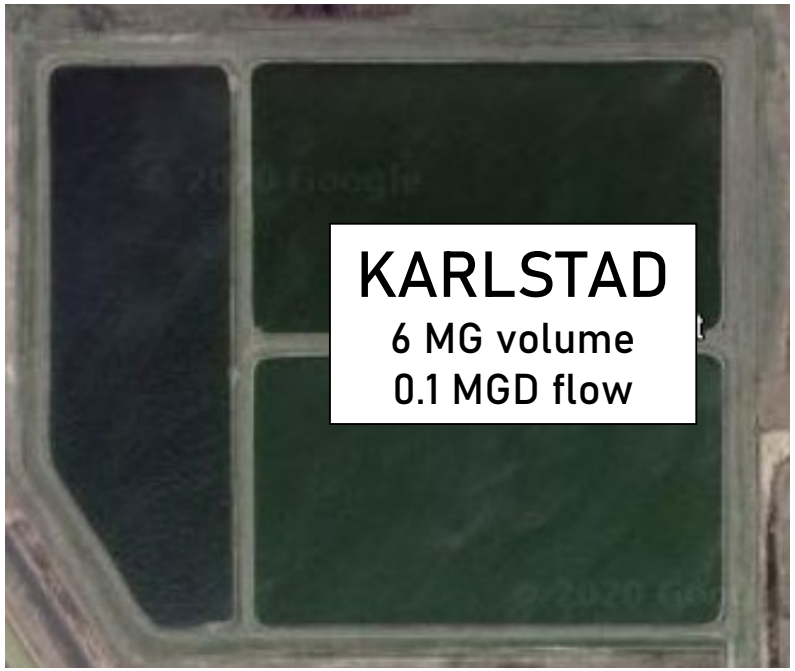
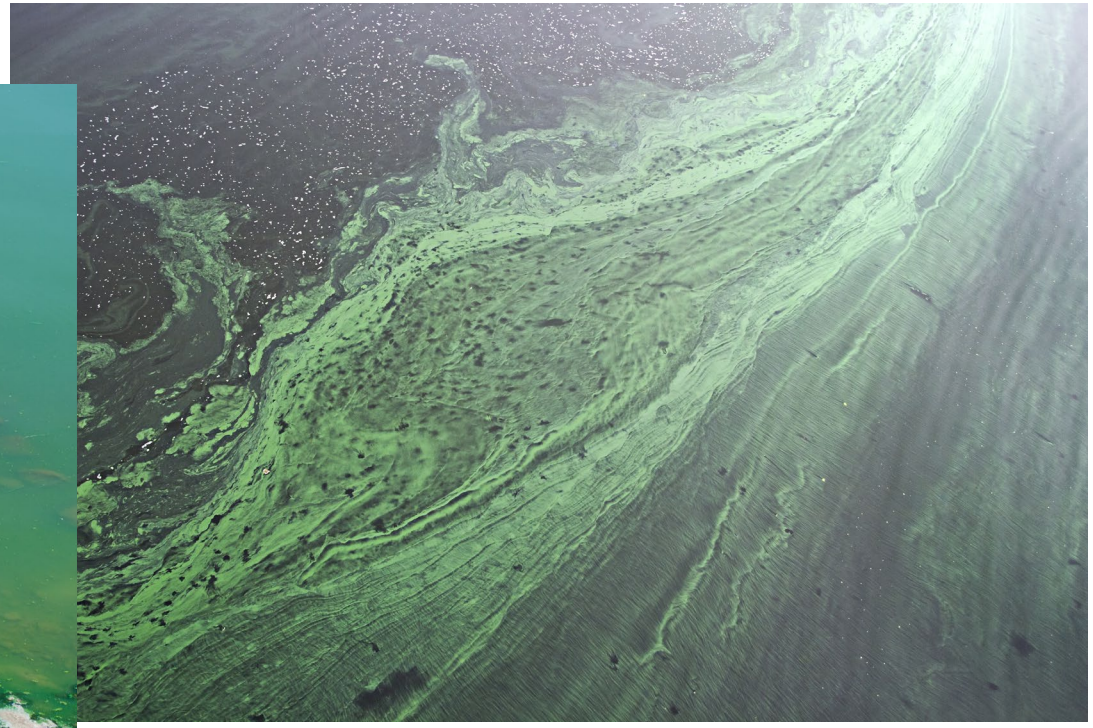


Image from Google Maps

Project Purpose

Improved nitrogen and phosphorus removal ➡ -Better treatment
-Prevent eutrophication



Project Overview

Partnered with Minnesota Pollution Control Agency and Minnesota Rural Water Association

Project Background

Treatment Pond

⬇

Red River

⬇

Lake Winnipeg

Karl Musser, 2007. 500 x 499. creative commons, https://commons.wikimedia.org/wiki/File:Redrivernorthmap.png

Project Background

Lake Winnipeg:

High nitrogen & phosphorus

Most pollution from Red River

Jacques Descloitres, *Manitoba*, 2002. 115 x 150. creative commons. NASA/GSFC.

