CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT
AGENDA FOR REGULAR MEETING
Kyle Arthur, General Manager
12500 Alameda Dr
Norman, OK 73026

TIME: 6:30 P.M.
THURSDAY, October 7, 2021

TO ACCOMMODATE THE PUBLIC, INCLUDING PRESENTERS OF AGENDA ITEMS, WHO WISH TO PARTICIPATE BUT NOT TO ATTEND THE MEETING IN PERSON, VIDEOCONFERENCE AND TELECONFERENCE CAPABILITY IS BEING MADE AVAILABLE. ALTHOUGH THIS ACCOMMODATION IS PROVIDED, MEMBERS OF THE PUBLIC INCLUDING PRESENTERS ARE WELCOME TO ATTEND THE MEETING IN-PERSON.

TO PARTICIPATE AND LISTEN TO THE MEETING BY TELEPHONE, CALL TOLL FREE, 1-866-899-4679 ENTER ACCESS CODE: 383-971-237

TO PARTICIPATE AND LISTEN VIA A COMPUTER, SMARTPHONE, OR TABLET, GO TO HTTPS://GLOBAL.GOTOMEETING.COM/JOIN/383971237

BOARD MEETING PACKET CAN BE FOUND ON WEBSITE: COMCD.NET. THIS AGENDA WAS POSTED IN THE NOTICE ENCLOSURE OUTSIDE THE COMCD OFFICE GATE AT 4:30 PM ON SEPTEMBER 30, 2021.

FOR ALL THOSE ATTENDING THE MEETING IN PERSON, FACE MASKS AND SOCIAL DISTANCING WILL BE REQUIRED TO PROTECT YOURSELF AND OTHERS ATTENDING.

A. CALL TO ORDER AND ROLL CALL

B. STATEMENT OF COMPLIANCE WITH OPEN MEETING ACT

C. ADMINISTRATIVE:

1. **FINAL DRAFT REPORT AND PRESENTATION FOR THE SHORELINE STABILIZATION/FLOATING WETLANDS PROJECT BY THE OKLAHOMA WATER SURVEY AT THE UNIVERSITY OF OKLAHOMA**

2. **REPORT OF ANNUAL MONITORING RESULTS BY THE OKLAHOMA WATER RESOURCES BOARD**

D. ACTION: PURSUANT TO 82 OKLA. STATUTES, SECTION 541 (D) (10), THE BOARD OF DIRECTORS SHALL PERFORM OFFICIAL ACTIONS BY RESOLUTION AND ALL OFFICIAL ACTIONS INCLUDING FINAL PASSAGE AND ENACTMENT OF ALL RESOLUTIONS MUST BE APPROVED BY A MAJORITY OF THE BOARD OF DIRECTORS PRESENT, A QUORUM BEING PRESENT, AT A REGULAR OR SPECIAL MEETING.THE FOLLOWING ITEMS MAY BE DISCUSSED, CONSIDERED AND APPROVED, DISAPPROVED, AMENDED, TABLED OR OTHER ACTION TAKEN:

3. **MINUTES OF THE REGULAR BOARD MEETING HELD ON THURSDAY, SEPTEMBER 2, 2021, AND CORRESPONDING RESOLUTION**

4. **FINANCIAL STATEMENTS FOR OPERATING ACCOUNT FOR AUGUST 2021, AND CORRESPONDING RESOLUTION**

5. **DISTRICTS' SCHEDULE OF REGULAR MEETINGS FOR CALENDAR YEAR 2022**

6. **ANNUAL REPORT FOR FY 20-21 TO CLEVELAND COUNTY COURT**

7. **ADDITIONAL EXPENDITURE IN EXCESS OF THE ORIGINAL CONTRACT AMOUNT FOR MATTHEWS TRENCHING PERTAINING TO THE DEL CITY PIPELINE PROJECT, AND CORRESONDING RESOLUTION**

E. DISCUSSION:

8. **LEGAL COUNSEL'S REPORT**

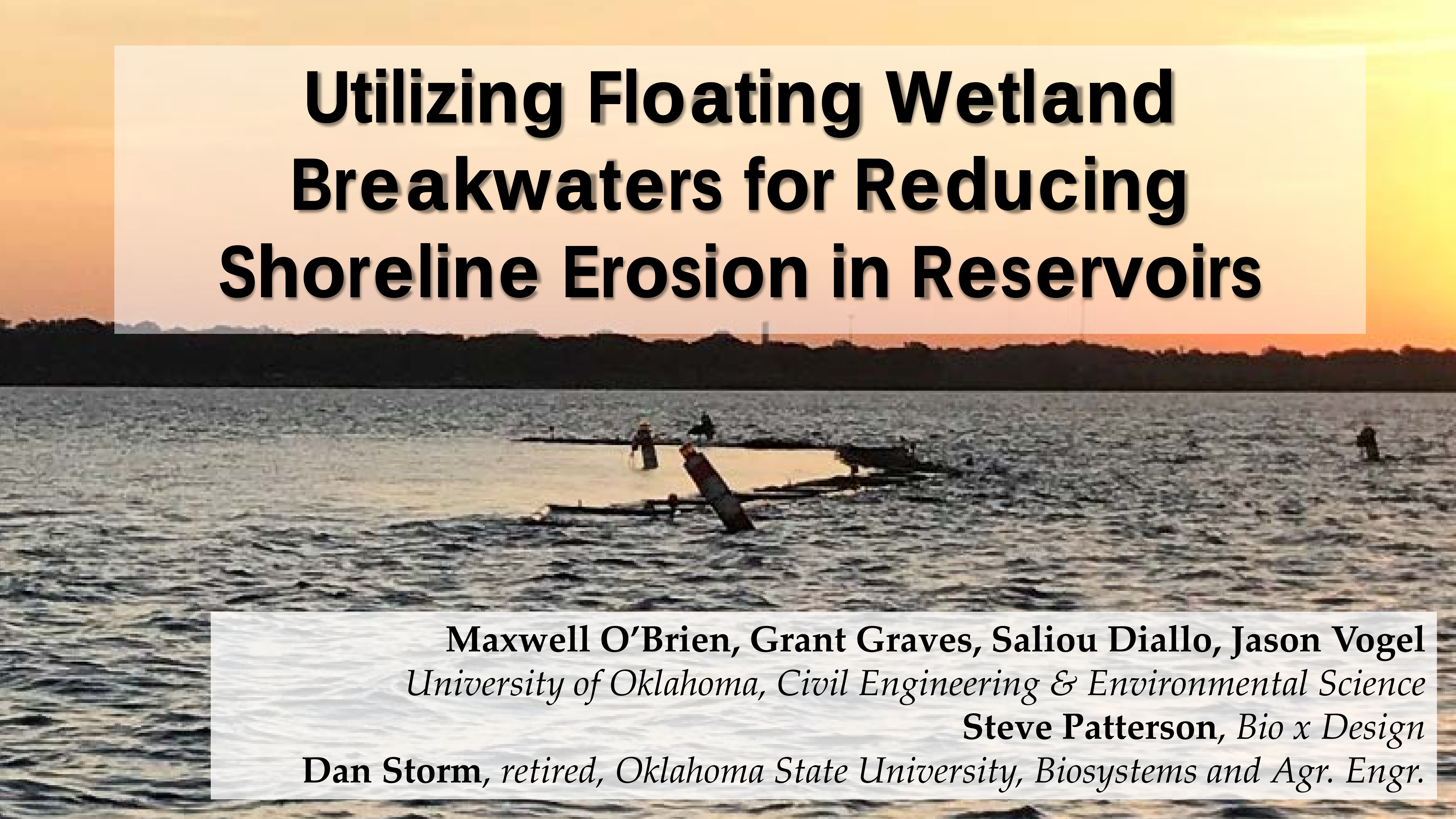
9. **GENERAL MANAGER'S REPORT**

10. **NEW BUSINESS (ANY MATTER NOT KNOWN PRIOR TO THE MEETING AND WHICH COULD NOT HAVE BEEN REASONABLY FORESEEN PRIOR TO THE POSTING OF THE AGENDA)**

F. ADJOURN

Item C.1.

Utilizing Floating Wetland Breakwaters for Reducing Shoreline Erosion in Reservoirs



Maxwell O'Brien, Grant Graves, Saliou Diallo, Jason Vogel
University of Oklahoma, Civil Engineering & Environmental Science
Steve Patterson, *Bio x Design*
Dan Storm, *retired, Oklahoma State University, Biosystems and Agr. Engr.*

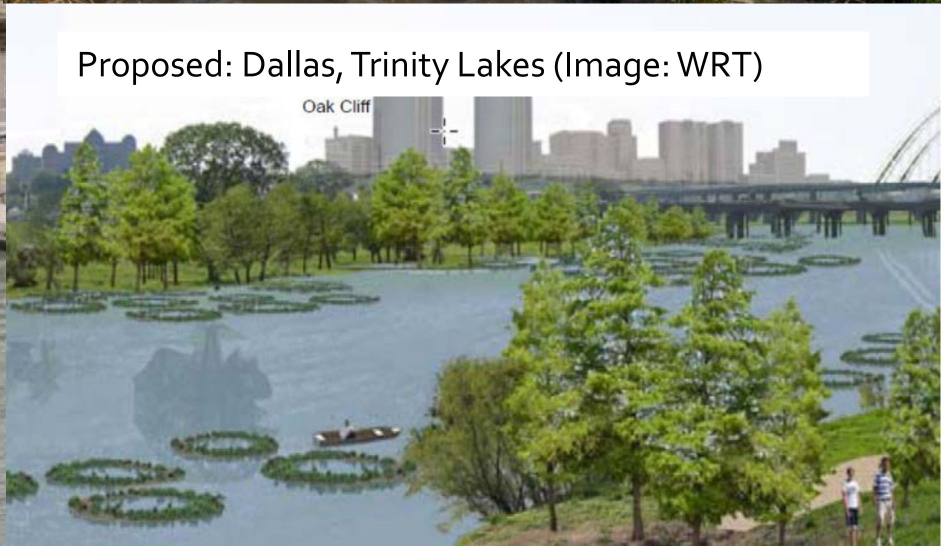
Background

Constructed floating wetlands


Chesapeake Bay Stormwater Network


(Photo: Martin Ecosystems)


Chicago River (Image: Martin Ecosystems)



Proposed: Dallas, Trinity Lakes (Image: WRT)

Pollutant Removal Summary
(from Chesapeake Bay Report FINAL REPORT)

- Majority of pollutant removal in the biofilm associated with roots
  - Enhanced particulate settling (dominant removal mechanism)
  - Biosorbance of P and dissolved metals
  - Favorable microbial growth enhances N removal processes
  - Net source of organic matter enhances the formation of flocs

Recommendations of the Expert Panel to Define Removal Rates for Floating Treatment Wetlands in Existing Wet Ponds

Sarah Lane, David Sample, Andy Lazur, Ryan Winston, Chris Streb, Drew Ferrier, Lewis Linker and Kevin Brittingham

APPROVED FINAL REPORT

WQGIT, September 12, 2016

Prepared by:

Tom Schueler and Cecilia Lane
Chesapeake Stormwater Network
and
David Wood
Chesapeake Research Consortium

Photo credit: Bill Hunt, NCSU

Pollutant Removal Summary
(from Chesapeake Bay Report FINAL REPORT)

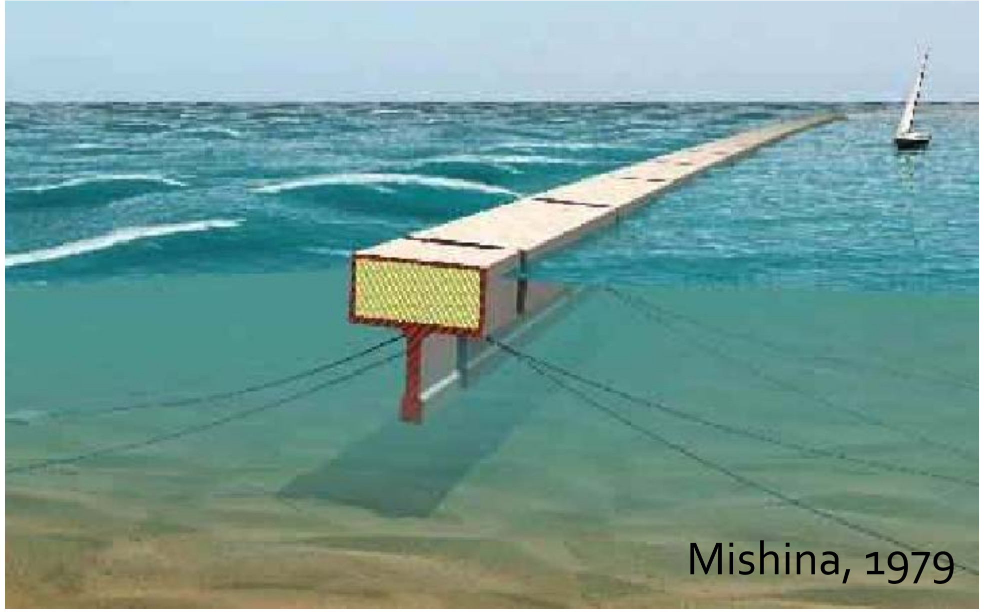
- Denitrification can occur in the mat
- Plant uptake not a major player, although this is variable
- Need at least 10% coverage to improve nutrient and sediment removal.

Table 7. Incremental Pollutant Removal Rates for FTW Pond Retrofits

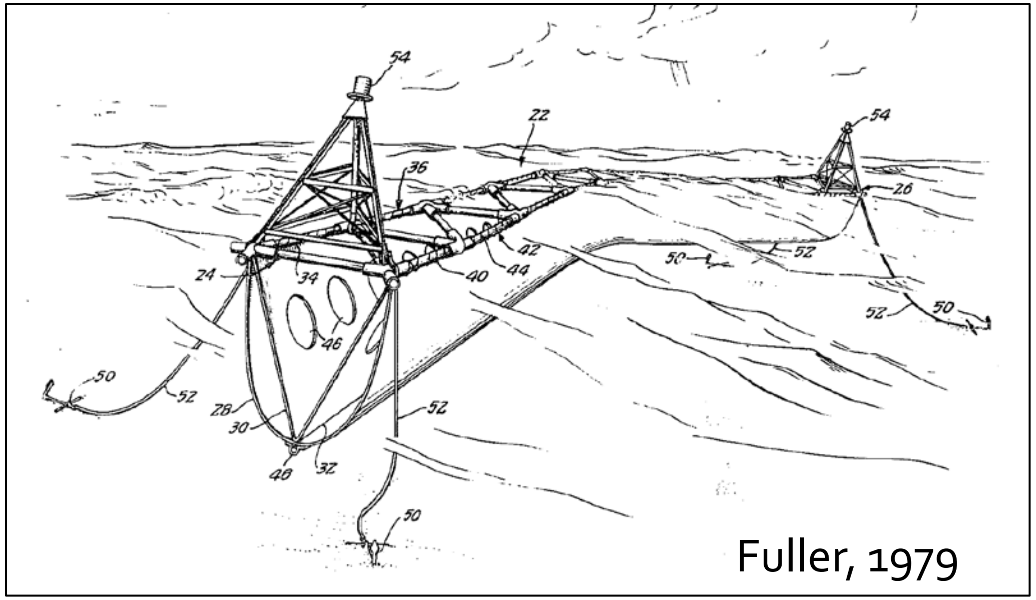
Pollutant	Raft Coverage in Pond				
	10%	**20%**	**30%**	**40%**	**50%**
Total Nitrogen	0.8%	1.7%	2.5%	3.3%	4.1%
Total Phosphorus	1.6%	3.3%	4.9%	6.5%	8.0%
Total Suspended Solids	2.3%	4.7%	7.0%	9.2%	11.5%

Floating Wavebreaks

wavebrake.com



Mishina, 1979



Fuller, 1979

Lake Thunderbird Floating Wetland Breakwaters

PROJECT BACKGROUND

- Shoreline erosion is a significant problem in many reservoirs in Oklahoma, including Lake Thunderbird, due to highly erodible and unstable shorelines with sparse vegetative cover that are exposed to continuous wave action.
- Traditional shoreline restoration approaches are often costly and produce varied results (e.g. rip-rap/artificial breakwater)
- Floating wetland breakwaters may be an alternative approach to reducing shoreline erosion by dissipating wave energy before impacts occur near the shore.
  - They also can provide habitat, ecological and recreational benefits.

Heavily eroded shoreline at Lake Thunderbird (OWRB).

Lake Thunderbird Floating Wetlands

PROJECT GOAL

- **Design, optimize, implement and monitor a floating wetland breakwater for wave reduction to reduce overall shoreline erosion at Lake Thunderbird.**

Heavily eroded shoreline at Lake Thunderbird (OWRB).

Project Outline

- **Full-scale Mesocosm (OU Aquatic Research Facility)**
  Aug 2018 – Mar 2019
  - **Test various frame parameters (# of pipes, pipe length) for wave height and energy reduction**
  - **Optimize and develop field frame design**

- **Laboratory (Carson Engineering Center)**
  Jul 2019 – Apr 2020
  - **Scaled models of mesocosm design, using frame ratios (pipe length, # of pipes)**
  - **Laboratory flume tests (wave height and energy reduction)**
  - **Test similarity of response at different scales**

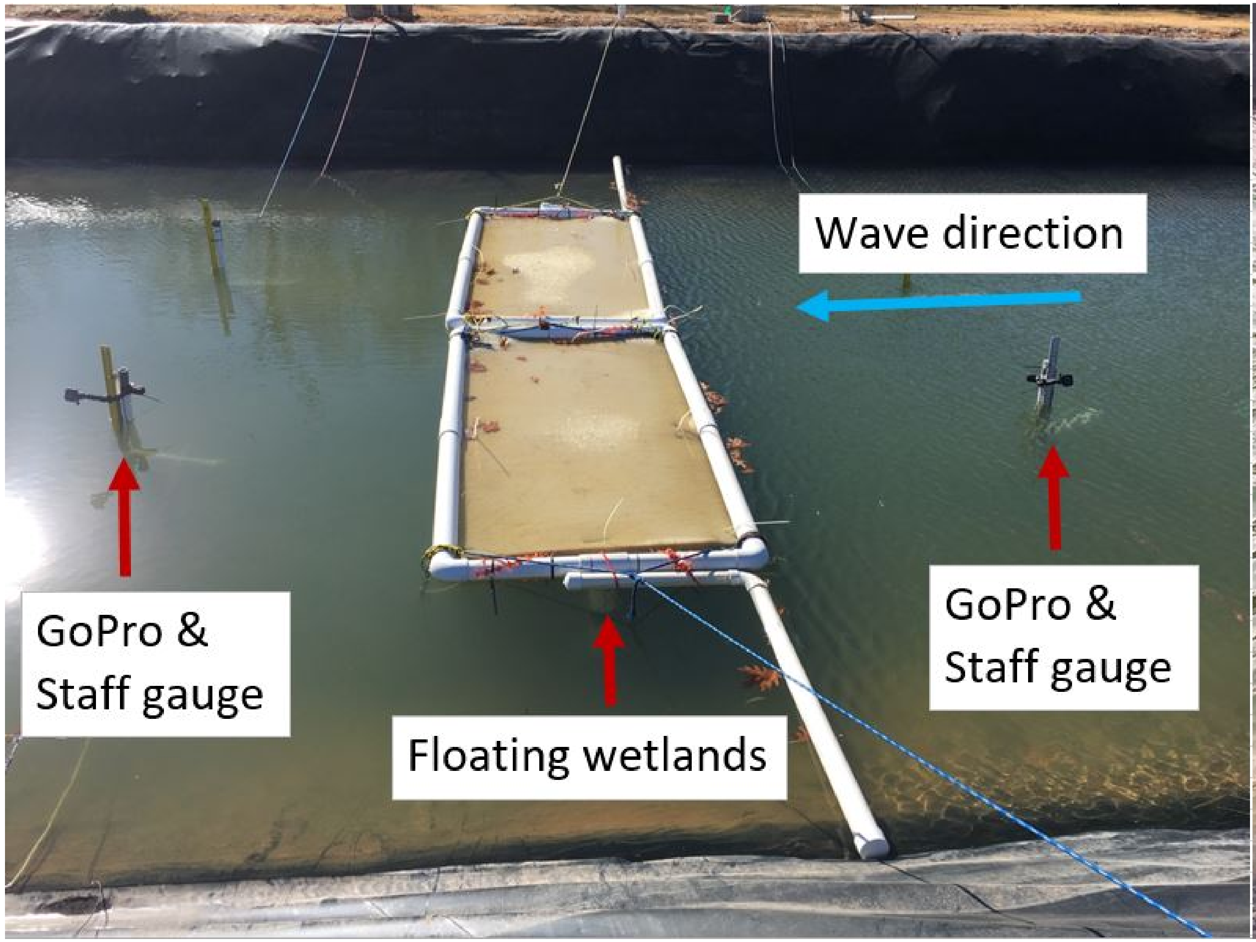
- **Field (Lake Thunderbird)** ***Apr 2019 - Feb 2021***
  - **Install a 200-foot section of floating wetland frame**
  - **Monitor and analyze wave height and energy reduction, shoreline erosion, and biological metrics (opportunistically) to evaluate performance**


Floating wetland frame testing at the OU Aquatic Research Facility (left)


Floating wetland frame at the OU Aquatic Research Facility

Step 1: Testing at the OU Aquatic Research Facility (ARF)

Full-scale Controlled Mesocosm System

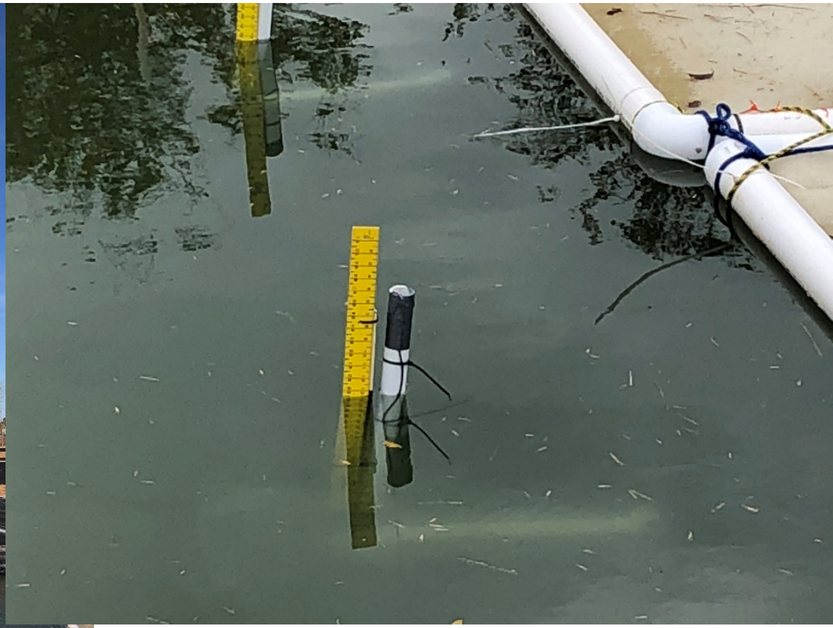


Full-scale Controlled Mesocosm System

Wave Measurement Techniques

Pond Measurements

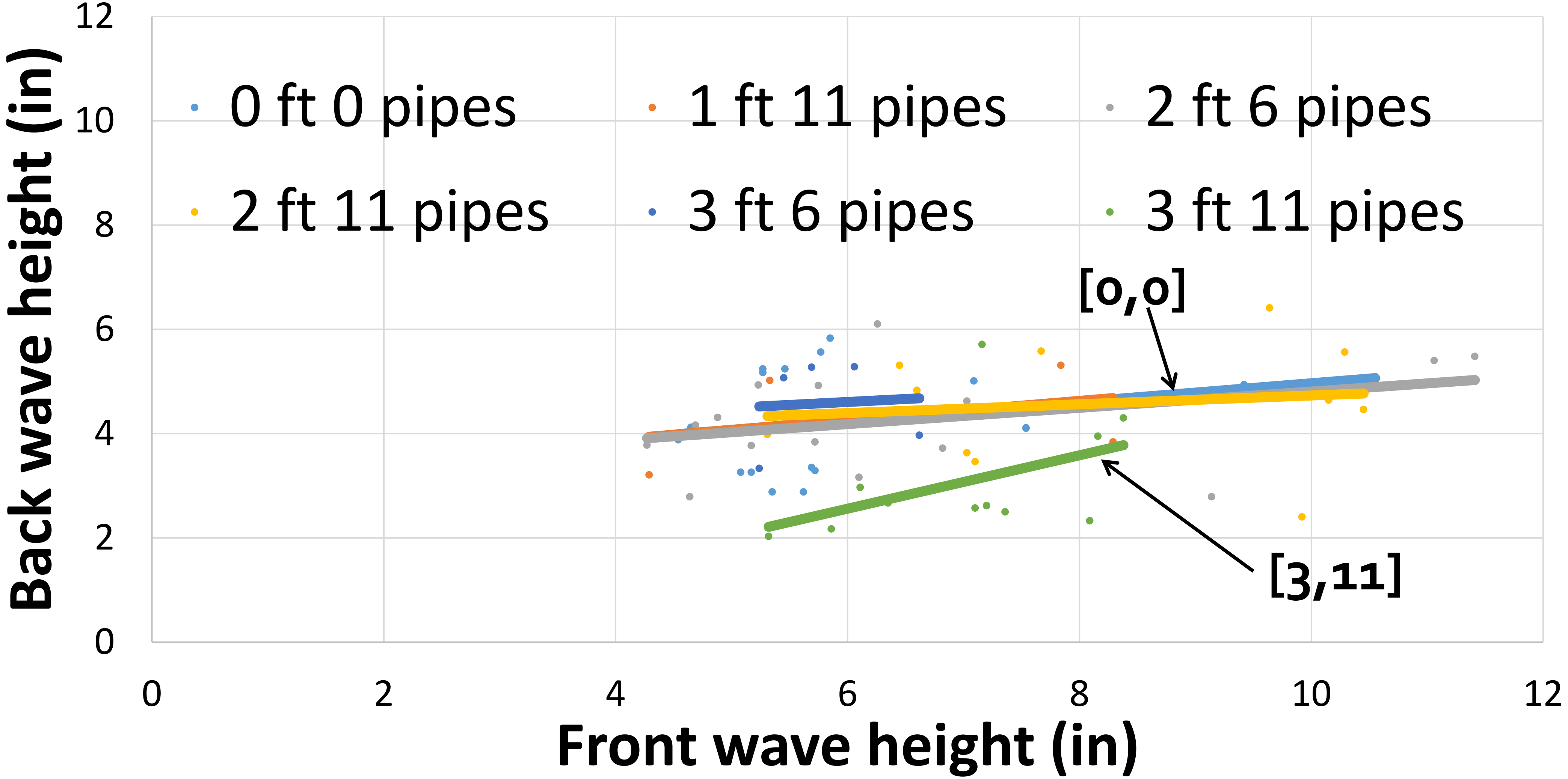
- Pressure Transducers
- Pitot tube w/ transducers
- GoPro video (staff gauge)



Testing Scenarios

- Pipe length
  - 0, 1, 2, 3
- Number of pipes
  - 0, 6, 11
- Rows
  - 1, 2

FWB Design Wave Height Comparisons
(all waves)



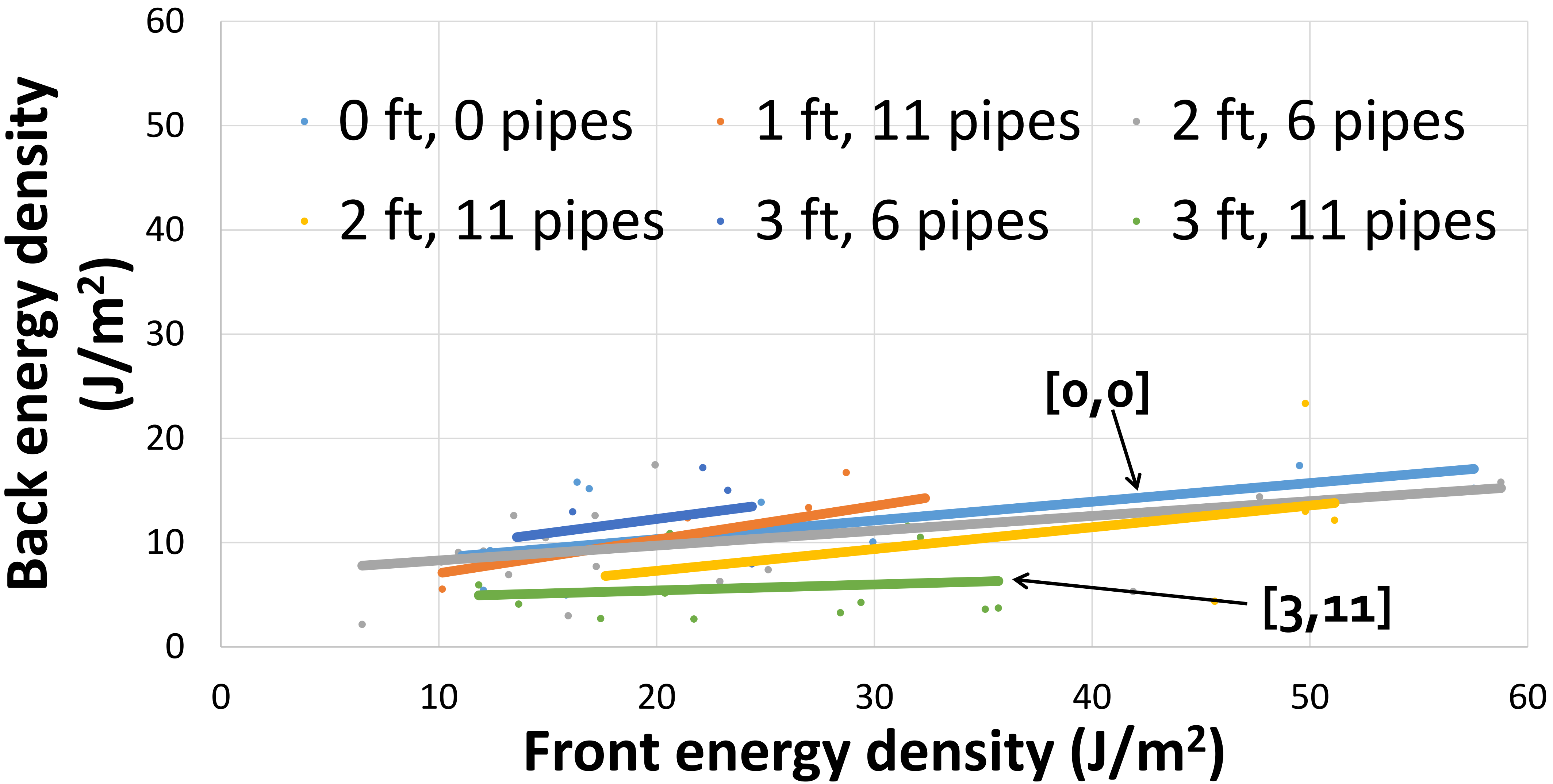
Wave Energy

$$E = 1/16\rho g H_{mo}^2$$

- E = mean wave energy density per horizontal area (J/m^2)
- Hmo = critical wave height (m)

- Source: Holthuijsen, Leo H. (2007). *Waves in oceanic and coastal waters*. Cambridge: Cambridge University Press. ISBN 978-0-521-86028-4

FWB Design Wave Energy Comparisons
(critical waves)



Energy Comparisons for a Six Inch Wave

Design Configuration	Energy Reduction from [0,0] (J/m^2)
[0 pipes,0 feet]	--
[6 pipes, 2 feet]	0.4 (4%)
[6 pipes, 3 feet]	-1.4 (-15%) **
[11 pipes, 1 foot]	0.9 (9%)
[11 pipes, 2 feet]	3.2 (34%)
[11 pipes, 3 feet]	4.3 (45%)

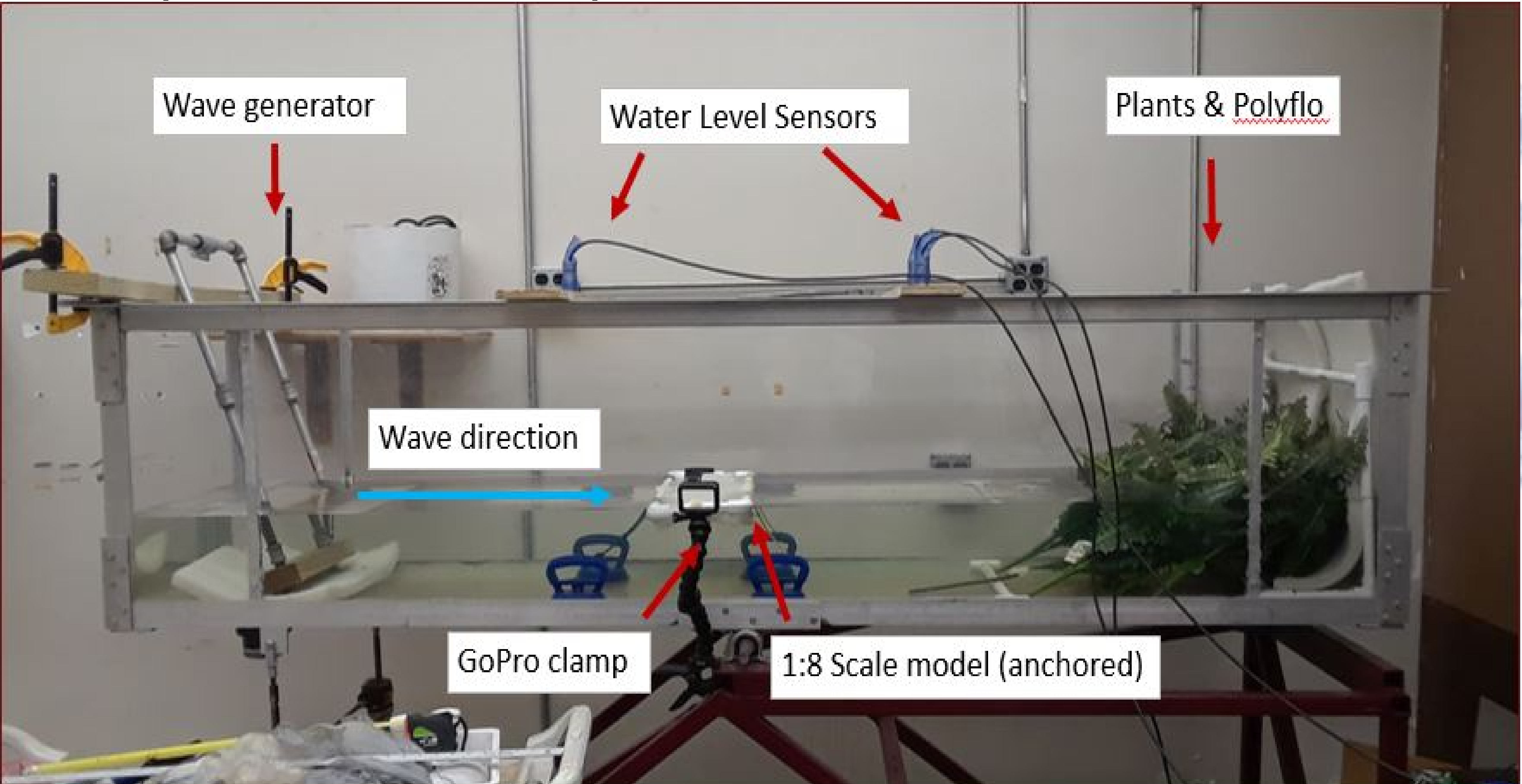
** limited wave range tested

Materials Cost Analysis on a 10 ft section

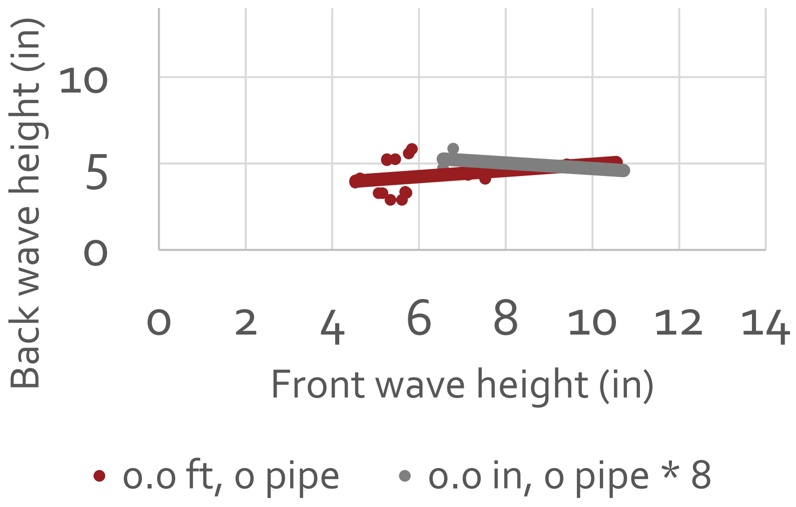
Design Configuration	Estimated Material Cost per 10 ft section	Cost per Energy Density Reduction
[0 pipes,0 feet]	$2,080	$424
[6 pipes, 2 feet]	$3,040	$573
[6 pipes, 3 feet]	$3,145	$898
[11 pipes, 1 foot]	$3,190	$550
[11 pipes, 2 feet]	$3,205	$396
[11 pipes, 3 feet]	**$3,220**	**$354**