Pollution Sources:

Cropland

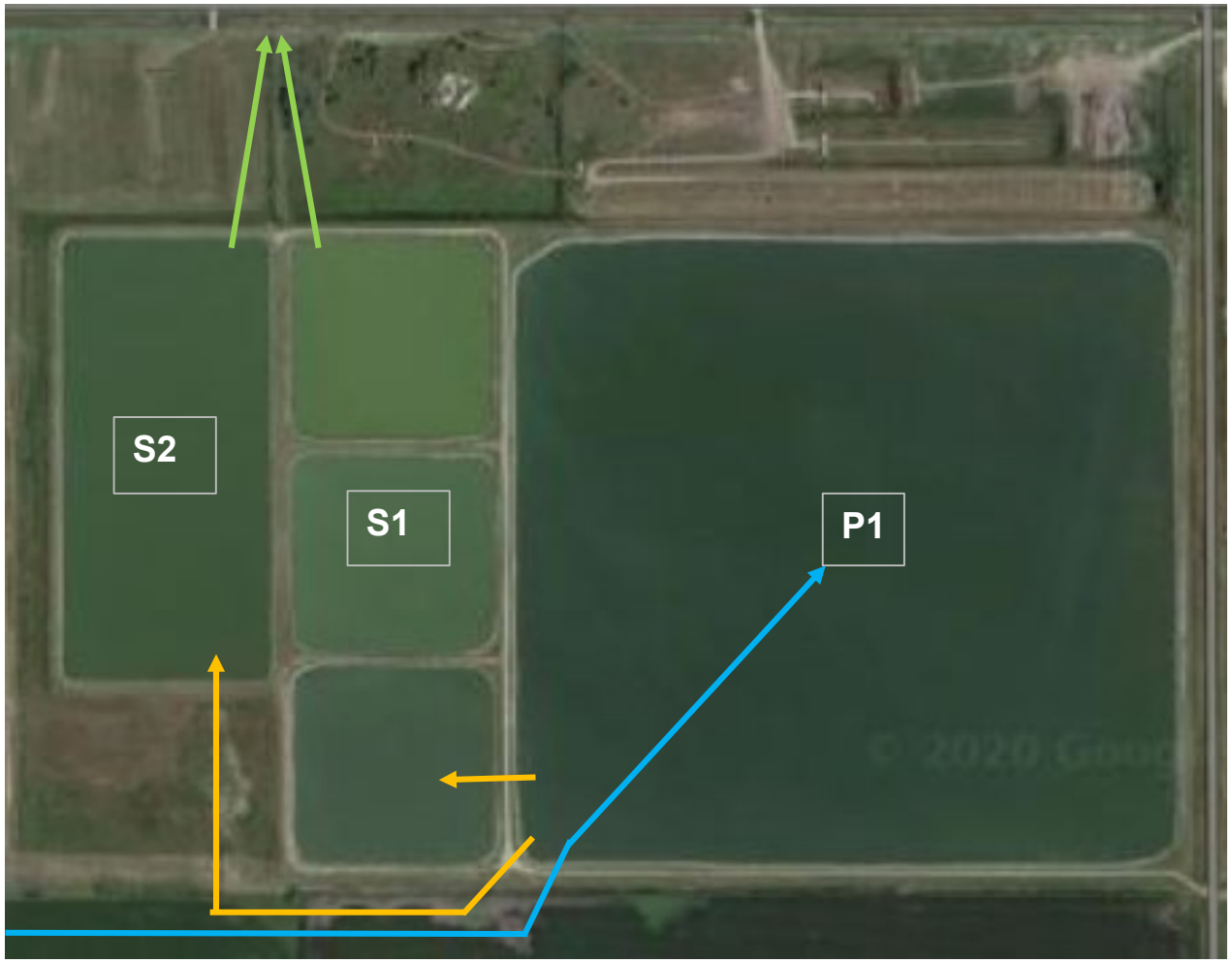
Bank Erosion

Pasture

Wetlands

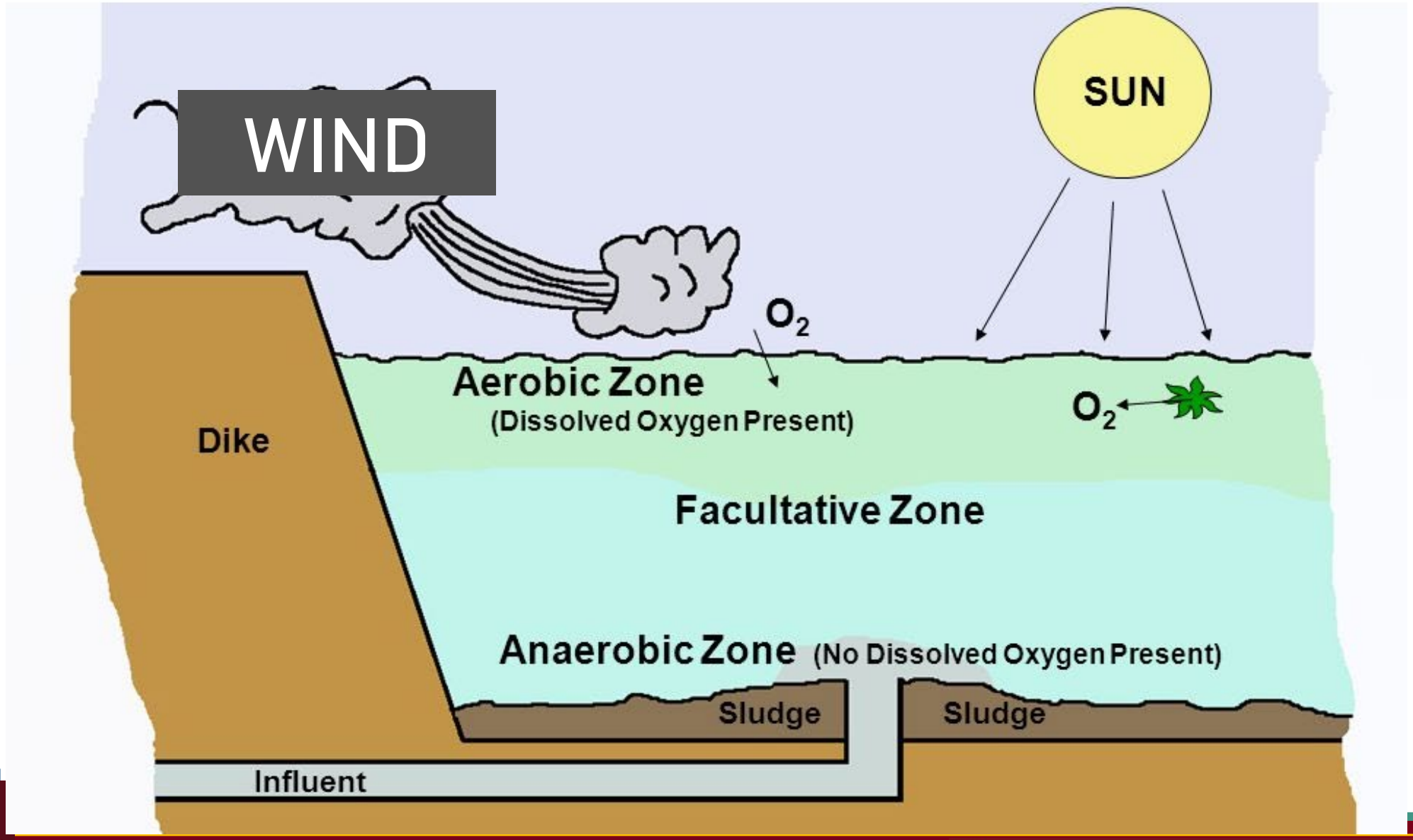
Point Sources

Breckenridge



Karlstad

Image from Google Maps



Creative commons, https://www.michigan.gov/documents/deq/wrd-ot-lagoon-manual_426356_7.pdf

Biological Phosphorus Removal

Primary Recommendation

Increase hydraulic retention time = Better phosphorus removal

$$\text{Actual HRT} = \frac{\text{Used Volume of Pond}}{\text{Influent Flow Rate}}$$

Influenced by:

Flow Pattern
Discharge Frequency
Consistency of Both

HRT = Hydraulic Retention Time

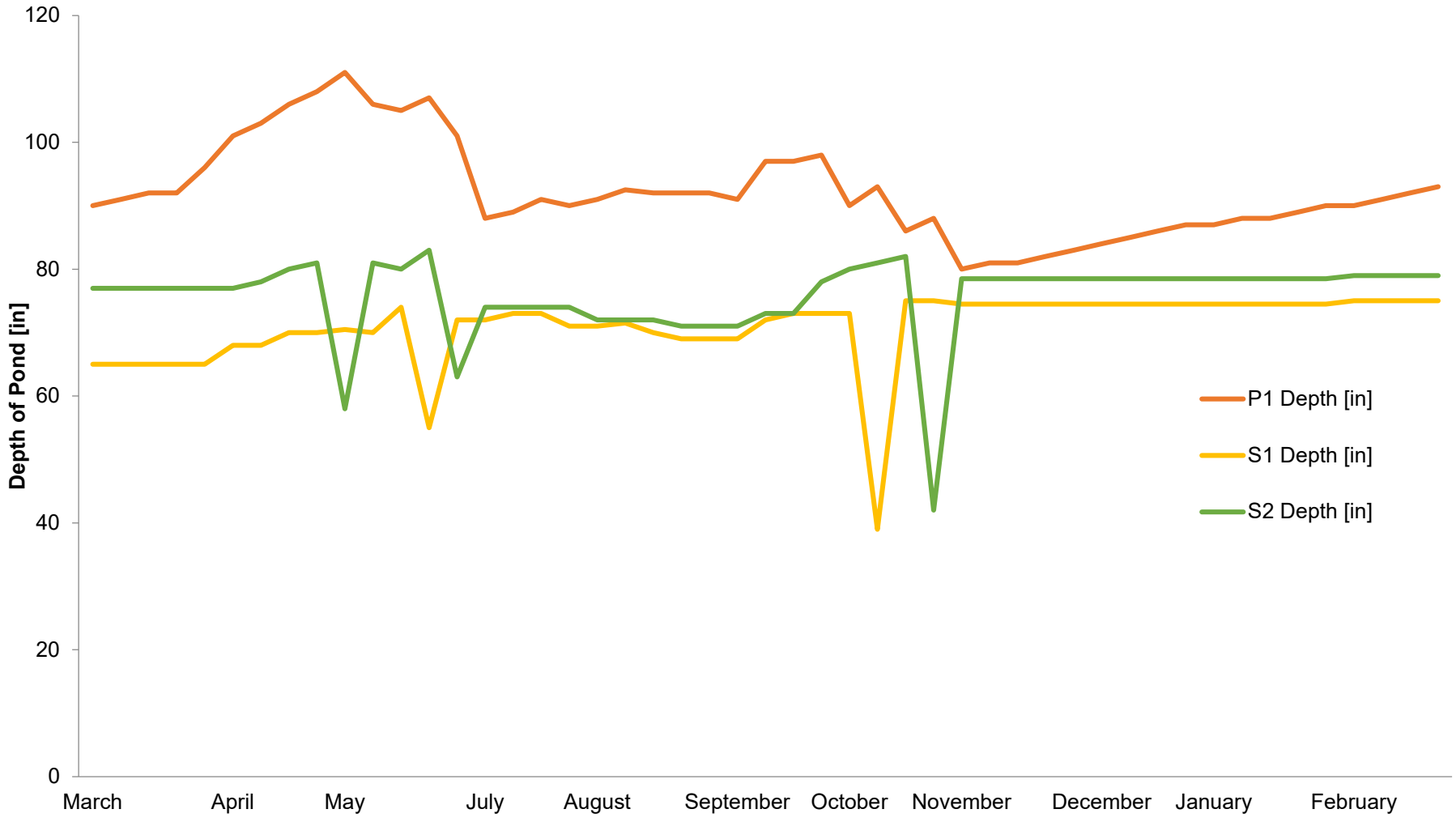
Breckenridge Current

Maximum Primary 1 Height = 9 ft = 108 in

Maximum Secondary 1 Height = 5 ft = 60 in

Maximum Secondary 2 Height = 6 ft = 72 in

Current HRT = 608 days



HRT = Hydraulic Retention Time

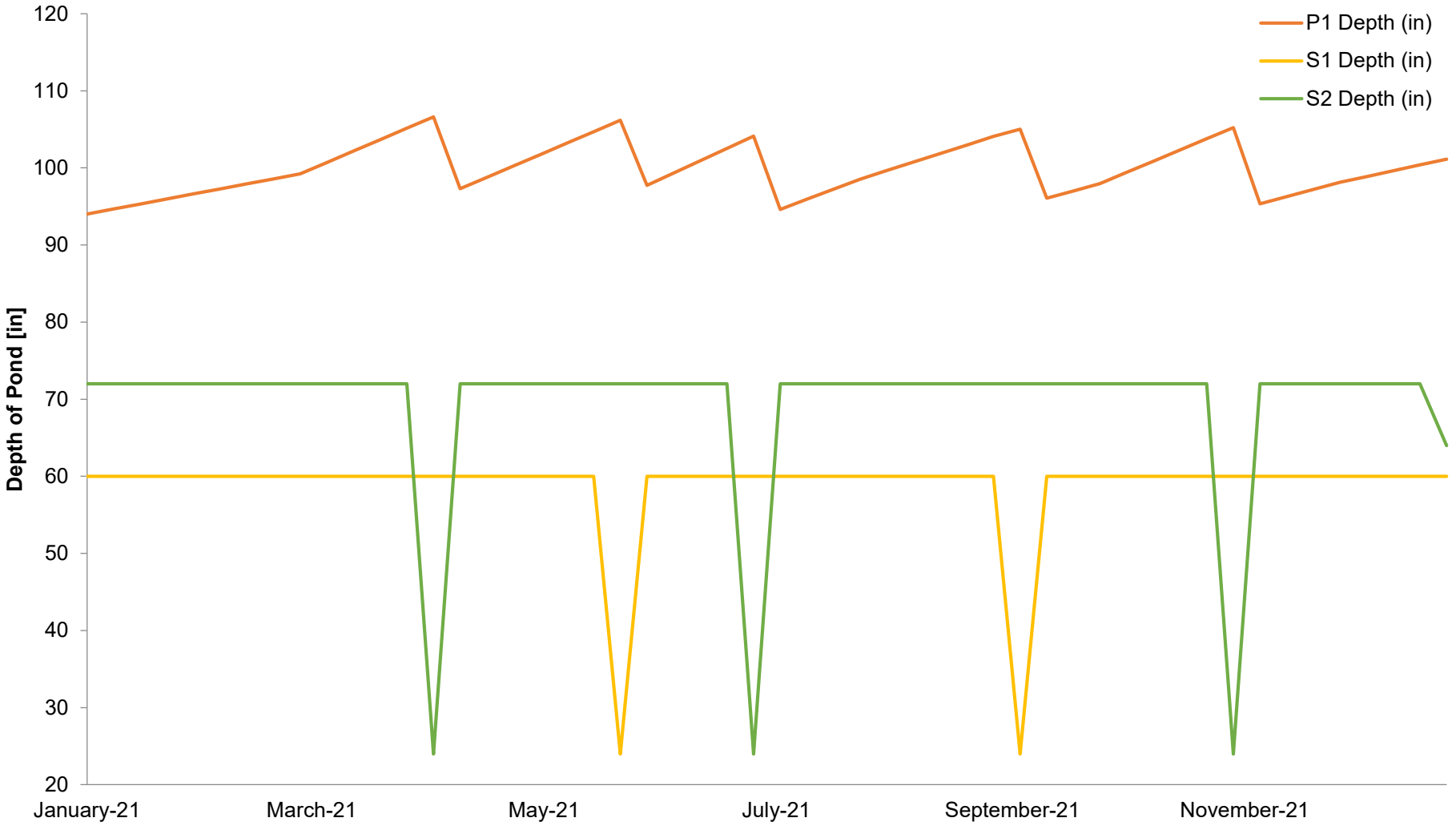
Breckenridge Ideal

Maximum Primary 1 Height = 9 ft = 108 in

Maximum Secondary 1 Height = 5 ft = 60 in

Maximum Secondary 2 Height = 6 ft = 72 in

New HRT = 771 days



HRT = Hydraulic Retention Time

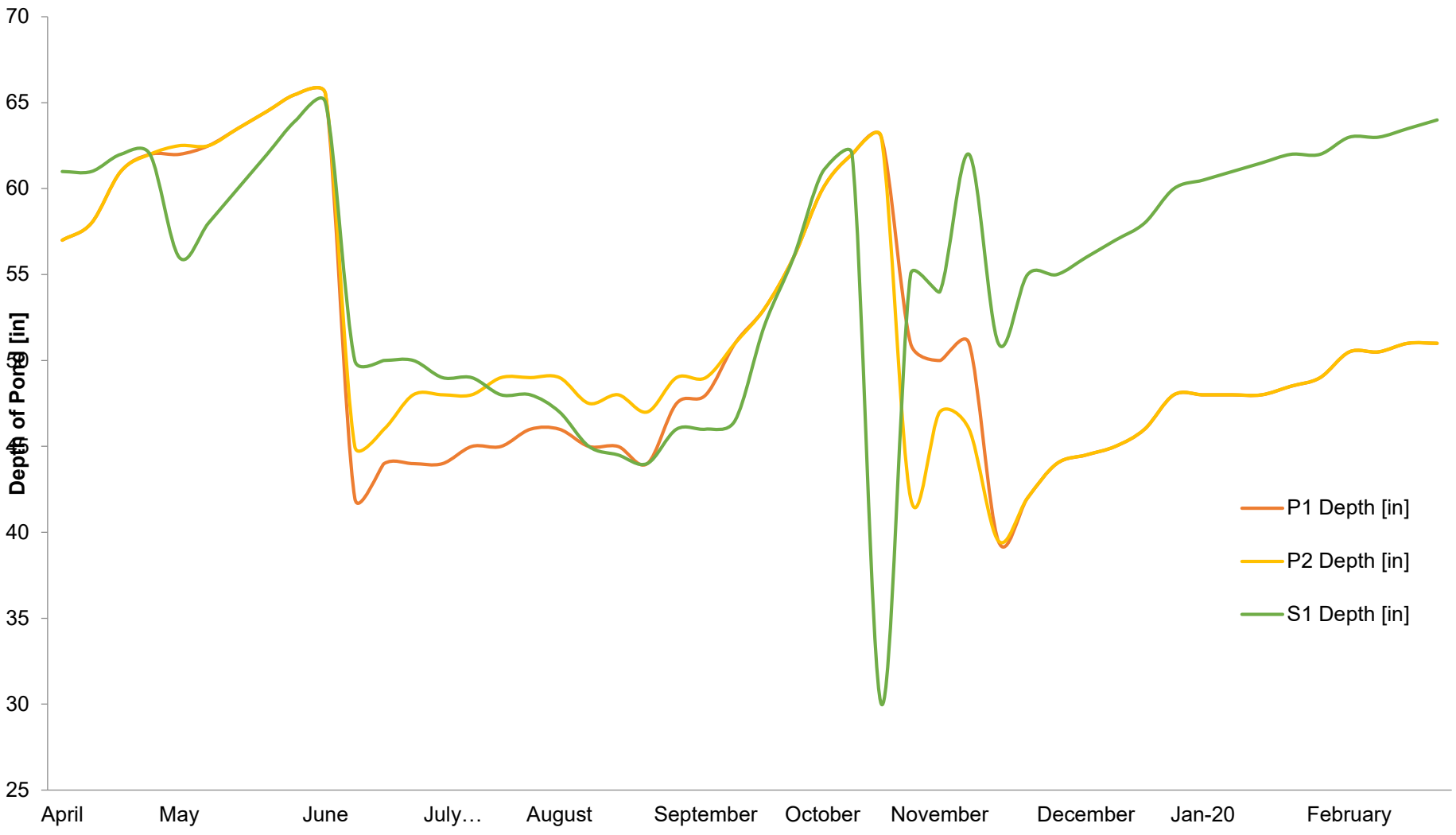