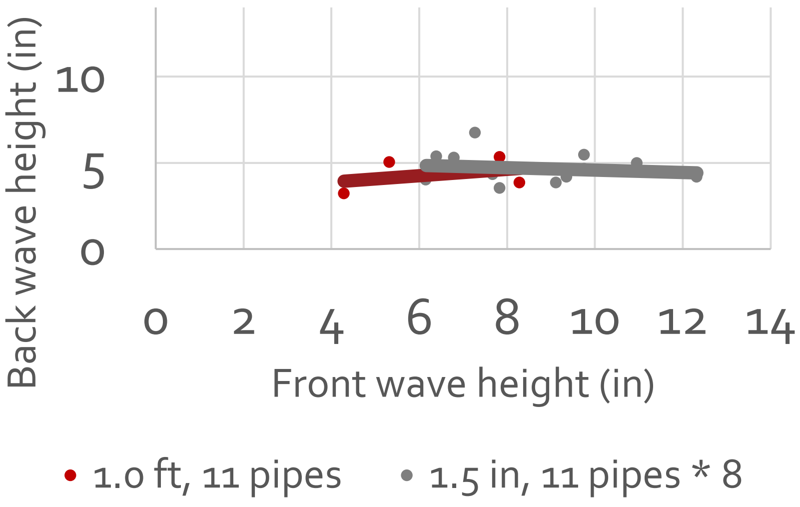
Step 2: Laboratory Scale Model Studies

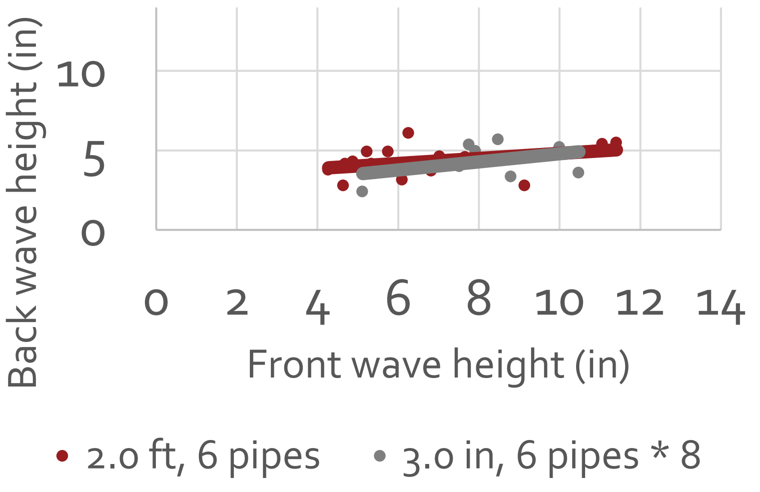
Experimental setup

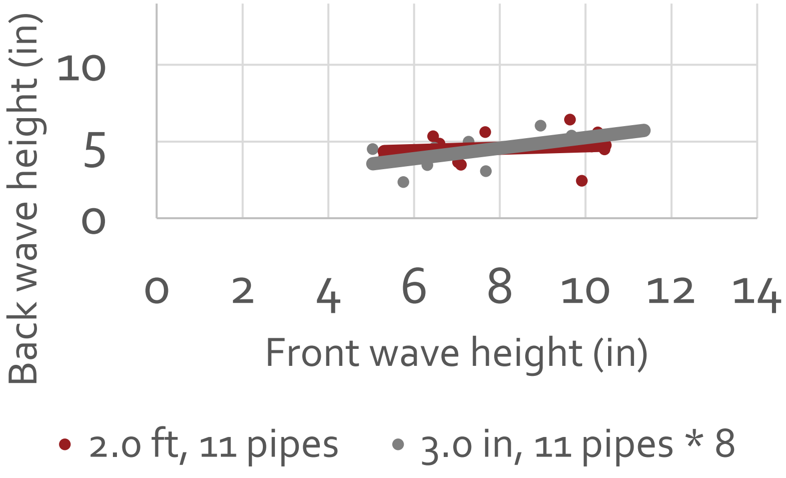


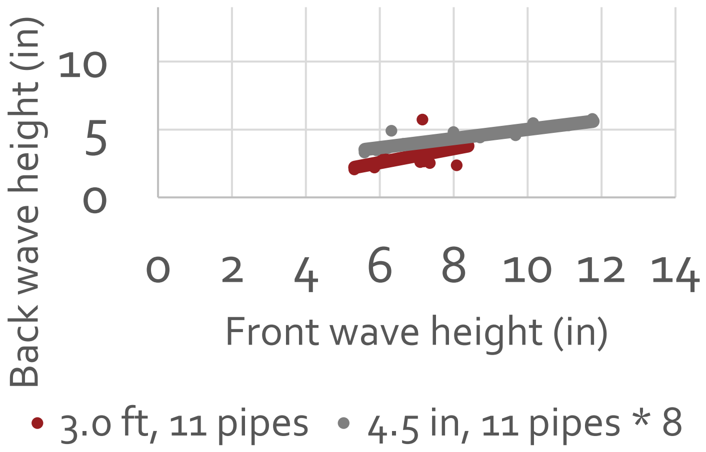
Scale comparison wave height



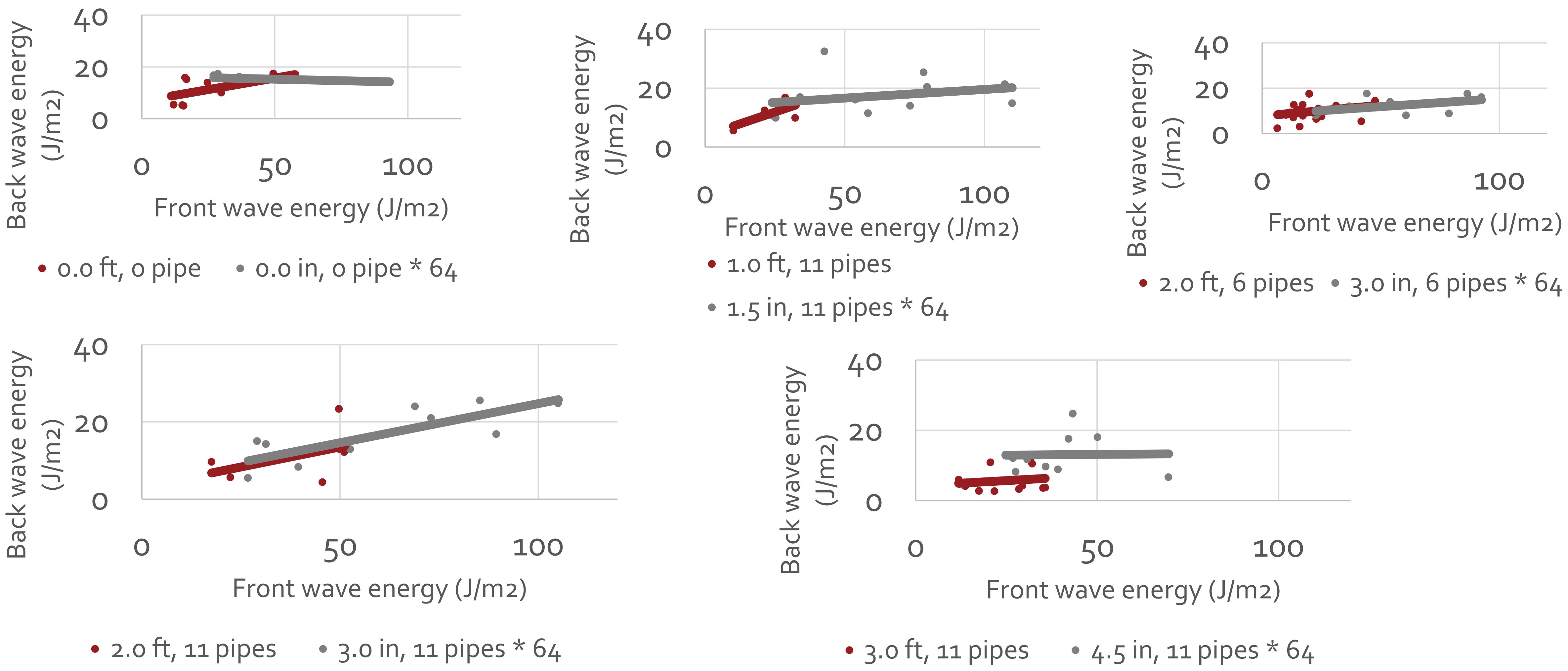








Scale comparison wave energy density



Conclusions

- Similar wave height and energy density reduction between prototype and model scale
- 3.0 ft, 11 pipes configuration significantly different at prototype scale for energy reduction
- Metal connectors used at prototype scale could have affected wave reduction through weight and submergence of the frames (force similitude) (Ozeren, 2009)

Significance

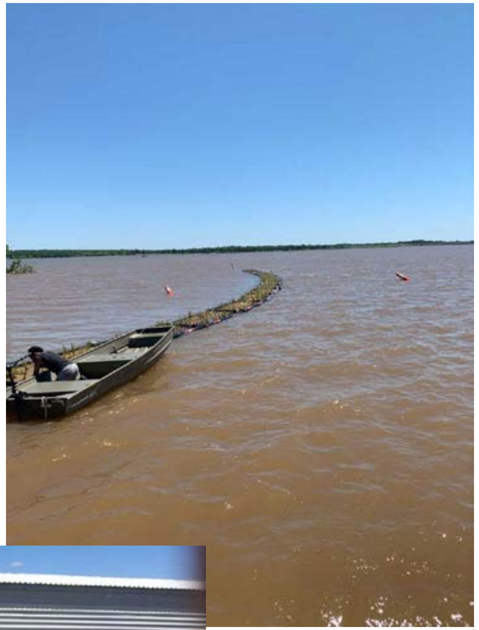
- Smaller versions of FWB frames can be utilized to predict performance at larger scales, paying special attention to force similitude.

Step 3: Lake Thunderbird Implementation

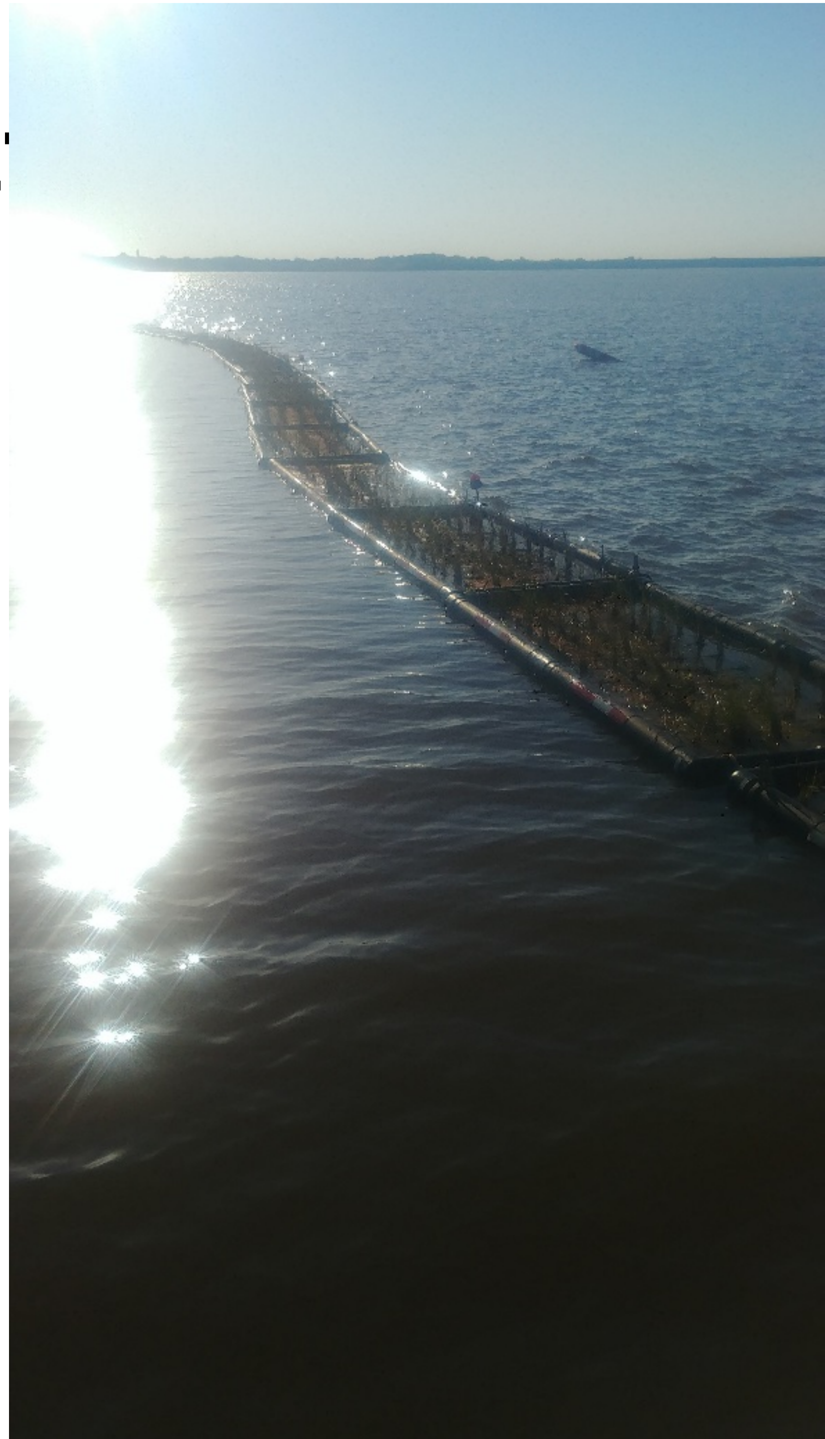
Lake Thunderbird Site Location

Floating Wetland Implementation

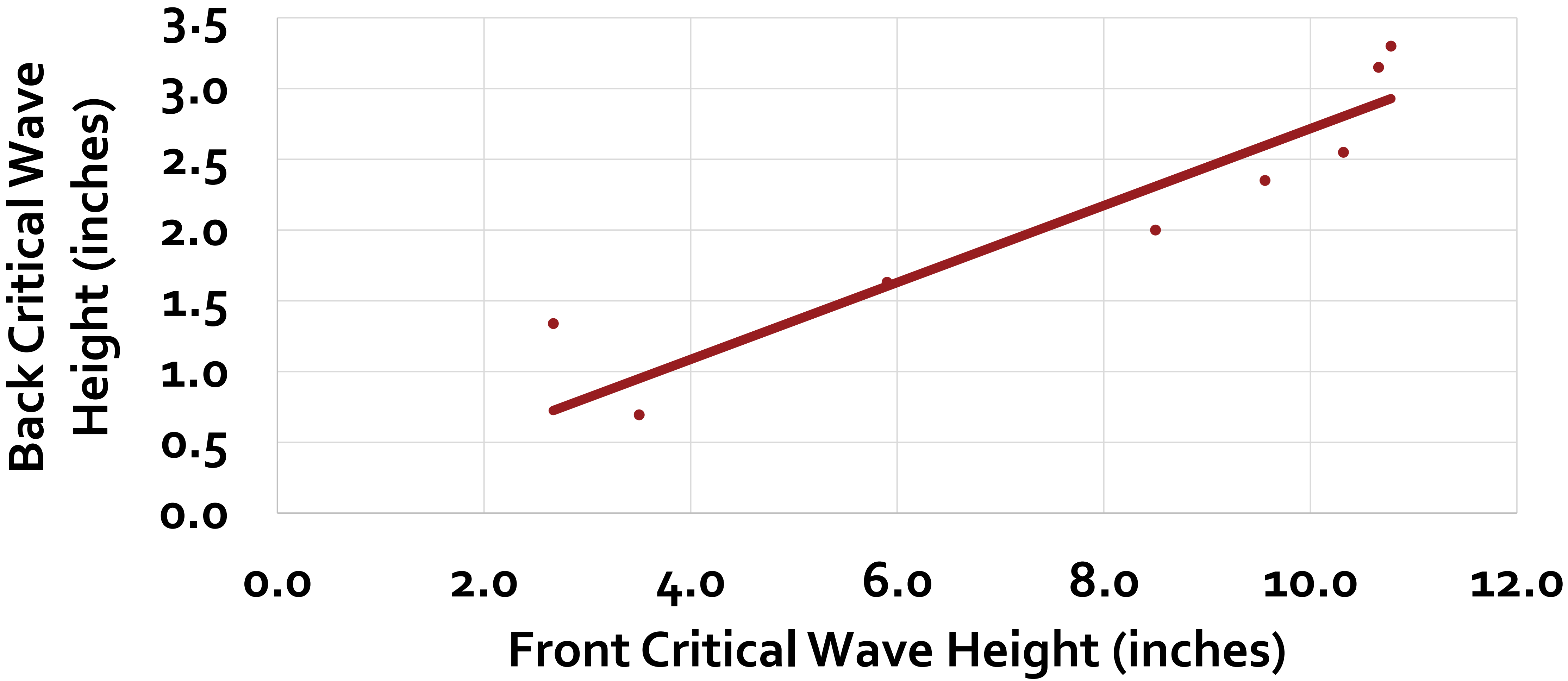
- Installed late May 2019
- Replanted June 2020 (in bold below)
- 200-foot long section
- Plants
  - **Common Rush *(Juncus effuses)***
  - **Water Willow (*Justicia americana)***
  - Pennywort (*Hydrocotyle verticillata)*
  - Water Primrose *(Ludwigia)*
  - March Mallow (*Hibiscus laevis)*



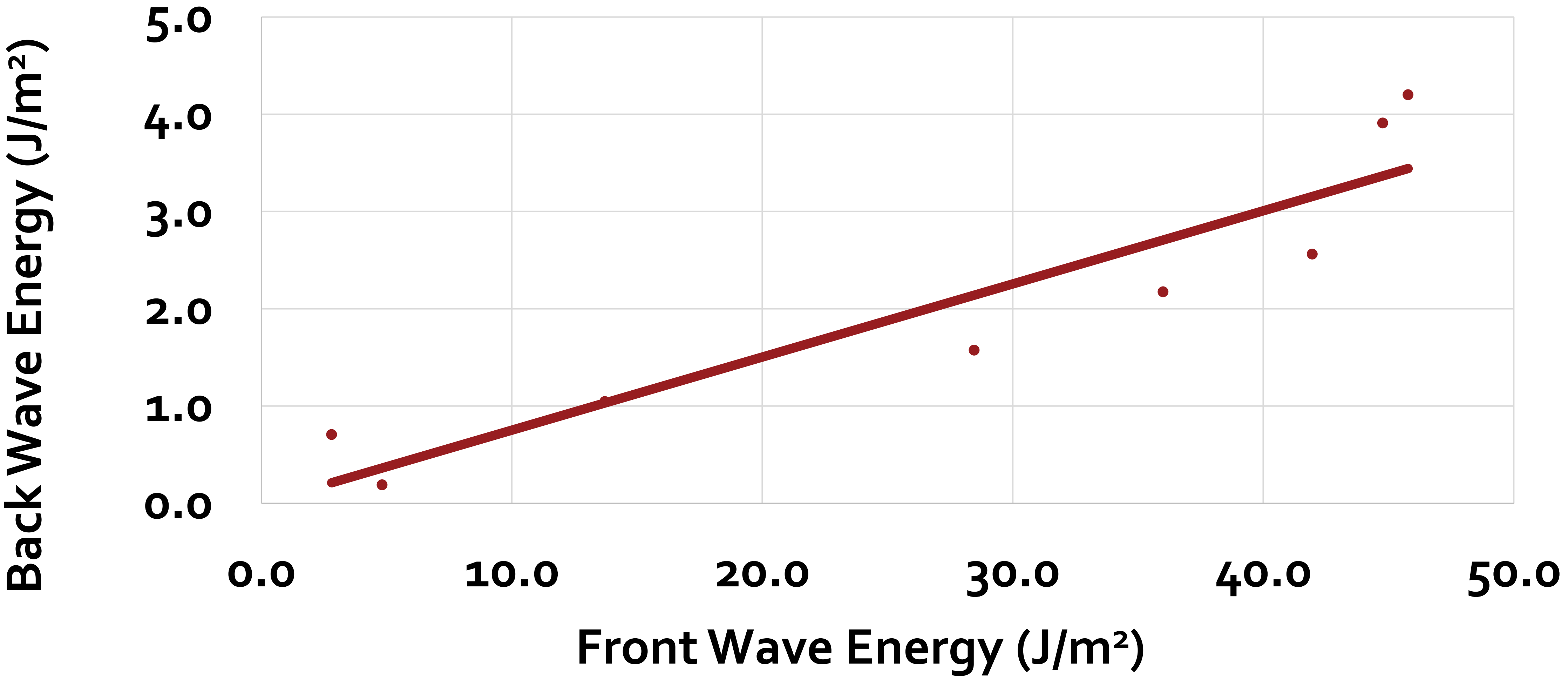
Floating Wetland Implementat
Planting



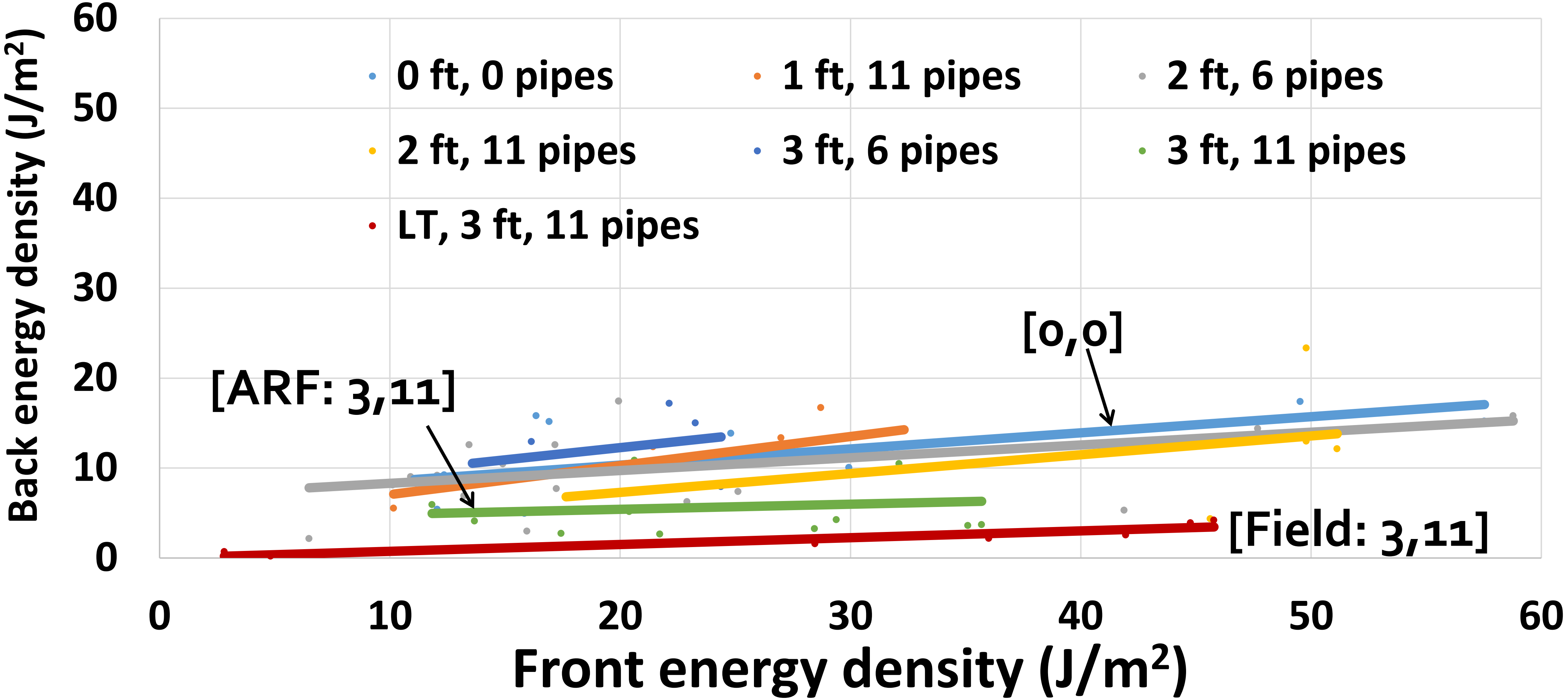
Field Wave Height Reduction Results
(11 pipes, 3 ft long)



Field Wave Energy Reduction Results
(11 pipes, 3 ft long)



Field and ARF (Mesocosm) Wave Energy Reduction Results



Comparison to Other Floating Wavebreaks

$$K_t = \frac{outgoing\ wave\ power}{incoming\ wave\ power}$$

Source	Wave Transmission Coefficient (K_t) range: Prototype scale	Model scale	Field Scale	Description
Neelamani (2018)	0.6 - 0.8	NA	NA	Pontoon floating breakwater with varying skirt wall sizes
Uzaki (2011)	NA	0.3 - 1.0	NA	Steel pontoon floating breakwater with trusses
Ozeren (2011)	0.2 - 0.9	NA	NA	Cylindrical floating breakwater
Webb (2014)	NA	0.4-1.0	NA	Biohaven floating wetland breakwater, no plants
FWB [0.0 ft, 0 pipes]	0.5-1.0	0.7-0.9	NA	Floating Wetland Breakwater with no ballast
FWB [1.0 ft, 11 pipes]	0.5-0.9	0.3-0.9	NA	Floating Wetland Breakwater with pipe ballasts
FWB [2.0 ft, 6 pipes]	0.3-1.0	0.3-0.7	NA	Floating Wetland Breakwater with pipe ballasts
FWB [2.0 ft, 11 pipes]	0.4-0.8	0.4-0.9	NA	Floating Wetland Breakwater with pipe ballasts
FWB [3.0 ft, 11 pipes]	0.3-0.8	0.5-0.8	0.2-0.5	Floating Wetland Breakwater with pipe ballasts

Jet Erosion Test (JET)

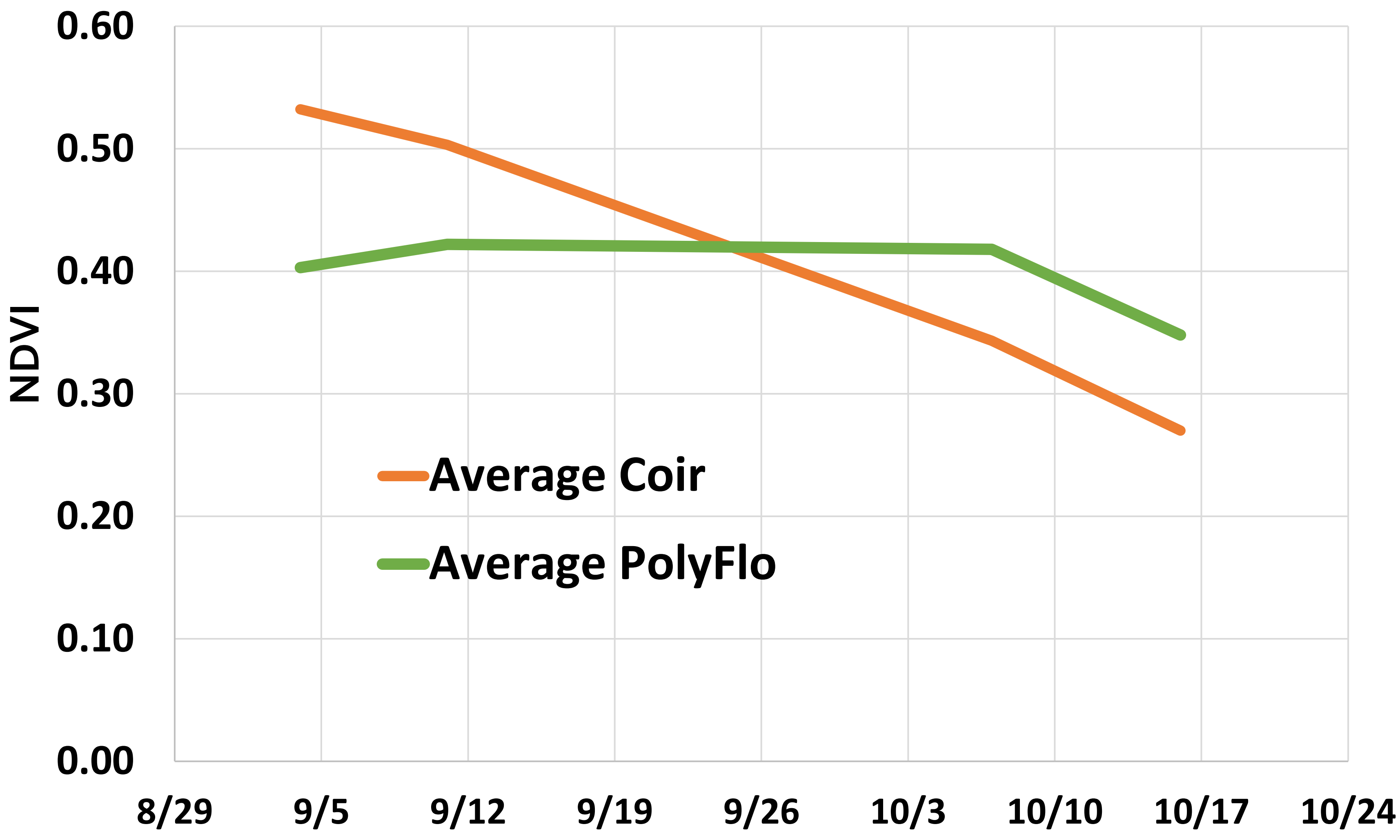
- A Jet Erosion Test (JET) estimates critical shear stress using a jet of water sprayed at a known pressure into the soil, and measuring the scour hole that is formed.
- Using linear wave theory, the critical shear stress for the soil to begin the process of detachment erosion on our study bank equates to the energy from a

<u>**3.1 inch wave**</u>

Wave Reduction Compared to JET Test Results for Days with a SW to SE wind

	No Wavebreak	With Floating Wetland Wavebreak, 11 Pipes, 3-ft Length [Field]
Incoming 5-minute Average Wave Height for outgoing wave (in), estimated from regression	Percentile	Outgoing Wave Height (in)
3.1	66%	0.8
11.4	96%	3.1
13.0	97%	3.5
47	*100%*	*13*

Plant Survival in Growth Material



Picture taken during planting

Fish Surveys

Lake Thunderbird Fish Survey Results (November 2019)					
Floating Wetland Breakwaters (FWBs)			Control		
Species	Count	Mean Length (mm)	Species	Count	Mean Length (mm)
Bluegill	2	158	Bluegill	0	--
Channel Catfish	1	372	Channel Catfish	0	--
Common Carp	1	508	Common Carp	1	660
Flathead Catfish	0	--	Flathead Catfish	1	710
Gizzard Shad	2	223	Gizzard Shad	6	216
Largemouth Bass	9	351	Largemouth Bass	2	450
Silverside	2	76	Silverside	7	51
Saugeye	0	--	Saugeye	2	272
White Bass	0	--	White Bass	6	216
White Crappie	1	234	White Crappie	0	--
Total	21 (7 types)		Total	18 (7 types)	

Fish Surveys

Lake Thunderbird Fish Survey Results (August 2020)					
Floating Wetland Breakwaters (FWBs)			Control		
Species	Count	Mean Length (mm)	Species	Count	Mean Length (mm)
Bluegill	1	147	Bluegill	0	--
Channel Catfish	1	290	Channel Catfish	0	--
Common Carp	0	--	Common Carp	0	--
Flathead Catfish	0	--	Flathead Catfish	0	--
Gizzard Shad	15	185	Gizzard Shad	40	216
Largemouth Bass	2	329	Largemouth Bass	0	--
Silverside	0	--	Silverside	0	--
Saugeye	0	--	Saugeye	0	--
White Bass	2	250	White Bass	1	216
White Crappie	0	--	White Crappie	0	--
Total	25 (4 types)		Total	41 (2 types)	

Design Modifications and Lessons Learned

- Leaky Seams
- Support Braces
- Plant Establishment
- Wave Measurement

Preliminary Materials Cost per Day of No Erosion over a 20 year design life

BMP	Material Cost per 10 ft section	Cost per Day of No Erosion over 20-yr Design Life *** ($/day/ft)
Rip Rap	$1,000-$22,000	$0.013-0.30
Living Shoreline	$1,000-$5,000	Not Determined
Retaining Walls	$3,800-$17,000	$0.052-0.23
Biohaven Floating Wetland Breakwater	$2,700	$0.047 (78% of the days)
Floating Wetland Breakwater [11 pipes, 3 feet]	$3,200 **	$0.046 (96% of the days)

Rip-rap Cost: various internet sources
Living Shorelines Cost Source: https://www.fisheries.noaa.gov/insight/understanding-living-shorelines ; reduction of erosion days cannot be estimated
Concrete Walls Cost Source: http://southatlanticalliance.org/wp-content/uploads/2016/04/17-Hoffman-The-Costs-of-Shoreline-Stabilization.pdf
Biohaven FWB Cost Source: Company quote; Percent wave reduction calculated based on Webb, 2014
** NOTE: Preliminary estimation that does not include installation, maintenance or time value of money; FWB costs should be reduced significantly with roto-mold

Next Steps

- Develop Roto-mold for one-piece frame
- Additional demonstration site with new frame, allowing ample time for plant establishment (entire season?)
- Focus on Poly-Flo media
- Continue researching best plants for these situations

Acknowledgements:

Central Oklahoma Master Conservancy District

US Bureau of Reclamation

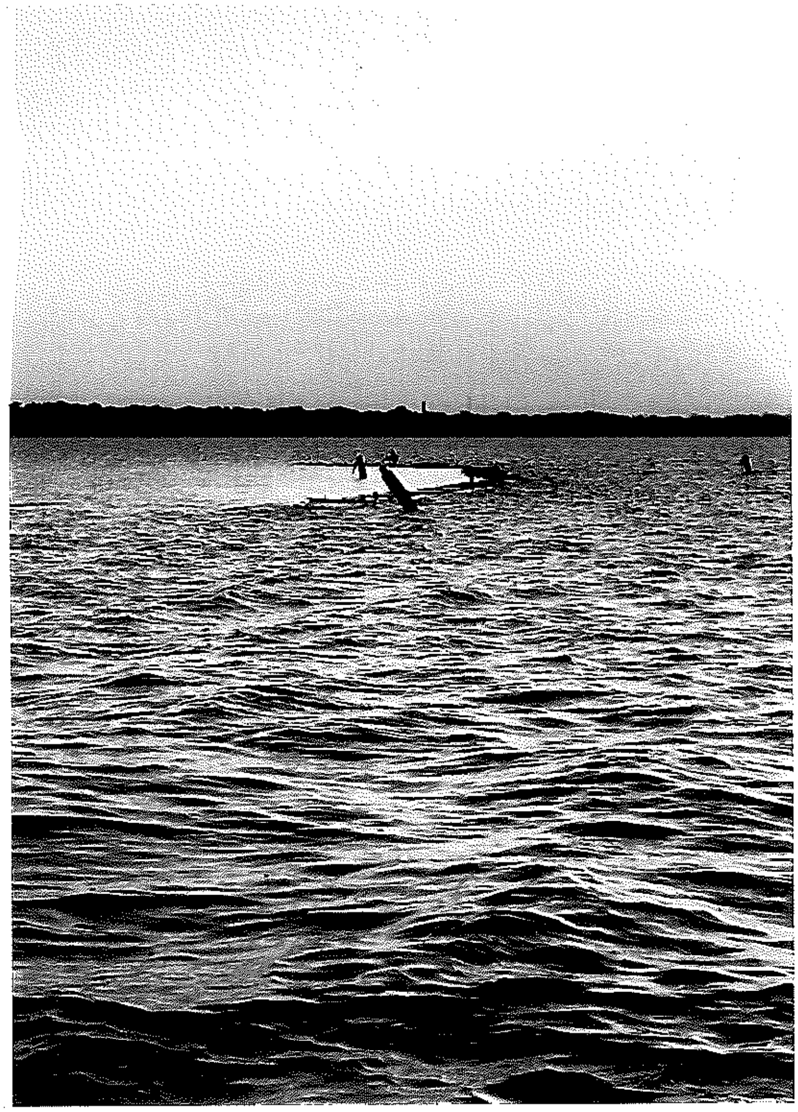
Steve O'Donnell, Oklahoma Department of Wildlife Conservation

Undergraduates and staff at the Oklahoma Water Survey

Questions??

Lake Thunderbird Shoreline Erosion Research Project

Final Project Report



Submitted by:

School of Civil Engineering and Environmental Science
University of Oklahoma

Submitted to:

Central Oklahoma Master Conservancy District

September 2021

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Executive Summary

Lake Thunderbird, which is located to the east and south of Oklahoma City, is on the Army Corps of Engineers 303(d) list of impaired water bodies due to three limiting factors, one of which is turbidity. The lake has approximately 50 miles of shoreline with 83% having some degree of erosion. Over the years, shoreline erosion has resulted in significant loss of shoreline and deposition of the eroded material into the lake, effectively reducing the holding capacity of the lake and adversely affecting water quality. To reduce the erosive action of the waves, this project completed to utilize floating wetland breakwaters (FWBs) anchored near the shoreline to reduce the energy from wave action.

The three objectives of this study were: (1) Test multiple FWB frame designs to determine the best design for maximizing wave-energy reduction; (2) Complete laboratory-scale experiments on model FWB frames to determine the viability of using scale models to predict full-scale performance; and (3) Complete field testing of the selected design to determine in-situ wave reduction and the resulting impact on shoreline erosion.

Overall, the project was successful in meeting the three project objectives. The full-scale mesocosm demonstrated that a frame design with 11 ballasts that were each 3-feet long per 10-foot section provided the most wave energy reduction per materials cost. Through the laboratory-scale experiments, we were able to utilize similitude concepts to demonstrate that, in general, we were able to predict full-scale wave-reduction performance using smaller scale models when similitude concepts are recognized in the design. Finally, our field implementation resulted in the best wave reduction performance of all of our tests at multiple scales, including comparisons to designs available in literature. Based on wind speed and fetch data for southerly winds and shear stress determination from the shoreline soils, we estimate that our FWB design is able to reduce 96% of the waves to height smaller than what is required to cause detachment erosion on that bank. In addition, the materials cost per foot was comparable to other shoreline erosion techniques. Within this report, we also discuss lessons learned during our process, along with next steps for further development of this FWB concept.

1 Objectives

Lakes and reservoirs are subject to water waves due to wind and wake action. These waves transfer energy that erodes and transports bank soil. This erosion affects ecosystems by reducing viable habitat on shorelines and banks, decreasing species diversity, and impacting water quality within the reservoir. As a result, there is a need for ways to reduce wave action in water bodies before they reach the shoreline. Floating breakwaters have been used to reduce wave size and floating wetlands have mostly been used to provide habitat and improve water quality. Using floating wetlands as breakwaters grants the benefits from both systems. The goal of this project is to determine the best design for FWBs for minimizing wave energy which will cause detachment erosion on reservoir shorelines. Overall, it is expected that these results will be best applied to shorelines with moderate erosion, as opposed to extreme erosion areas with a cut bank where mass wasting will be the dominant form of erosion.

The three objectives of this study were: (1) Test multiple FWB frame designs to determine the best design for maximizing wave energy reduction; (2) Complete laboratory-scale experiments on model FWB frames to determine the viability of using scale models to predict full-scale performance; and (3) Complete field testing of the selected design to determine in-situ wave reduction and the resulting impact on shoreline erosion. These objectives were addressed through the following tasks: (1) Complete a literature review on floating breakwaters and floating wetlands; (2) develop a range of FWB frame designs and test them in a full-scale mesocosm with controlled, artificial waves; (3) test scaled-down versions of the FWB to investigate similitude relationships and the ability to use small-scale models to predict performance at full scale; (4) install and monitor wave reduction for the best design at one location in Lake Thunderbird; (5) use a jet erosion test (JET) to determine the critical sheer stress and resulting wave height required for detachment erosion to occur at the bank of interest; (6) utilize the monitoring and JET results to predict long-term wave a reduction at the Lake Thunderbird site based on soil type and historical wind data; (7) opportunistically collect other relevant data and observations, which may include fish population, plant root length, media type integrity, and plant coverage in the design implemented in the reservoir, and (8) discuss lessons learned and future recommendations for continued design and implementation improvements.

Overall, there is a gap in current research on the design and use of floating wetlands as wavebreaks. A broad body of knowledge on wavebreaks is present in both coastal and inland water settings. Floating wetlands have utilized for water quality and habitat improvement. However, floating wetlands have generally not been designed with wave reduction as the primary objective. A FWB has the potential for wave reduction while also providing other ecosystem benefits. Additionally, investigation of the similitude relationships associated with their performance allows for efficient design and implementation at multiple scales and in different sizes of reservoirs.

2 Literature Review

Coastal systems, lakes and reservoirs are subject to shoreline erosion. Breakwaters have been utilized in these systems for wave reduction, and floating wetlands have been utilized for water quality and habitat improvements. FWBs can potentially be used to provide all of these benefits. Performing a similitude study on FWBs can determine how they would perform when designed for different scales. Furthermore, implementation and monitoring of a FWB in a reservoir, such as Lake Thunderbird, can provide insight and direction of how to best implement these structures for shoreline erosion management.

2.1 Shoreline Erosion

Erosion is the geological process in which earthen materials are worn away and transported by natural forces such as wind or water (National Geographic Society, 2018). While this process occurs across the landscape, shoreline erosion has been a serious concern in reservoirs around the world. Shoreline erosion can occur by two principle mechanisms—detachment erosion, which is the dislodging of the soil particle from water impact, and mass wasting, which is the movement of rock and soil down a slope under the influence of gravity. This study will focus on wave reduction, which is a primary cause of detachment erosion on shorelines.

Marani et al. (2011) used observations and dimensional analysis to determine that the erosion rate of marsh edges was directly proportional to wave power. Leonardi et al. (2016) used data from eight different sites in the United States, Italy, and Australia, and found a linear positive relationship between wave power and erosion rate in salt marshes. Ozeren and Wren (2018) performed a wave erosion analysis on cohesive and non-cohesive embankments and concluded that both embankments eroded at a similar rate due to wave action. Water waves are often a function of the wind speed and direction (Kinsman, 2002; Sayah et al., 2005). In large reservoirs, there is enough space for wind to gradually form bigger waves that hit the shore with relatively high energy. This accentuates the erosion process of the shore. For natural systems that are not heavily destabilized, reducing the forcing function of the waves can reduce the erosion of the shoreline.

The negative effects of shoreline erosion on local ecosystems include loss of property, water quality issues from the soils eroding into the lake, loss of shoreline access for recreation, and habitat destruction for fisheries and wildlife (Allen, 2001). Sadeghian et al. (2017) states that the accumulation of sediment in a reservoir decreases the storage capacity and lifespan of the reservoir.

2.2 Lake Thunderbird

Lake Thunderbird is a 6,070-acre reservoir in northeast Cleveland County, Oklahoma, that impounds the Little River and Hog Creek, and has approximately 86 miles of shoreline (Wu et al., 2019). It has a long history of sediment impairment and is currently on the EPA 303(d) list for impairment by turbidity, which is caused by excess sediment both from erosion from within the watershed and from the shoreline or the reservoir (ODEQ, 2020). Allen (2001) describes the shoreline of the lake as variations of red sandy clay loams that are underlain by sandstone and shale. Furthermore, they describe the soils "very noncohesive, nutrient deficient, and tend to be acidic. These characteristics together make these soils very erosive and difficult to revegetate without man's assistance." A bathymetric study of the lake conducted by the OWRB (2002) found that the pool capacity of the lake has been reduced from 119,600 acre-feet in 1966 to 105,644 acre-feet in 2001 for a loss of capacity of 13,956 acre-feet or 11.7% in 35 years (OWRB, 2002). This observed loss rate is 14% higher than reportedly estimated by the United States Bureau of Reclamation in correspondence with the OWRB in 1965, which was attributed to "larger grained sediment washed in from the watershed" (OWRB 2002). Wu et al. (2019) has also recommended that best management practices (BMPs) be adopted to prevent shoreline erosion.

2.3 Breakwaters

2.3.1 Bottom-Mounted Breakwaters

Breakwaters are structures that have been widely used to dissipate wave energy and protect shorelines. They are common in harbors and come in different forms. The main types of bottom-mounted breakwaters are: conventional rubble mound breakwater, rubble mound breakwater with monolithic crown wall, berm or S-slope breakwater and caisson-type breakwater (EPA, 2006). These breakwater designs are shown in Figure 1. Conventional rubble mound breakwaters have a trapezoidal cross section with an armour layer and are preferred in locations where the water depth is less than 15 m because of the amount and cost of material required for construction. Conventional rubble mound breakwaters with crown walls are mainly used for port protection and allow access to the breakwater for port operations and maintenance. For berm breakwaters, the armourstone is placed in a berm on the seaward slope. The armourstone, the rock used for wave protection, is allowed to move to a certain extent during severe storm events to form a stable profile. Low-crested breakwaters are used for protection in areas where overtopping is acceptable. They are usually built when aesthetics are considered and can be partially emergent or fully submerged. Caisson-type breakwaters are rubble-mound breakwaters with a caisson on top of the mound. These are mainly used for port protection and are less expensive than conventional rubble mound breakwaters in water depths above 15-m. Finally, horizontally composite breakwaters are rubble-mound breakwaters with a caisson behind the mound. These types of breakwaters are built on the seafloor and may be connected to the shore. Bottom-mounted breakwaters require relatively large quantities of material and are often not aesthetically pleasing. As a result, these types of breakwaters are mainly used in ports and harbors where the safety of local workers is of great concern.