Karlstad Current

Maximum Primary 1 Height = 6 ft = 72 in

Maximum Primary 2 Height = 6 ft = 72 in

Maximum Secondary 1 Height = 6 ft = 72 in

Current HRT = 244 days



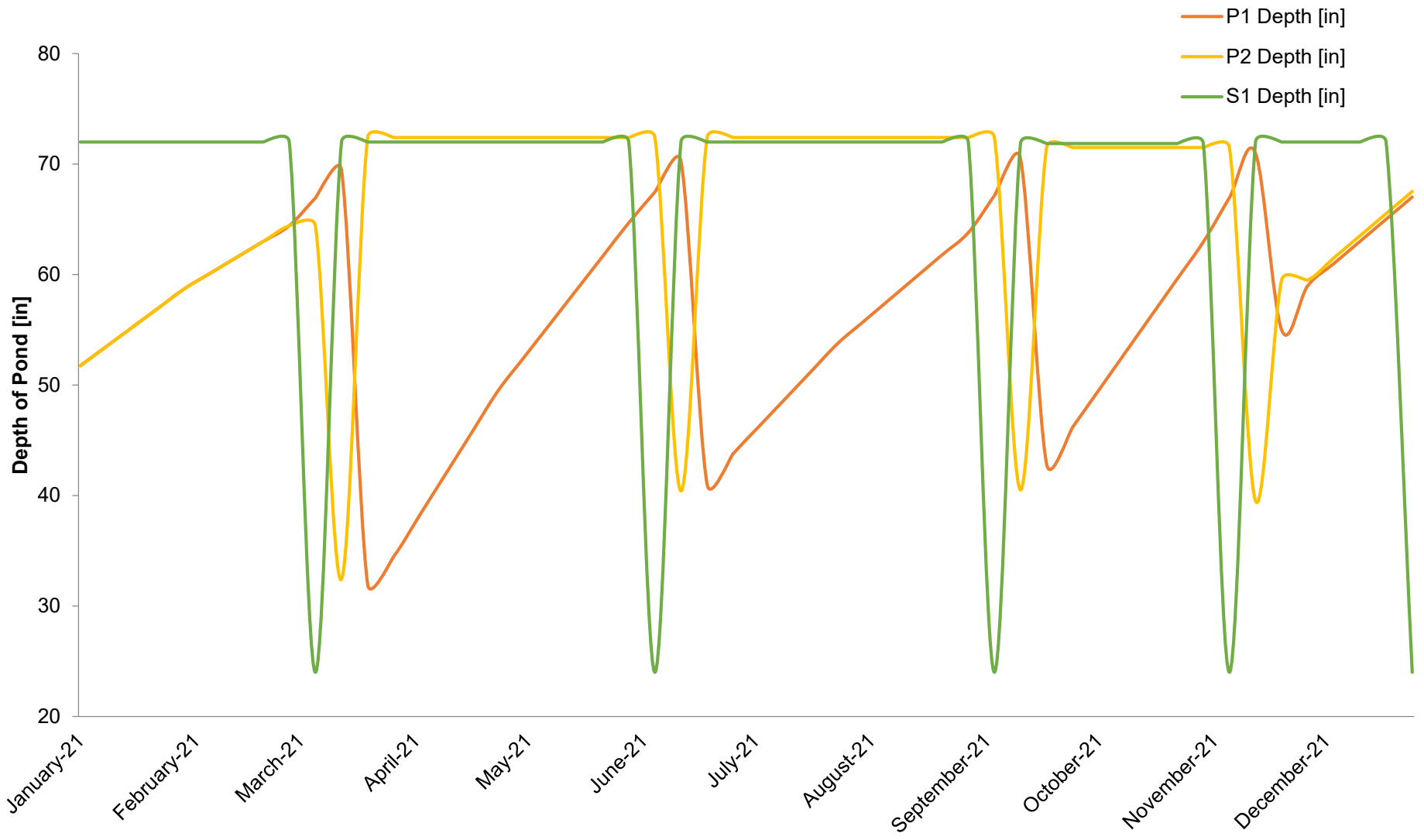
Karlstad Ideal

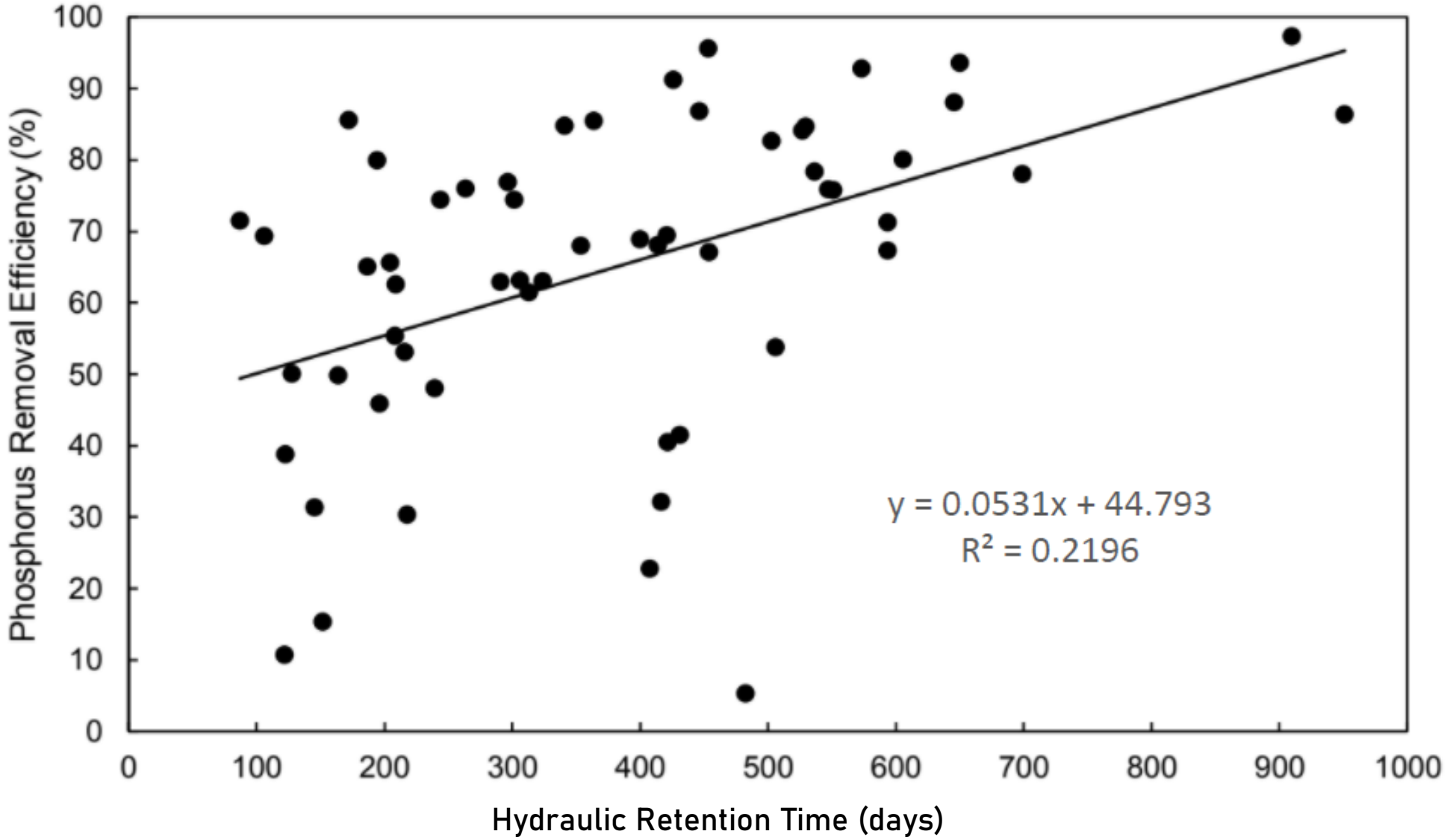
Maximum Primary 1 Height = 6 ft = 72 in

Maximum Primary 2 Height = 6 ft = 72 in

Maximum Secondary 1 Height = 6 ft = 72 in

New HRT = 350 days




Phosphorus Removal Efficiency (%)
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
y = 0.0531x + 44.793
R² = 0.2196
Hydraulic Retention Time (days)