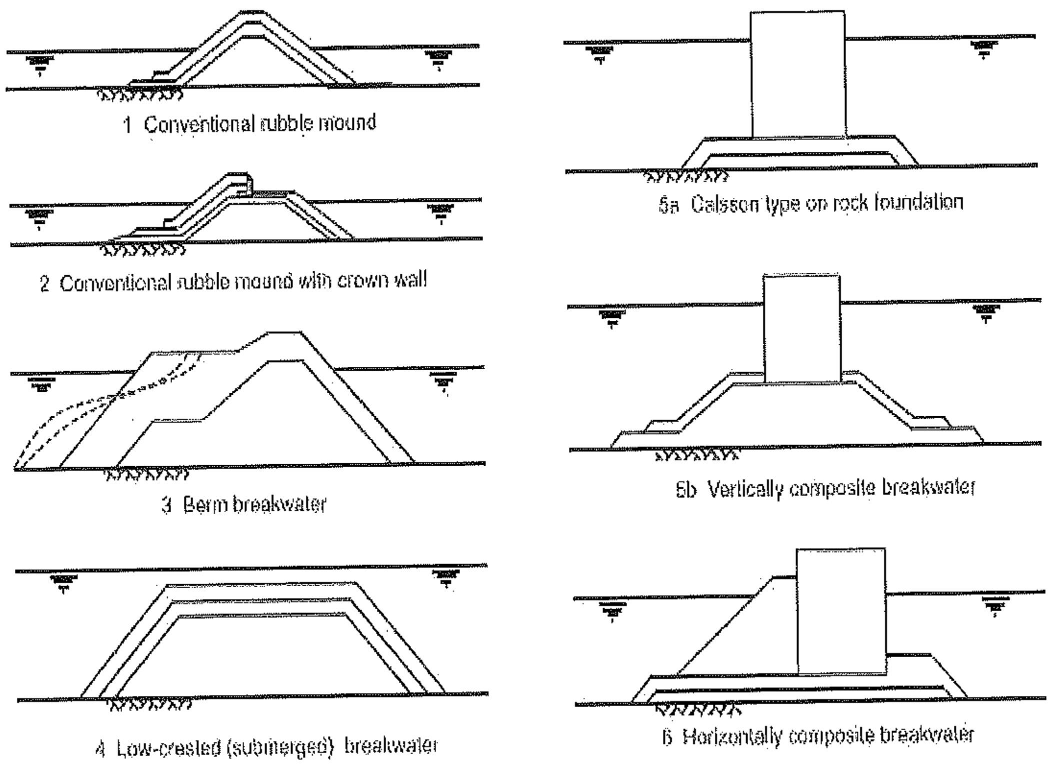


Figure 1: Types of bottom-mounted breakwaters (Environmental Protection Agency, 2006)

2.3.2 Floating Breakwaters

Floating breakwaters are floating structures designed to absorb waves and reduce their energy. Floating breakwaters are often restricted to relatively calm and shallow water areas, as they are structurally weaker than bottom-mounted breakwaters (Uzaki et al., 2011). The advantage of floating breakwaters is that they are adaptable to fluctuations in water level, are mobile and easily relocated, are independent of the condition of bottom sediment, and offer less obstruction to water circulation and fish movement. One drawback of using floating breakwaters is that they offer minimal habitat or water quality improvements. Floating breakwaters are often constructed using concrete or steel and do not provide services to the ecosystem they are in, other than wave reduction.

Structurally, floating breakwaters provide several different advantages compared to traditional fixed breakwater systems. Traditional fixed breakwater systems are usually very difficult and time consuming to install in because they are typically fixed to the water body floor. Floating breakwaters provide an "economic alternative to fixed structures for use in deeper waters," defined as depths greater than 20 feet (McCartney, 1985). Additionally, floating breakwaters do not disturb or impede aquatic ecosystems, water currents, and fish migrations, nearly as much as traditional fixed breakwaters, therefore preserving wildlife habitats (McCartney, 1985). Further, floating breakwaters do not disturb the underlying sediment as much as traditional fixed break water systems. They also have many potential applications beyond decreasing shoreline erosion, including boat basin protection and boat ramp protection (McCartney, 1985). Floating breakwaters can typically be classified into four different categories, each with their own advantages and disadvantages, which include box, pontoon, mat, and tethered floats.

Box breakwaters (Figure 2) are typically modular and reinforced. Flexible connections between each unit allow the system to act like one entity. These large units are often constructed using concrete or steel (McCartney, 1985). The largest concern for this type of floating breakwaters is the primary points of connection between the other units and the mooring system. The connection points in the modular design can face a significant amount of pressure, causing them to break, which is why they are a major concern. The mooring system is a primary concern because if the frames become detached from one another the system stops acting as one and loses much of its functionality.

BOX Solid rectangle	 SECTION	Reinforced concrete units are the most common type. They may be empty or filled with light material
Barge	 SECTION	Derived from army

Figure 2. Schematics of two types of box breakwaters (McCartney, 1985).

Pontoon floating breakwaters (Figure 3) function very similarly to box breakwaters in the sense that they are constructed units positioned in series and connected to each other to function as one. One distinct advantage that pontoon breakwaters have over box breakwaters is that, "the overall width can be of the order of half the wavelength," making the expected reduction of the wave height significant (McCartney, 1985). The reduction of wave height can be contributed to the total amount of area that the wave has to crest over and cross through before moving on past the breakwater. The disadvantages are similar to those of box floating breakwaters. Uzaki et al. (2011) used a pontoon floating breakwater with a truss in their analysis and found wave transmission coefficients (the ratio of transmitted wave height to the incident wave height) ranging from 0.1 to 1.0, depending on the ratio of water depth to wavelength.

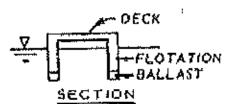
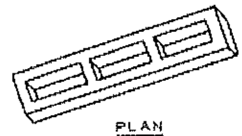
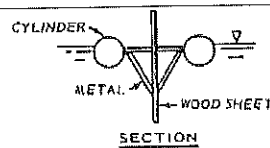
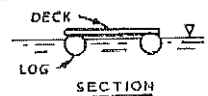
PONTOON Twin pontoon		Catamaran shape
Open compartment		Sometime called Alaska type
A frame		
Twin log		Deck is open wood frame

Figure 3. Schematic of four types of pontoon breakwaters (McCartney, 1985).

Tire-mat breakwaters (Figure 4) are floating mats comprised of new or used tires tied together to form a floating breakwater. These systems have a few distinct advantages including low capital cost, easy removal for maintenance, lower maintenance cost, and low anchors loads required to keep the system in place. However, tire-mat breakwaters also have limited application because they are best suited for areas with mild wave action and can break apart easily, which makes them an environmental liability.

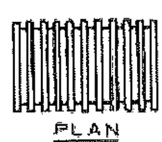
MAT Tire mat		Scrap tires strung on pole framework or bound together with chain or belting. Foam flotation is usually need
Log mat		Log raft chained or cabled together

Figure 4. Schematic to two types of mat breakwater systems.

Tethered float breakwaters (Figure 5) have minimal research on their applicability and effectiveness at reducing incoming wave energy relative to other types of floating breakwaters. Harms (1979) found that tire breakwaters were significantly less expensive then tethered float breakwaters and were also much better at dissipating wave energy.

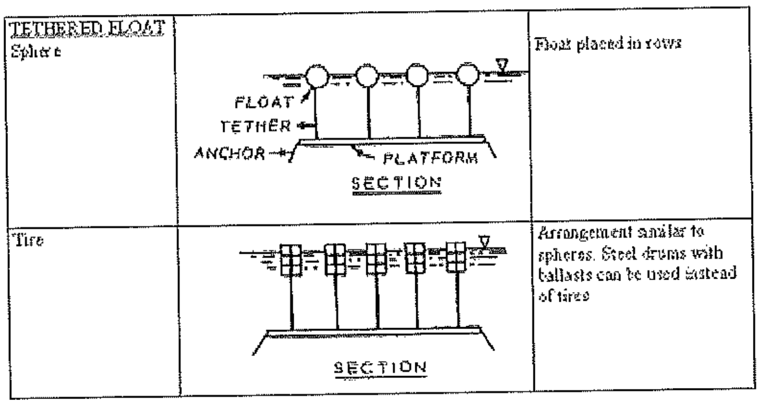


Figure 5. Schematics of two types of tethered float breakwater systems (McCartney, 1985).

The Y-frame floating breakwater includes a ballast or skirt wall attached to the bottom (example shown in Figure 6). Y-frame breakwaters function with ballasts or skirt walls to reduce the breakwater width to wavlength ratio, achieving a lower transmission coefficient, which is the ratio of the power of the incoming to outgoing waves hitting the wavebreak (Mani, 1991; Mani, 2017; Neelamani, 2018). Adding the ballasts thus brings down the capital cost of the system.

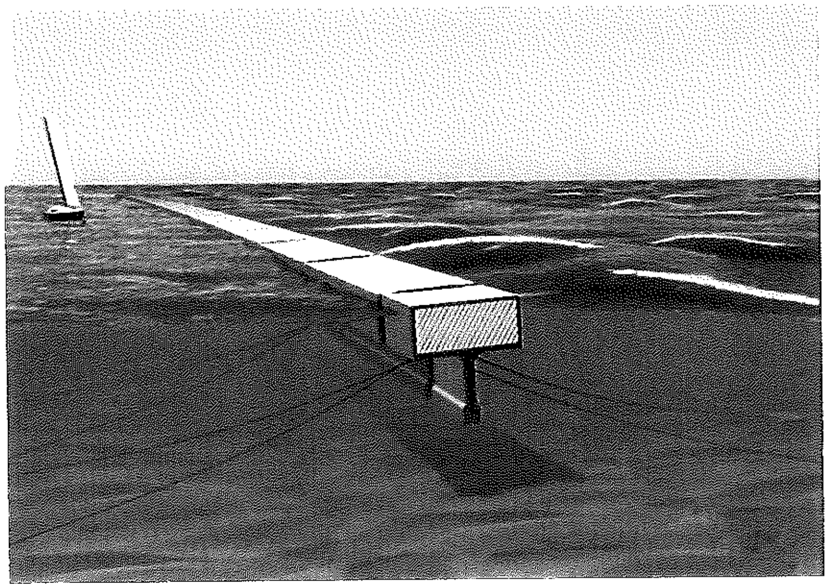


Figure 6. Side view of a Y-frame floating breakwater (McCartney, 1985).

2.4 Floating Treatment Wetlands

Floating treatment wetlands are an emerging engineering option with promise for simultaneous water quality improvement and habitat creation (Strosnider et al., 2017). They are general comprised of rafts that have rooted, emergent macrophytes growing on a mat floating on the surface of the water rather than rooted in the sediment (Headley, 2008). These systems are often engineered to mimic properties of natural floating treatment wetlands, which employ plants and other microbes to take place in phytoremediation, bioremediation, and hydroponics to remove nutrients such as nitrogen and phosphorus. The primary mechanisms that floating treatment wetlands use for nutrient removal are microbial transformation and uptake, macrophyte assimilation, absorption into organic and inorganic substrate materials, and volatilization" (Stewart, 2008). OWRB (2013) demonstrated that floating treatment wetlands are capable of providing water quality and habitat benefits in Lake Eucha in northeast Oklahoma. It has been observed that percent nutrient removal in floating treatment wetlands is directly related to the percent vegetative coverage of the floating wetland within a water body (Table 1), with a large surface coverage required for significant percent removal of nutrients and total suspended solids (Scheuler et al., 2016). Although full-scale implementation and testing of floating treatment wetlands is limited, they have thus far shown mixed results in improving water quality (Strosnider et al., 2017).

Table 1. Incremental pollutant removal rates for floating treatment wetlands in ponds (Scheuler et al., 2016).

	Raft Coverage in Pond (%)				
	10	20	30	40	50
	Percent Removal (%)				
Total Nitrogen	0.8	1.7	2.5	3.3	4.1
Total Phosphorus	1.6	3.0	4.9	6.5	8.0
Total Suspended Solids	2.3	4.7	7.0	9.0	11.5

2.5 Floating Wetland Breakwaters

Floating wetlands have been shown to be effective for improving water quality and increasing wildlife habitat in a reservoir in Oklahoma (OWRB, 2013). This report also recommended additional research be completed to investigate their potential as wavebreaks to protect the shoreline and reduce overall erosion. In systems where wave reduction is necessary, but aesthetics and ecosystem services are also of concern, a floating wetland breakwater (FWB) hybrid could be a useful solution. However, they must be structural sound enough to withstand the repetitive forces of large waves. Martin Ecosystems (2017) has developed the only commercial application of a floating wetland design that would also work as a breakwater, which has a materials cost of approximately \$270 per foot (Biohaven quote, 2019). Webb (2014) tested the performance of the Martin Ecosystems BioHaven® Floating Breakwater in a controlled flume without plants, with wave transmission coefficients (k_t) ranging between 0.44

and 0.99. This study is the only available literature that the authors could find on the ability of floating wetlands to be utilized primarily as breakwaters.

2.6 Similitude

The concept of similitude is often used so that measurements made on a system at one scale, in the laboratory for example, can be used to describe the behavior of other similar systems outside the laboratory at a larger scale. In engineering, a model is a representation of a physical system that may be used to predict the behavior of the system in some desired respect. The physical system for which the predictions are to be made is called the prototype. With the successful development of a valid model, it is possible to predict the behavior of the prototype under a certain set of conditions. Construction of a successful model is accompanied by an analysis of the conditions it is tested under. Similitude is achieved when there is geometric, kinematic and dynamic similarity between the model and the prototype. A model and prototype are geometrically similar if they are the same shape and all body dimensions in all three coordinates have the same linear-scale ratios. For kinematic similarity, the time rate of change motions of the fluid flow must be the same in the model and the prototype. Dynamic similarity is reached when all the forces acting on the system are in a constant ratio for both scales. Flow conditions for a model test are completely similar if all relevant dimensionless parameters have the same corresponding values for model and prototype. Complete similitude is often not possible; therefore, scaling is usually implemented using the most important dimensionless parameter (Stern, 2013). For systems involving free-surface flow such as flow around a ship or across FWBs, the Froude number is the important similarity parameter. The Froude number is a dimensionless number defined as the ratio of inertial forces to gravitational forces. For free surface flow systems, similitude can be conducted based on an equality of Froude numbers.

Ozeren (2009) and Webb (2014)performed similitude study on floating breakwaters using this method and was able to estimate the wave reduction of a specific floating breakwater design.

3 Methods

To fully understand the capabilities of FWBs for wave reduction, the performance of FWB frame designs were tested at three different scales under artificial and natural conditions. The scales included a full-scale controlled mesocosm, laboratory-scale, and field-scale implementations.

3.1 Full-scale Controlled Mesocosm

A full-scale, controlled mesocosm study was completed to assess the applicability of using floating wetlands as wavebreaks with the goal of reducing bank erosion in reservoirs due to wave action and to determine which design would be best for field implementation into Lake Thunderbird. Prior to field implementation a variety of frame parameters, which will be discussed later, a variety of prototype floating wetland breakwater frames were tested at the Aquatic Research Facility (ARF) of the University of Oklahoma. The ARF is an eight-acre facility located on the south research campus of the university and contains approximately 33 ponds accompanied by four climate-controlled greenhouses. A pond that is 191 feet in length, 48 feet wide, and holds a consistent depth between 5 and 10 feed, seen in Figure 7, was constructed to test the parameter combinations under a variety of wave heights and frequencies to determine which set provided the greatest overall wave reduction.

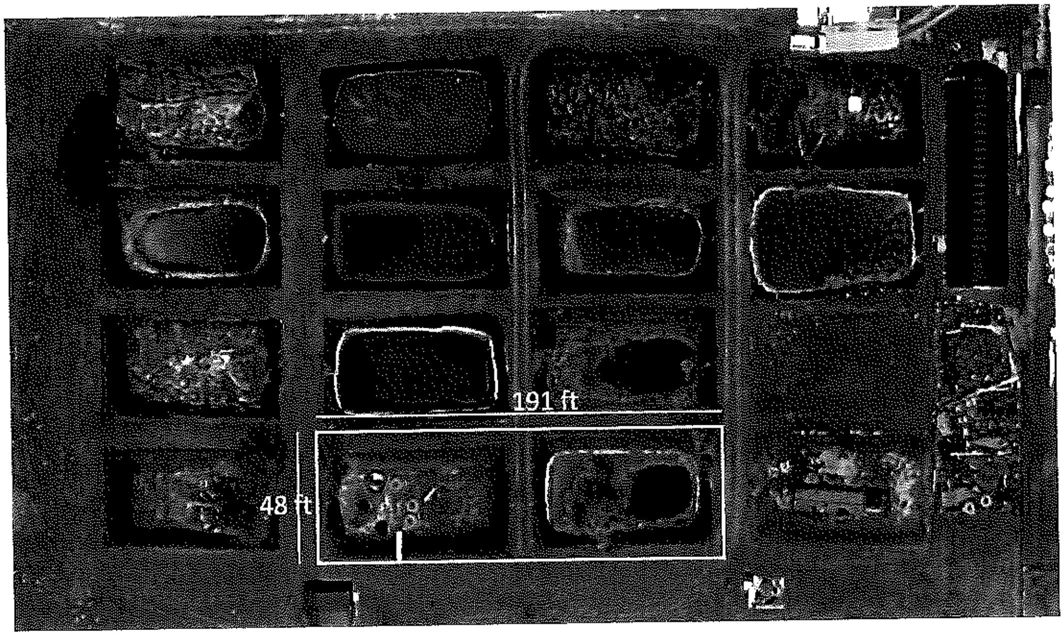


Figure 7. Aerial view of the Aquatic Research Facility study pond location in Norman, Oklahoma.

3.1.1 Experimental Setup

The full-scale controlled mesocosm FWB system was developed based on a modified Y-frame model design. The design consisted of a 10-ft by 5-ft rectangular frame made of 4-inch polyvinyl chloride (PVC) pipe. The ballasts were also made of 4-inch PVC pipes and were attached 2 inches below the main frame. A 6-inch layer of Polyflo filter material (Americo Manufacturing Company Inc., Acworth, GA) was placed inside the rectangular frame. The number of pipes in the skirt wall varied between 0, 6 and 11 pipes. The length of the pipes in the skirt wall varied between 0.0, 1.0, 2.0 and 3.0 ft. Two FWBs adjacent to each other were fastened together on one side and positioned perpendicular to the direction of incoming waves. Figures 8, 9 and 10 below are schematics of the FWBs, and Figure 11 shows an upside-down FWB frame out of the water and being prepared for the next set of frame parameters to be tested.

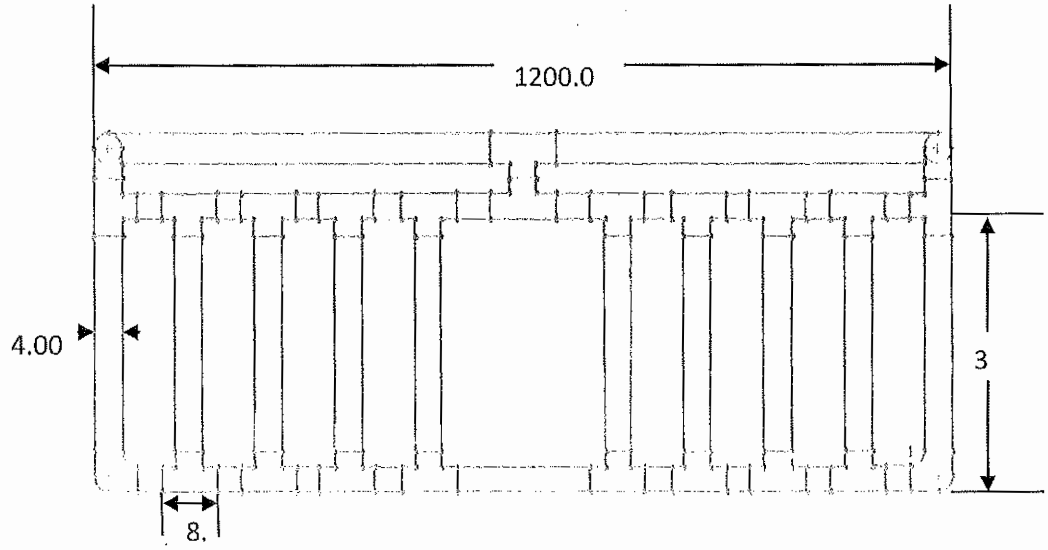


Figure 8. Cross-sectional view of the prototype floating wetland breakwaters showing the dimensions of the pipe ballasts.

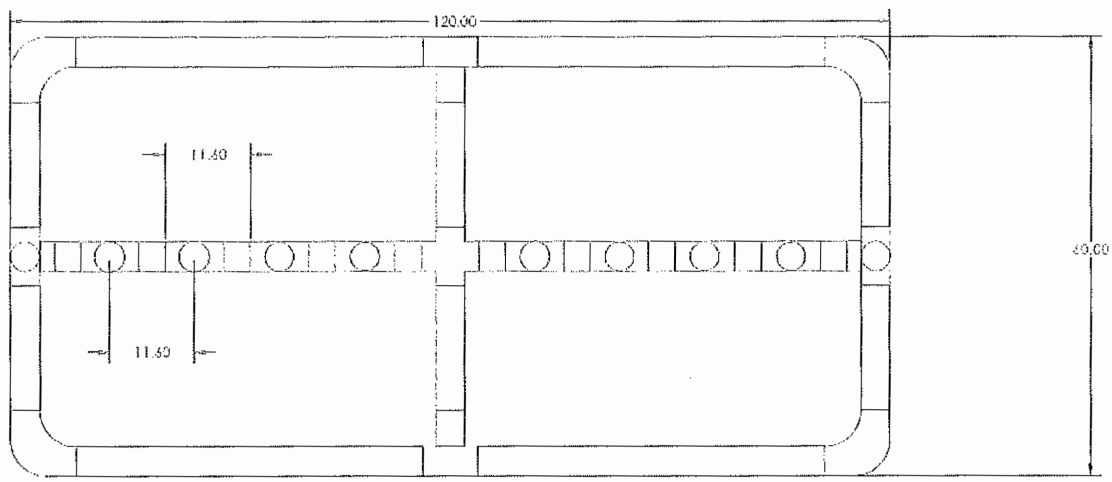


Figure 9. Top view of the prototype floating wetland breakwater frame, showing the top dimensions in inches.

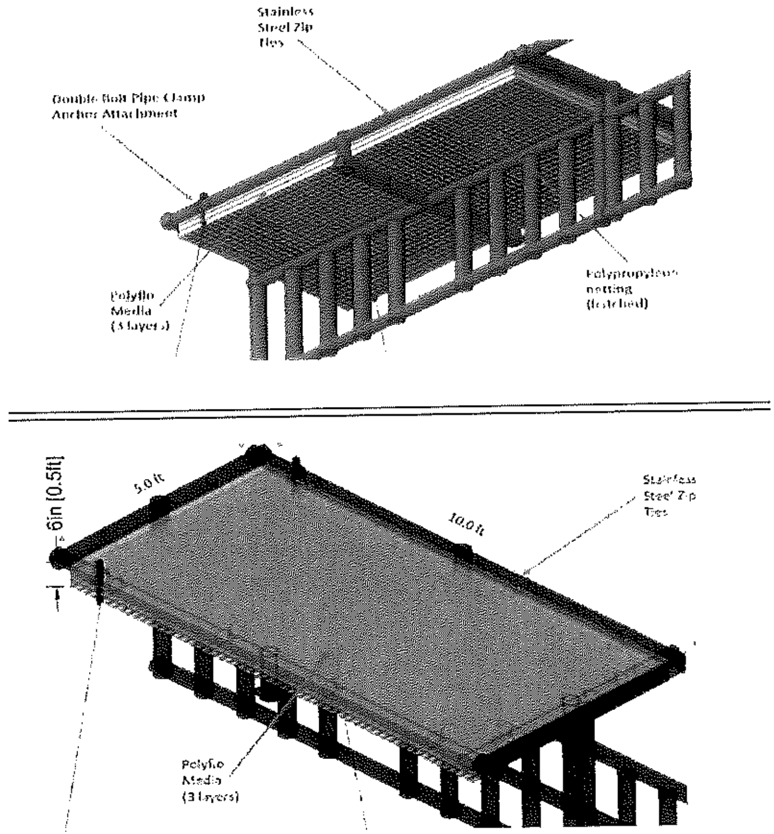


Figure 10. Three-dimensional representation of the FWB design shown from underneath (top) and above (bottom).

Figure 11. Floating wetland breakwater frame used for the prototype system (upside-down). Photo by Maxwell O'Brien.

A wave generator made waves ranging from 3 inches to 14 inches in amplitude. The wave generator, shown in Figure 12, was comprised of paddles attached to a metal frame. The frame was connected by a metal beam to a modified tiller on the back of a John Deere 870 tractor (John Deere, Moline, IL). As the tiller rotated, the beam would push and pull the metal frame, causing the paddles to move back and forth and generate waves in the process. The rotations per minute (RPM) of the modified tiller controlled the frequency of the waves while the stroke length of the modified tiller controlled the wave height. Attaching the metal beam to the outer edge of the tiller would result in a higher radius of rotation and would push the paddles farther, thus increasing the amount of water moved and the wave height. Each experimental combination of number of pipes and pipe length was subjected to different wave heights during runs. The system was maintained in deep wave conditions, which is defined as the depth of the water is greater than half the wavelength of the water waves (Thurman & Trujillo, 2001). The wavelength was estimated visually, and opportunistically checked from photos and determined to be smaller than double the water depth. The depth of the water in the pond increased from the side of the wave generator to the other end, and was approximately 8 feet at the location where the FWBs were placed in the pond. Waves that travelled through the FWBs had roughly half of the pond length left to travel before reaching the end of the pond. This was done to minimize the reflection of waves (sometimes referred to as bathtub effect), which would affect the wave measurement results. Also, runs were limited to two minutes, which is the approximate minimum time when we would start to see the influence of wave reflection on backside wave measurements. The FWBs were anchored at the four corners using rope and cement blocks, and were sized such that minimal space was present between them and the edges of the pond. Because of the position and anchoring pattern on the FWBs, their only types of motion were pitch (up-down rotation by the transverse or side-to-side axis) and heave (linear up-down motion).

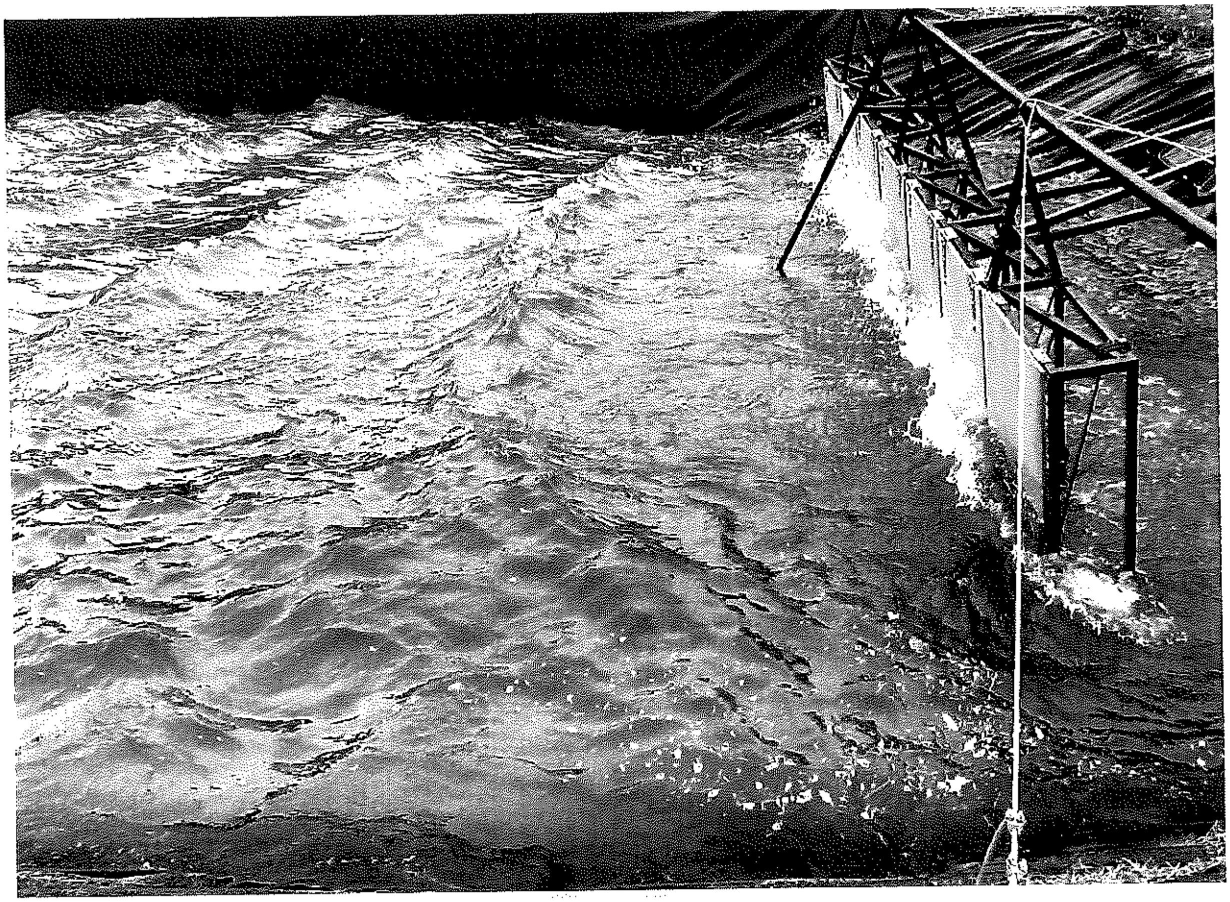


Figure 12. Custom wave generator used for the prototype system. Photo by Maxwell O'Brien.

3.1.2 Wave Height Data Collection

The wave height and period were measured in front of and behind the prototype FWBs during the experimental runs at the ARF. Wave heights were recorded using HERO 7 Black cameras made by GoPro (GoPro, San Mateo, CA), which were attached to meter stick staff gages, which recorded the oscillation of the water level on the meter stick during. The staff gauges were attached to anchors and held vertically at the water surface. Figure 13 shows the experimental setup for the base system. After completion of the run, minimum and maximum heights of each wave were manually recorded and saved in an Excel spreadsheet for analysis.

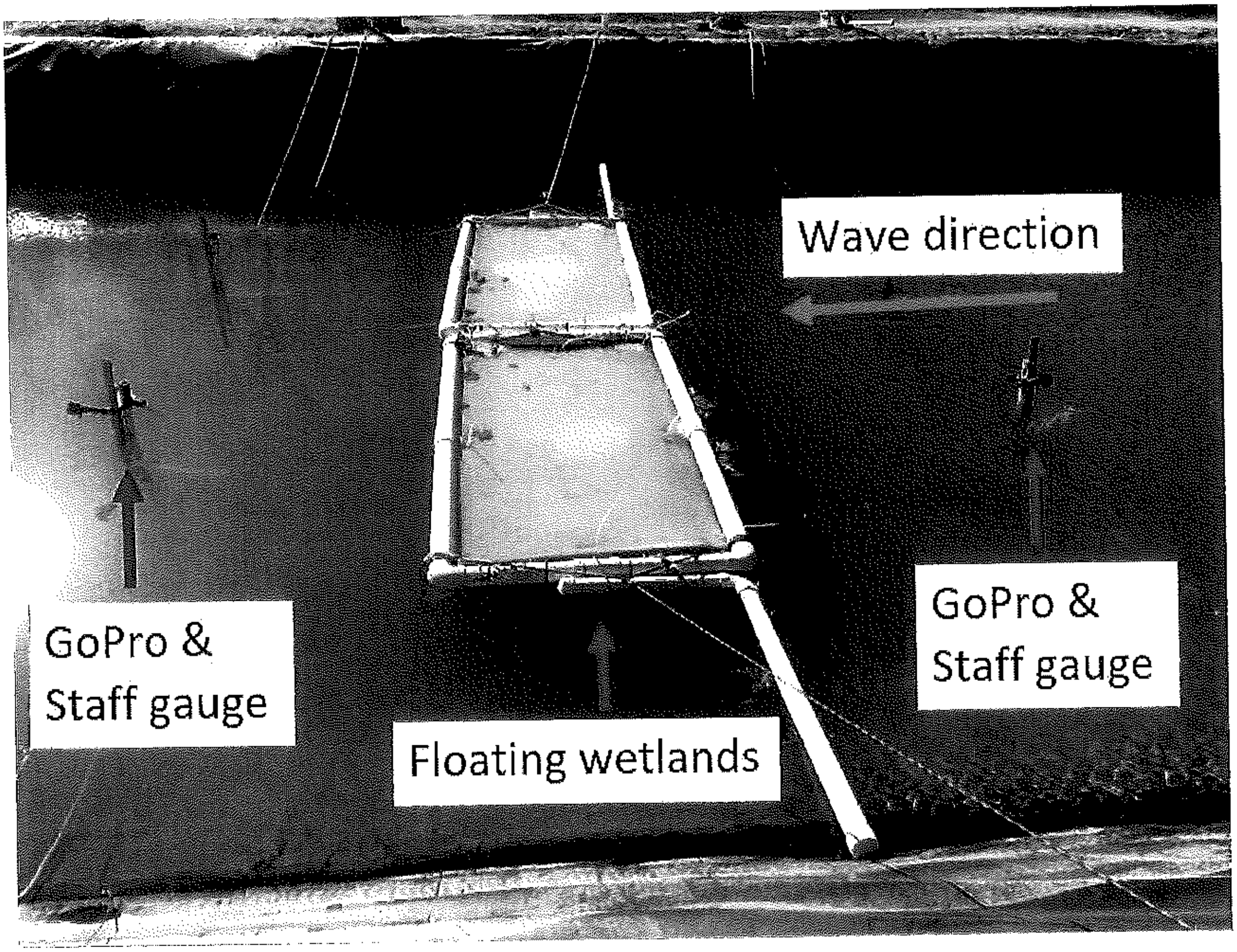


Figure 13. Experimental setup for the full-scale mesocosm system at the Aquatic Research Facility in Norman, Oklahoma. Photo by Maxwell O'Brien.

3.2 Laboratory-scale Controlled Scale Models

Laboratory-scale scale models were tested in laboratory S-22 in Carson Engineering Center at the University of Oklahoma. After properly scaling the FWBs used for the prototype using the Froude number method, the scale model was tested in a flume for waves that were manually generated.

3.2.1 Scaling

The Froude number was used to scale the FWB system from the prototype scale to the small scale. The Froude number is the ratio of inertial forces over gravitational forces and is denoted as,

$$Fr = \frac{u}{\sqrt{gL}}$$

where

- u is the relative flow velocity
- g is the acceleration due to gravity
- L is a representative length of a system such as diameter or width

The Froude number is often used when dealing with free-surface flow systems. It is appropriate here because the FWBs are located at the surface of the water and interact with waves. In order to properly scale a free-surface system like FWBs, an equality of Froude numbers must be achieved between the prototype system and the model. This allows for proper scaling of the FWBs as well as the forces that act on them. A scale of 1:8 based on the length was used for the experiments. All lengths pertaining to the FWB frame, as well as wave heights were scaled by a ratio of 1:8 compared to the initial design to account for geometric similitude. This resulted in FWB frames that were 7.5 in wide. The pipe lengths tested were 0.0, 1.5, 3.0 and 4.5 inches, which correspond to 0.0, 1.0, 2.0, and 3.0 ft pipes, respectively, for the full-scale mesocosm. The length of the frame was not required to be scaled exactly as long as the fraction of the cross section occupied by pipes did not change. It was assumed that the FWB is not required to be longer than the incoming waves, as long as every wave is fully intercepted by the FWB. For example, a wave measuring 6-in across hitting the center of a 12-in long FWB would be reduced the same as if it hit the center of a 24-in long FWB. The FWB model was constructed to be only slightly smaller than the flume that it was installed in such that the incoming waves would fully be intercepted by the model. On the prototype, the outer diameter of the pipe was 4.5 in and length of the frame was 10 ft, or 120 in. This means that for 11 pipes, the fraction of the length that was obstructed by pipes in the cross section was (11*4.5 in) / 120 in = 0.41. For 6 pipes, the fraction was 0.22. At the 1:8 scale, the frames were 23.5 inches long and the pipe outer diameter was 0.84 inches which corresponds to 0.5 in PVC pipe. For the same cross-sectional area obstructed by pipes, the number of pipes were 11 and 6 pipes as shown in Figure 14.

$$(0.41 * 23.5 \text{ in}) / 0.84 \text{ in} = 11.47 = 11 \text{ pipes}$$

$$(0.22 * 23.5 \text{ in}) / 0.84 \text{ in} = 6.15 = 6 \text{ pipes}$$

Figure 14. Calculations for the number of pipes for the floating wetland breakwater scale models.

Since the numbers of pipes were rounded, the new fractions of length occupied by pipes and the associated difference were calculated in Figure 15.

For 11 pipes: $(11 * 0.84 \text{ in}) / 23.5 \text{ in} = 0.39$

The difference was then: $(0.41 - 0.39) / 0.41 * 100\% = 4.7\%$

For 6 pipes: $(6 * 0.84 \text{ in}) / 23.5 \text{ in} = 0.21$

Figure 15. Calculations of the errors resulting from the difference in numbers of pipes for the floating wetland breakwater scale models.

For the sake of this experiment, 4.7% was deemed an acceptable level of error. As described by Le Mehaute (1976), the Froude number leads to the following relationship:

$$\left(\frac{V_m}{V_p}\right)^2 = \frac{L_m}{L_p} = \lambda$$

where

V is wave velocity

L is characteristic length

m refers to the scale model

p refers to the prototype or full scale

λ is the scaling ratio which is 1:8 or 0.125

Knowing that wavelength is equal to wave velocity multiplied by wave period, rearranging Equation (2) yields the following relationship:

$$\frac{T_m}{T_p} = \frac{\frac{L_m}{V_m}}{\frac{L_p}{V_p}} = \lambda^{\frac{1}{2}}$$

where T is time frame which corresponds to wave period

By scaling the wave period in the experiments by a factor of $(1/8)^{1/2}$, the velocity and wavelength were properly scaled. The wave periods observed at the prototype scale varied between 1.3 and 2.3 seconds. As a result, the target wave periods used in the 1:8 scale experiments were between 0.46 and 0.81 seconds.

Dynamic similitude between the prototype and the model was not fully achieved because the FWBs at the prototype scale had metal connectors in the skirt wall whereas the model scale FWBs had PVC connectors. This resulted in a density discrepancy in the scaling and could have yielded better wave reduction results for the FWBs at the prototype scale.

3.2.2 Experimental Setup

The model-scale experiments were conducted in a 7.0 ft x 2.0 ft x 2.0 ft flume (Figure 16). Deep-wave conditions, where the water depth is greater than half of the wavelength of the incoming waves, were maintained in all runs. The wavelength was estimated visually and determined to be smaller than double the known water depth. The FWBs were anchored with small bungee cords attached to Marshalltown 4.5-in diameter, 15-lbs blue rubber tile suction cups (Marshalltown, Marshalltown, IA) at the four corners of the frame. Experiments at both scales used this anchoring pattern. Waves were generated on one end of the flume by manually raising and lowering a piece of wood in the water at a constant pace. The waves then traveled towards the other end of the flume. Artificial plants and Polyflo filter material were placed at the end of the flume to dissipate the wave energy and prevent wave reflection.

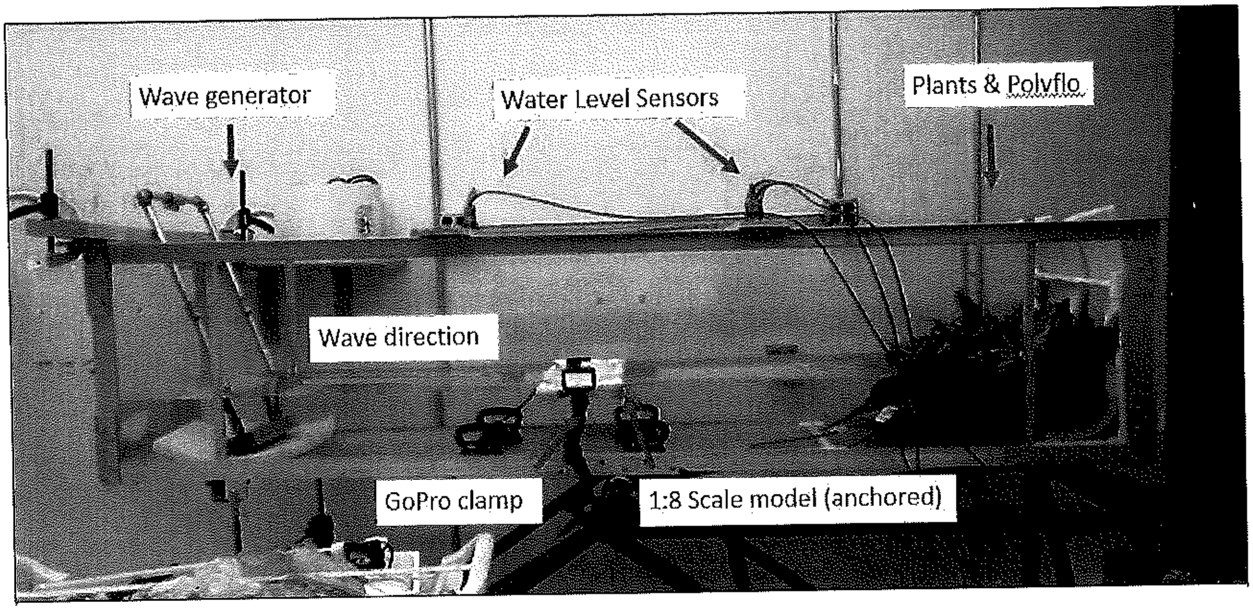


Figure 16. Experimental setup for the scale model similitude studies in Carson Engineering Center at the University of Oklahoma.