Phosphorus Removal Improvements

	Breckenridge	Karlstad
New HRT	771 days	350 days
- Current HRT	- 608 days	- 244 days
= HRT increase	= 163 days	= 106 days
× P Removal Efficiency	× 0.05%/day	× 0.05%/day
= Increase in Efficiency	= 8.15%	= 5.3%

HRT = Hydraulic Retention Time

Yearly Phosphorus Savings

	Breckenridge	Karlstad
Increase in Efficiency	8.15%	5.3%
P Savings per Year	556 lbs	102 lbs

Breckenridge Solutions

Recommendation	Change Type	Waste Reduced (per year)	Implementation cost	Cost Effectiveness (per lb)	Cost savings	Payback period	Status
Increase Hydraulic Retention Time	Procedure change	560 lb Phosphorus	$0	$0	NA	NA	Recommended
Reduce Resident and Migratory Geese and Duck Populations	Product Addition	250 lbs Phosphorus 900 lbs Nitrogen	$820	$3.30 Phosphorus $0.90 Nitrogen	NA	NA	Recommended
Add Aluminum Sulfate	Product Addition	270 lbs Phosphorus	$4,900/year	$18 Phosphorus	NA	NA	Recommended
Reduce Inflow & Infiltration	Process Addition / Equipment Change	1,900 lb Phosphorus	NA	NA	NA	NA	Recommended

Karlstad Solutions

Recommendation	Change Type	Waste Reduced (per year)	Implementation cost	Cost Effectiveness (per lb)	Cost savings	Payback period	Status
Increase Hydraulic Retention Time	Procedure change	100 lb Phosphorus	$0	$0	NA	NA	Recommended
Reduce Resident and Migratory Geese Populations	Product Addition	100 lbs Phosphorus 300 lbs Nitrogen	$550	$5.50 Phosphorus $1.80 Nitrogen	NA	NA	Recommended
Add Aluminum Sulfate	Product Addition	75 lb Phosphorus	$2,800/year	$38 Phosphorus	NA	NA	Recommended
Reduce Inflow & Infiltration	Process Addition / Equipment Change	75 lb Phosphorus	NA	NA	NA	NA	Recommended

Personal Benefit

- Working from home & personal accountability
- Project management
- Finding information on my own

- Learning about wastewater
- Gaining insight on “The Bigger Picture”