3.2.3 Wave Height Data Collection

Wave heights and periods were measured using Senix Toughsonic 3 (Senix Corporation, Hinesburg, VT) ultrasonic water-level sensors. The sensors were placed above the water surface and measured depth to water on a continuous basis. These sensors measured the wave heights in front of and behind the FWB scale model and were synchronized to take simultaneous measurements. To validate the data from the ultrasonic sensors, a HERO 7 Black GoPro captured videos of selected runs. Meter sticks were placed in front of and behind the FWB so that wave peaks and troughs could be estimated on the GoPro videos and recorded in Microsoft Excel (Microsoft Corporation, Redmond, WA). Results from the GoPro videos were then compared with the data from the sensors for validation.

3.3 Field-scale Implementation and Monitoring

The breakwater design chosen from the mesocosm experiments was implemented into Lake Thunderbird during the Spring of 2019 and 2020 at the location seen in Figure 17. One 200 foot long section was installed that was comprised of twenty (20) ten-ft frames and anchored with twenty, half full, 55-gallon drums of concrete to hold them in-situ. The 200-ft section was chosen because it is approximately the length of the bank that the system is attempting to protect from wind wave and wake action, and for budgetary reasons. In 2019, all frames were outfitted with Polyflo media for plant growth, while in 2020 these systems were modified so that the 5 frames on each end were outfitted with coir matting and the middle ten frames had a modified design for Polyflo media. Proper permissions for the installations were obtained from the US Bureau of Reclamation.

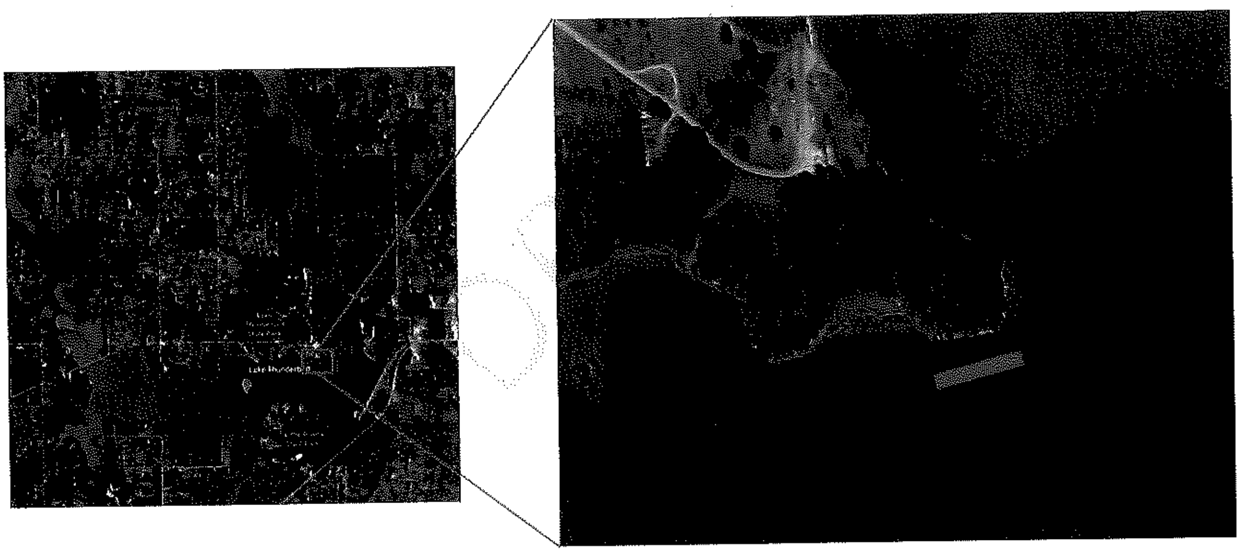


Figure 17. Location of field implementation for the 200-ft floating wetland breakwater. The study location is highlighted by the red rectangle.

Figure 18 shows the overall design of the floating breakwater system illustrating anchor, ADCP, frame, and buoy placement. Note that Figure 18 was the initial plan and shows 22 anchors, however during installation it was decided that 20 anchors would be sufficient because of the available sites for anchor attachment. Each one of the wetland frames were planted initially with Soft Rush (*Juncus effusus*) and then later supplemented with American water-willow (*Justicia Americana*).

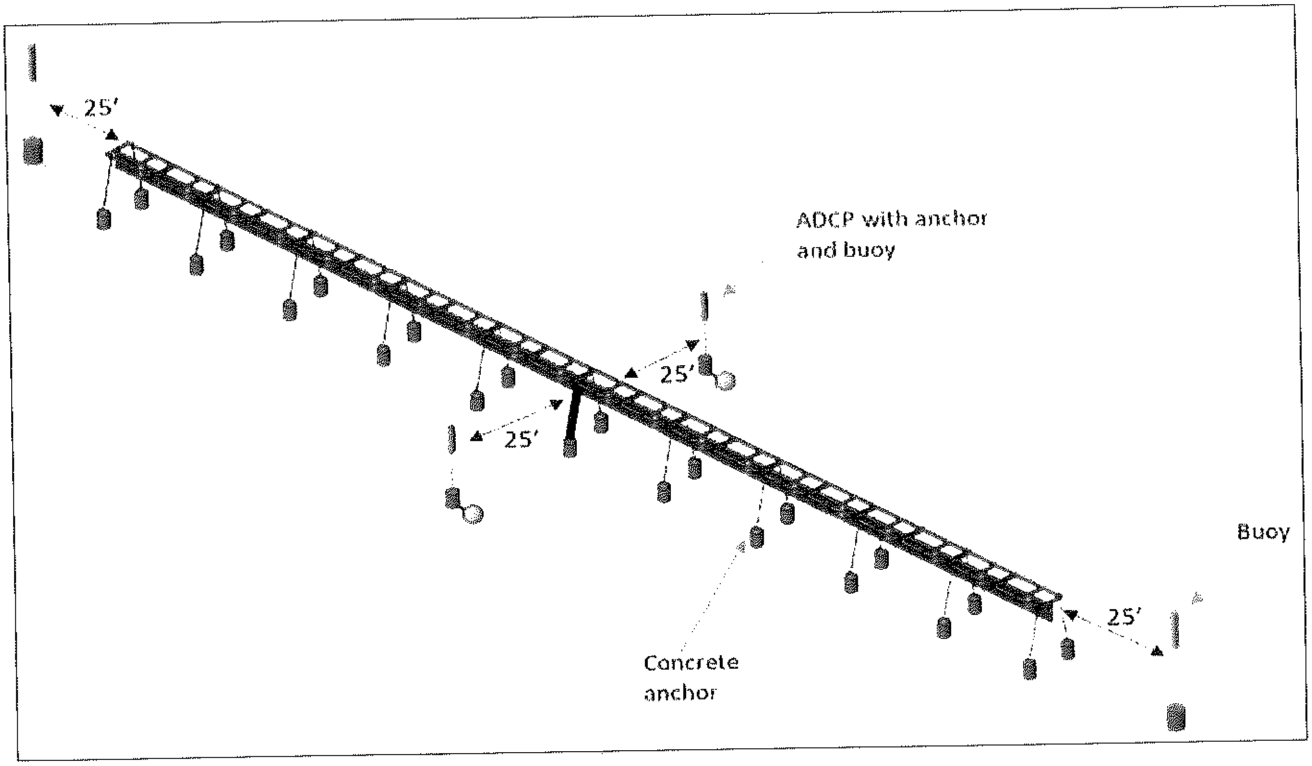


Figure 18. Diagram of the design of the 200-ft section of floating wetland breakwater installed into Lake Thunderbird, including anchors and buoys.

3.3.1 Wave Height Data Collection

Wave height data at the field study location in Lake Thunderbird was collected from a period of August 2020-February 2021. As previously mentioned, ADCPs were initially attempted to be utilized for wave-height data collection. However, due to time constraints and technical issues with the units the decision was made to return to GoPro video analysis. GoPro cameras were attached to a staff gauge inside (near bank) and outside the FWBs to compare the wave height reduction across the FWBs. Data was collected when the predominant wind direction was coming from the Southeast to Southwest, with the goal of capturing waves that are crossing approximately perpendicular to the floating wetland structure. Furthermore, additional data was collected by creating artificial waves with a boat to simulate wave pulses through the floating wetlands.

In addition to the GoPro analysis, we were able to collect supplementary wave height measurements using photographs from specific days where we already had GoPro video data from the backside of the wetlands using a pixel ruler (https://www.rapidtables.com/web/tools/pixel-ruler.html). These wave statistics for this method were validated using historical Mesonet wind data for the area and the following equation:

$$H_f = \frac{\lambda_5 u^2}{g}$$

where

H_f is the height of a fully formed wave

λ_5 is the dimensionless coefficient approximately equal to 0.27

u is the wind speed

g is the acceleration due to gravity

3.3.2 Biological Sampling

Once the FWBs have been positioned and anchored in the locations, opportunistic biological monitoring was opportunistically completed in an attempt to understand the full capabilities of these systems. The FWBs were monitored for their capabilities as a fish habitat by taking fish surveys with the assistance of Steve O'Donnell and the Oklahoma Department of Wildlife Conservation. Additionally, handheld GreenSeeker measurements for normanlized difference vegetation index (NDVI) were measured from a constant height of 2.5 ft above selected frames during the fall of 2020 to assess plant survivability in the two different media.

3.3.3 Jet Erosion Test

A Jet Erosion Test (JET) was also completed on the bank at the FWB location to determine the erodibility parameters of the soil using a JET apparatus and other essential pieces (North Carolina State University Department of Biological and Agricultural Engineering, Raleigh, NC). The remaining portions required to perform the JET and the sampling method were completed per methods described by Hanson and Cook (2004).

3.3.4 Estimation of Wave Energy to Cause Erosion

In order to relate the impact of wave height on bank shear stress; we used Linear Wave (aka Airy Wave) theory. This is applied to fluids that are irrotational or non-breaking wave forms. Wave motion exerts shear on near bank sediment and when wave energy exceeds the critical shear stress for initiation of motion of the sediments, the bank material is scoured. For cohesive material the critical shear stress depends on the degree of compaction. Therefore, the rate at which sediments erode depends on the shear stress exerted on the bank and on the critical shear stress at which erosion is initiated.

Waves approaching a bank are affected by the frictional forces along the bottom. As long as the wave does not break, the transported energy per unit time remains constant. Since the waves in Lake Thunderbird are small, Linear Wave theory was used to compute celerity of propagation and related this to particle velocity near the bottom.

In order to apply Linear Wave theory, some basic assumptions were used. These include: the depth of water is uniform; the wave is periodic with a period defined in seconds; only two-dimensional flow (i.e., horizontal in x-axes and vertical in z-axes); and the Coriolis forces are negligible. Linear Wave theory is an approximation of wave propagation by neglecting boundary layer effects that occur near the bed, neglecting viscous and turbulent stresses so that wave motion is considered fully irrotational; and the wave amplitude is relatively small compared to the wave length.

To determine the celerity of propagation, c, the wave length is related to the period:

$$c = \frac{\lambda}{T}$$

where λ is the wave length, in m and T is the period, in seconds. Since this is the distance the wave travels per the time the wave took to travel the same distance; celerity of propagation is often expressed as:

$$c = \sqrt{\frac{g\lambda}{2\pi} tanh\left(\frac{2\pi D}{\lambda}\right)}$$

where D is the depth of water. Commonly, k_s is known as the wave dispersion coefficient such that

$$k_s = \frac{2\pi}{\lambda}$$

which can be substituted into the celerity of propagation equation for ease of solver computation.

In the following analysis of wave energy induced shear stress, it was further assumed that the energy losses associated with wave refraction and wave shoaling were negligible. Wave will be attenuated in shallow depths via wave energy dissipation through associated with benthos associated friction. Denny (1995) proposed this simple mechanistic approach to Linear Wave theory while noting that the observed rate of energy dissipation would be accumulative as the first derivative of the wave height relative to axial flow (toward bank). The shear stress, τ_b, can be described as:

$$\tau_b = \frac{1}{2} f_w \rho u_m^2$$

where f_w is the dimensionless friction factor that accounts for wave energy dissipation through sediment friction and u_m is the maximum near bed orbital velocity, in m/s. The friction factor is a function of the Reynold's number and the wave amplitude at the bed or the sediment grain size. While there are standard monographs to relate the friction factor with the Reynold's number; the near bed orbital velocity is required. This presents a circular solution; therefore, the approach used herein evaluated the relationship of the shear stress with maximum near bed orbital velocity as a function of the friction factor.

The maximum near bed orbital velocity, u_m, is determined using the approach described by Denny.

$$u_m = \frac{\pi H_o}{T} \left(\sinh \frac{2\pi}{\lambda} \right)^{-1}$$

where H_o is the wave height in m.

4 Results and Discussion

The wave height and energy reduction results provide a baseline of all three scales of wave reduction performance at each of the three scales for the various FWB frame designs. These results are compared across scales and field results are compared to historical wave heights to determine the percentage of waves that would be reduced. Opportunistically collected biological parameters related to the FWBs in the field are also presented.

4.1 Full-scale Controlled Mesocosm

A full-scale controlled mesocosm study of various frame designs with was completed at the ARF, where number and length of pipe ballasts were tested to determine which combination maximized the reduction of incoming wave heights and energy for field implementation.

4.1.1 Wave Height

Wave height comparisons and resulting trendlines for the full-scale mesocosm at the ARF are shown in Figure 19. The individual run results demonstrated a high degree of variability for incoming waves with a range of 4-11 inch average wave height. In general, all designs showed similar wave reduction trends except for the design with 11 pipe ballasts that were 3 feet long. This design demonstrated more average reduction across the approximate 5.5-8.5 inch wave range for which they were tested than the other designs. Even though data collection times were limited to reduce reflection, it is expected that wave reflection from the back of the mesocosm pond at the ARF may have contributed to the high variability of these individual measurements.

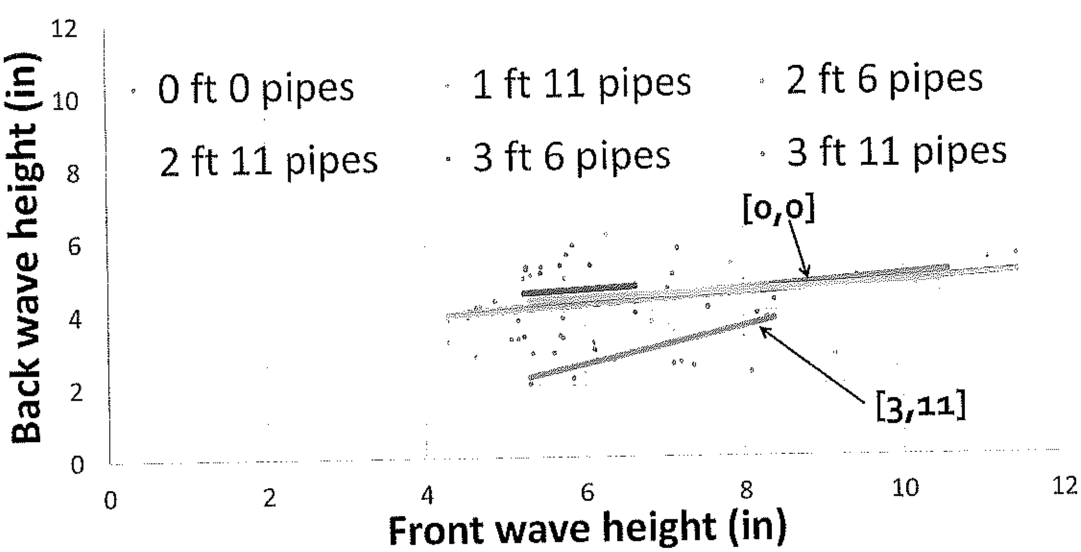


Figure 19. Incoming and outgoing wave height comparisons and linear trendlines for the full-scale mesocosm at the Aquatic Research Facility at the University of Oklahoma in Norman, Oklahoma.

4.1.2 Wave Energy Density

The wave energy density and resulting trendlines for each of the design configurations are shown in Figure 20. Because wave energy density is computed on the critical wave height, which represents the top third of wave heights, the energy trendlines begin to visually separate themselves, with the 3-foot, 11-pipe design still showing the best removal of the designs. Table 2 shows the difference in wave energy density for a six-inch wave based on the trendline predictions for each various designs, showing that the 3-foot, 11-pipe design decreases wave energy by another 45% over having no ballasts/pipes.

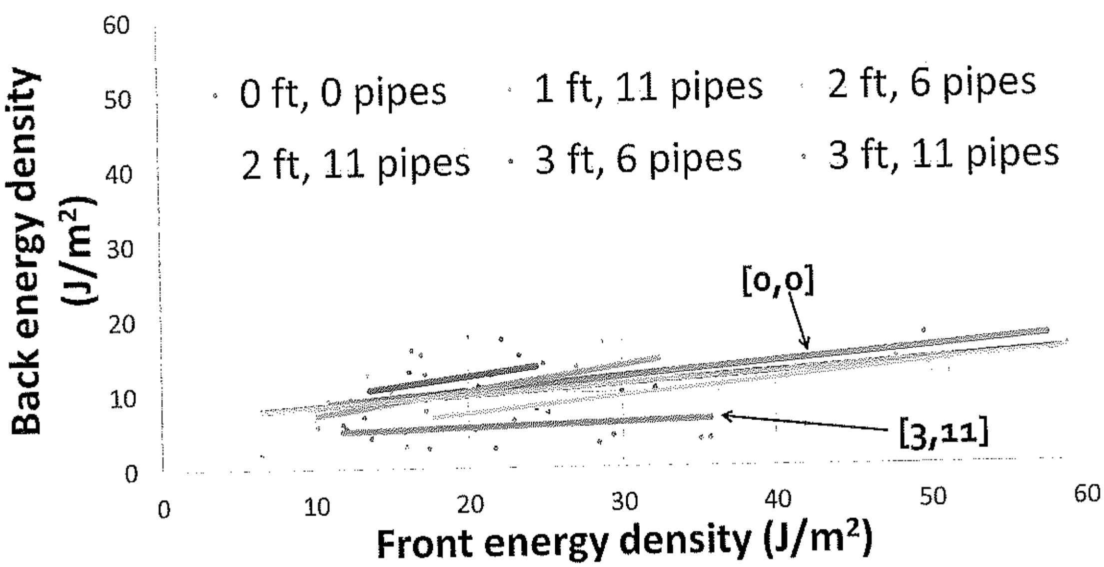


Figure 20. Incoming and outgoing wave energy density comparisons and linear trendlines for the full-scale mesocosm at the Aquatic Research Facility at the University of Oklahoma in Norman, Oklahoma.

*Table 2. Wave energy density comparisons for various floating wetland breakwater frame designs for a six inch wave. Design configurations show the number and length of pipe ballasts. ** the six pipe, three foot tests represented a limited range of wave height.*

Design Configuration	Energy Reduction from [0,0] (J/m^2)

[0 pipes,0 feet]	--
[6 pipes, 2 feet]	0.4 (4%)
[6 pipes, 3 feet]	-1.4 (-15%) **
[11 pipes, 1 foot]	0.9 (9%)
[11 pipes, 2 feet]	3.2 (34%)
[11 pipes, 3 feet]	4.3 (45%)

4.1.3 Preliminary Cost Analysis

A preliminary cost analysis (Table 3) was performed comparing the amounts of wave energy reduction to the cost of a ten-foot section of floating wetlands. Materials include pipes, connectors, planting media, and plants. Neither the cost of installation and maintenance nor the time value of money is included in these preliminary calculations. The FWB design with the lowest cost per energy density reduction, which was 11 pipe ballasts that were three foot long, was chosen for implementation in Lake Thunderbird.

Table 3. Preliminary cost analysis based on price per 10-ft length of material and the corresponding amounts of wave energy density reduction, based on a six-inch wave. The bolded selection indicates the design that was selected for field implementation.

Design Configuration	Estimated Material Cost per 10-ft section	10-ft Section Cost per Energy Density Reduction for a 6-inch wave
[0 pipes,0 feet]	$2,080	$424
[6 pipes, 2 feet]	$3,040	$573
[6 pipes, 3 feet]	$3,145	$898
[11 pipes, 1 foot]	$3,190	$550
[11 pipes, 2 feet]	$3,205	$396
[11 pipes, 3 feet]	**$3,220**	**$354**

4.2 Laboratory-scale Controlled Scale Models

Wave reduction experiments by FWB frames at the 1:8 scale was evaluated in the laboratory. Wave-height and energy-density results are compared between FWB design configurations and between scales. These results demonstrate that as long as similitude relationships are maintained and wave reflectance is limited, laboratory-scale models can be utilized to predict performance in the field.

4.2.1. Wave Height and Energy Reduction

Wave heights and energy densities on the front and back of the various FWB designs were investigated for each scale. Figures 21A-21E and 22A-22E compare the wave height and energy results for the prototype scale and the 1:8 scale. In these figures, the results are normalized for scale. This means that for the 1:8 scale, wave-height values were multiplied by 8 and wave-energy density values were multiplied by 64.

Visually, most of the trendlines for the wave height and the wave-energy density graphs overlap. This would suggest that the wave reduction performance of FWBs at different scales is comparable. The outlier is for the 3.0 ft,, 11 pipes frame where the trendlines are distinct from each other on the wave height as well as the wave-energy density graphs (Figures 21E and 22E). This frame is the exception in this data set and suggests that the prototype scale performed better than the 1:8 scale as the trendline for the prototype data is placed lower than that of the 1:8 scale data.

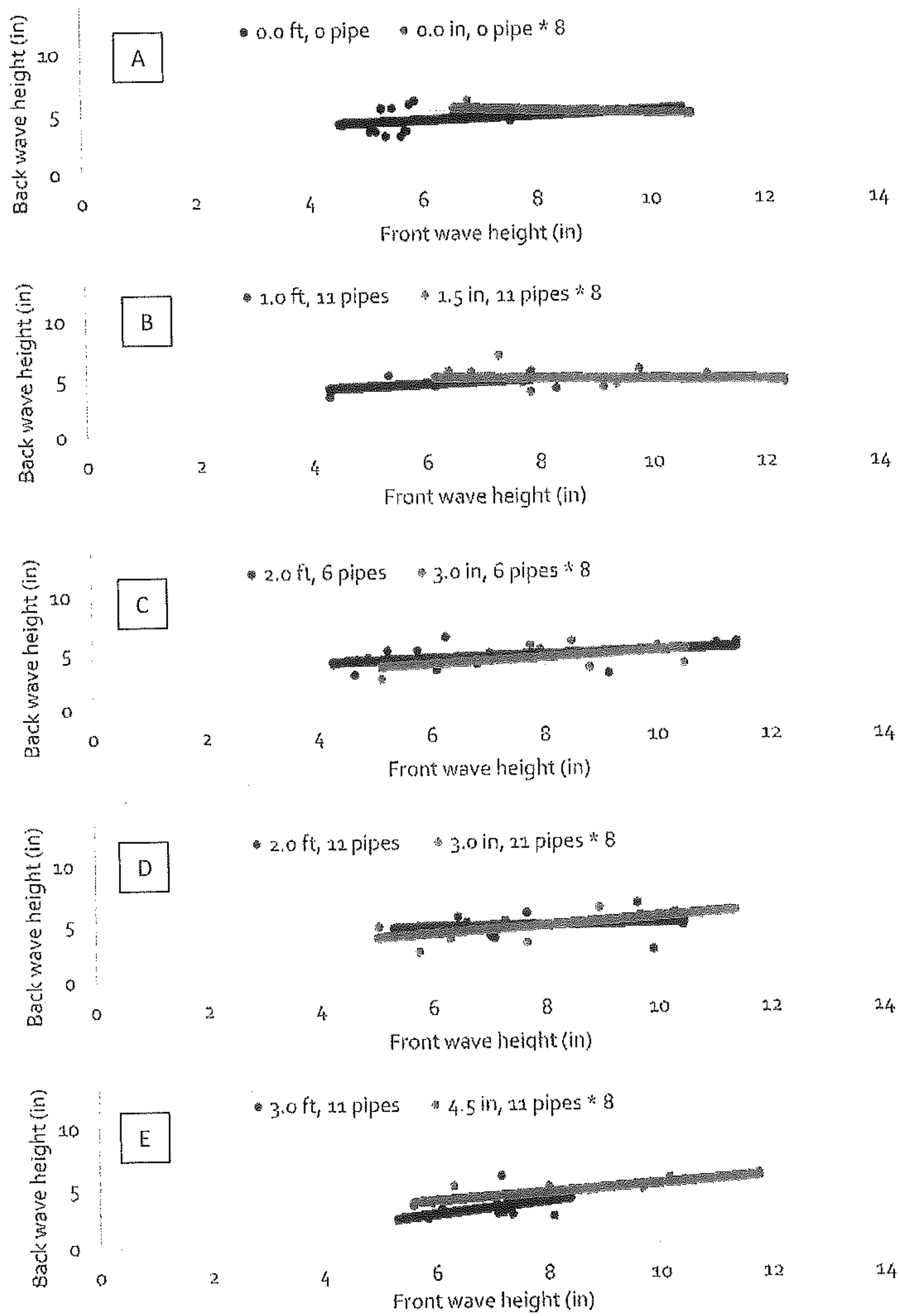


Figure 21. Front and back average wave height comparisons for the full-scale and 1:8 scale for (A) no pipe design, (B) 11 pipes, 1 foot long design, (C) 6 pipes, two foot long, (D) 11 pipes, 2 foot long, and (E) 11 pipes, 3 foot long.

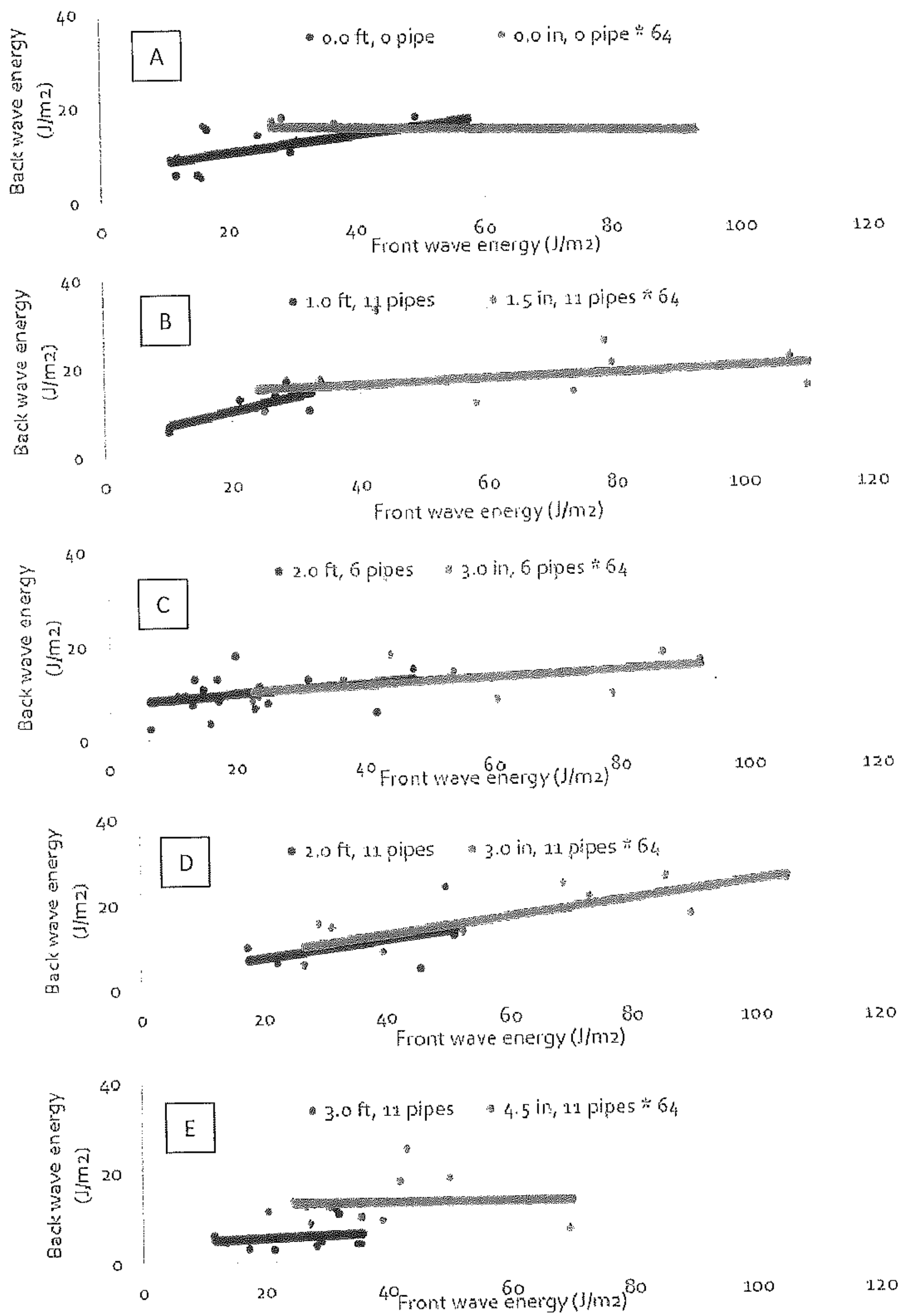


Figure 22. Front and back average wave energy density comparisons for the full-scale and 1:8 scale for (A) no pipe design, (B) 11 pipes, 1 foot long design, (C) 6 pipes, two foot long, (D) 11 pipes, 2 foot long, and (E) 11 pipes, 3 foot long.

The Mann-Whitney U test was used to compare the wave height and wave-energy density between the full-scale mesocosm scale and the 1:8 laboratory scale for the different FWB design configurations (Table 4). The Mann-Whitney U test resulted in no significant difference ($p<0.05$) in wave height reduction between the prototype scale and the 1:8 scale FWB frames except for the 0.0 ft, 0 pipe frame for wave height, 2.0 ft 6 pipes frame for wave energy density, and the 3.0 ft, 11 pipes frames for both wave height and wave energy density. As mentioned in the visual analysis, the 3.0 ft 11 pipes distribution appears to demonstrate better wave reduction than the other frame configurations at the prototype scale, whereas at the 1:8 model scale it performed similarly to the other frames. The 3.0 ft 11 pipes frame seems to be an exception in these comparisons, and may be a result in differences in scaled weight per length at the two scales, as the relative width and density of PVC at these two scales is different, especially when for large number of pipes and connections in each system. If the experiment were repeated, we would record their linear weights (mass/length) to ensure that they compared relative to force similitude.

Table 4. p values for Mann-Whitney U test comparing prototype scale and 1:8 model scale wave height and wave-energy density distributions for different floating wetland breakwater frame ballast configurations.

	Pipe Ballast configuration	p-value
Wave height	0.0 ft 0 pipe	0.01
	1.0 ft 11 pipes	0.64
	2.0 ft 6 pipes	0.51
	2.0 ft 11 pipes	0.65
	3.0 ft 11 pipes	<0.01
Wave-energy Density	0.0 ft 0 pipe	0.09
	1.0 ft 11 pipes	0.06
	2.0 ft 6 pipes	0.04
	2.0 ft 11 pipes	0.18
	3.0 ft 11 pipes	<0.01

To investigate the effect of pipe length and number of pipes on FWB wave reduction, the Mann-Whitney U test was used to compare the wave height and energy density results from the different FWB configurations tested to one another. Tables 5-8 show the p-values for the Mann-Whitney U test comparing these FWB configurations. The results indicate that there is generally no significant difference in wave height and energy density reduction between the different FWB configurations tested, except for the 3.0 ft 11 pipes configuration in the field, which is significantly different from those of all other configurations at the prototype scale for both wave height and wave energy density. At the model scale, the 1.5 in 11 pipes configuration and the 3.0 in 6 pipes configuration are also significantly different when comparing wave energy density results. The 3.0 in 6 pipes configuration seems to perform better than the 1.5 in 11 pipes configuration, although this may be an artifact of the data related to a relatively small sample set.

Table 5. p values from Mann-Whitney U test comparing wave height reduction of different floating wetland breakwater (FWB) configurations at the laboratory 1:8 model scale. p values less than 0.05 are highlighted and are considered significantly different.

FWB configuration	**0.0 in, 0 pipe**	**1.5 in, 6 pipes**	**1.5 in, 11 pipes**	**3.0 in, 6 pipes**	**3.0 in, 11 pipes**	**4.5 in, 11 pipes**
0.0 in 0 pipe		0.13	0.25	0.17	0.23	0.10
1.5 in 6 pipes			0.69	0.80	0.87	0.77
1.5 in 11 pipes				0.31	0.98	0.39
3.0 in 6 pipes					0.63	0.85
3.0 in 11 pipes						0.65

Table 6. p values from Mann-Whitney U test comparing wave energy density reduction of different floating wetland breakwater (FWB) configurations at the laboratory 1:8 model scale. p values less than 0.05 are highlighted and are considered significantly different.

FWB configuration	**0.0 in, 0 pipe**	**1.5 in, 6 pipes**	**1.5 in, 11 pipes**	**3.0 in, 6 pipes**	**3.0 in, 11 pipes**	**4.5 in, 11 pipes**
0.0 in 0 pipe		0.25	0.85	0.17	0.88	0.61
1.5 in 6 pipes			0.78	0.05	0.67	0.18
1.5 in 11 pipes				0.04	0.54	0.22
3.0 in 6 pipes					0.25	0.31
3.0 in 11 pipes						0.61

Table 7. p values from Mann-Whitney U test comparing wave height reduction of different floating wetland breakwater (FWB) configurations for the full-scale mesocosm. p values less than 0.05 are highlighted and are considered significantly different.

FWB configuration	0.0 in, 0 pipe	1.5 in, 6 pipes	1.5 in, 11 pipes	3.0 in, 6 pipes	3.0 in, 11 pipes
0.0 ft 0 pipe		0.80	0.95	0.37	0.001
1.0 ft 11 pipes			0.72	0.55	0.012
2.0 ft 6 pipes				0.44	0.001
2.0 ft 11 pipes					0.005

Table 8. p values from Mann-Whitney U test comparing wave energy density reduction of different FWB skirt wall configurations for the full-scale mesocosm.. p values less than 0.05 are highlighted and are considered significantly different.

FWB configuration	0.0 in, 0 pipe	1.5 in, 6 pipes	1.5 in, 11 pipes	3.0 in, 6 pipes	3.0 in, 11 pipes
0.0 ft 0 pipe		0.83	0.79	0.88	0.006
1.0 ft 11 pipes			0.58	0.66	0.01
2.0 ft 6 pipes				0.93	0.006
2.0 ft 11 pipes					0.02

4.3 Field-scale Implementation

The mesocosm scale tests resulted in a design that produced the most cost-efficient wave height and energy reduction amongst our tested designs. That design was implemented in a 200-ft-long section into Lake Thunderbird in the Spring of 2019. These FWBs were monitored for wave height and energy reduction, along with opportunistic measurements of other biological parameters including fish and wildlife habitat and a measure of live green vegetation coverage.

4.3.1 Wave Height and Energy Reduction

Critical wave height and energy reductions were evaluated through a combination of ADCP data, GoPro video, and image analysis. Figure 23 shows the average front-wave heights compared to the corresponding wave heights after the waves had passed through the FWBs for eight different measurement periods.

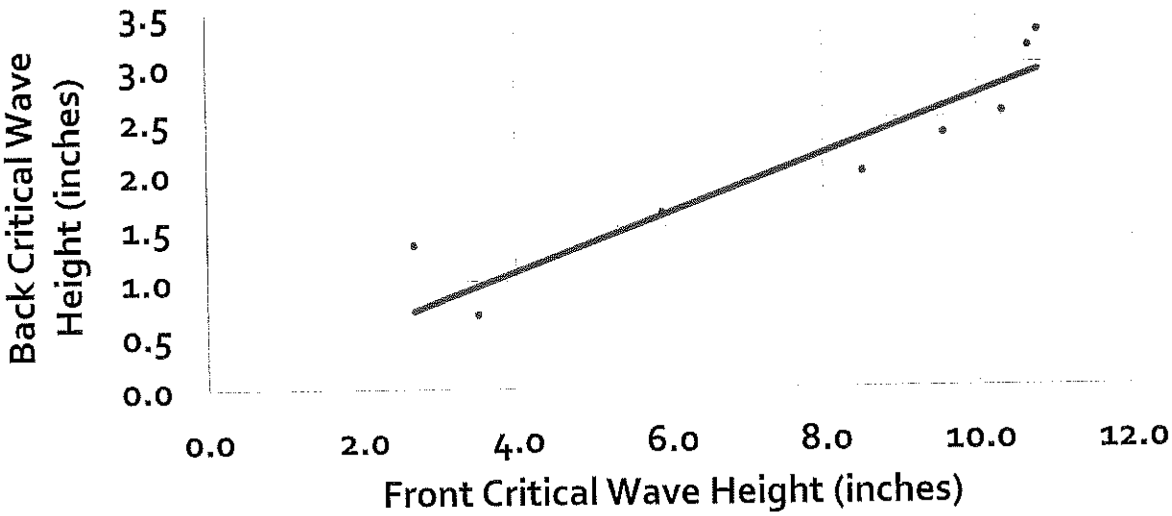


Figure 23. Comparison of the average critical wave height before and after a wave crosses the floating wetland breakwaters installed at Lake Thunderbird.

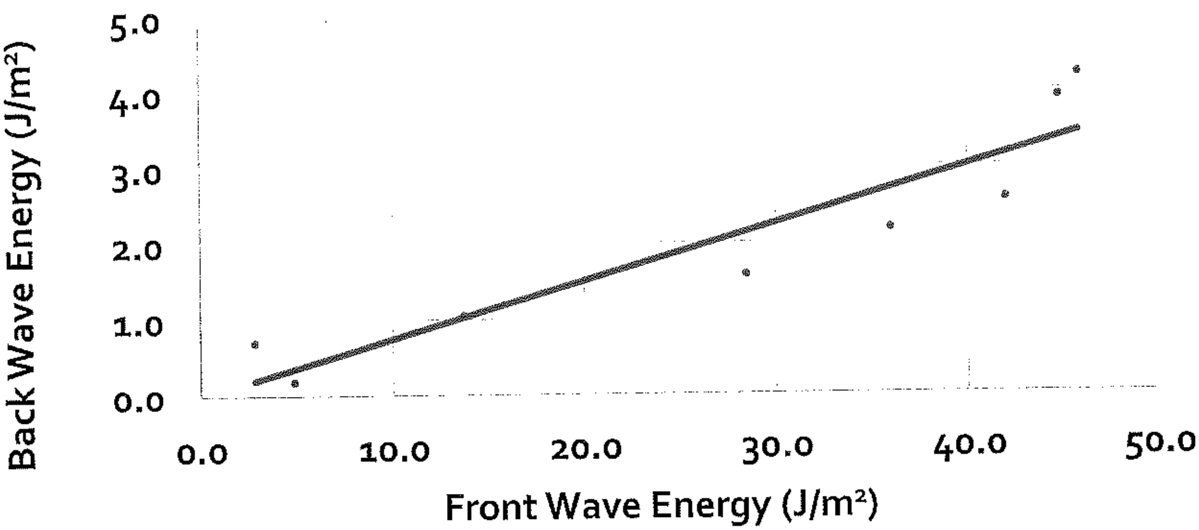


Figure 24. Comparison of the average wave energy density before and after a wave crosses the floating wetland breakwaters installed in Lake Thunderbird.

In addition to wave-height reduction, an energy-density reduction analysis was also performed on the collected wave-height data, as shown in Figure 24. On average, FWBs caused 70-80% reduction in wave height and 91-94% percent reduction for wave energy density. These field-scale results demonstrated greater wave reduction than the full-scale controlled study at the ARF. These results will be further discussed later in this report comparing all three scales of this study.

4.3.2 Estimation of Long-term Erosion Minimization at the Study Bank

The long-term minimization of forces that can cause detachment erosion was completed by combining JET test results with wave height estimations based on 5-minute weather data from the Norman, Oklahoma Mesonet site.

4.3.2.1 Jet Erosion Test (JET) Results

A JET was performed on the bank where the FWBs were located. Following the procedure outlined in Hanson and Cook (2004) and the JET Spreadsheet tool provided by Dr. Garey Fox form the North Carolina Department of Biological and Agricultural Engineering. Results of this analysis areshown in Figure 25.

87
50

τ_c (Pa)	3.86
k_d (cm^3/N·s)	32.03

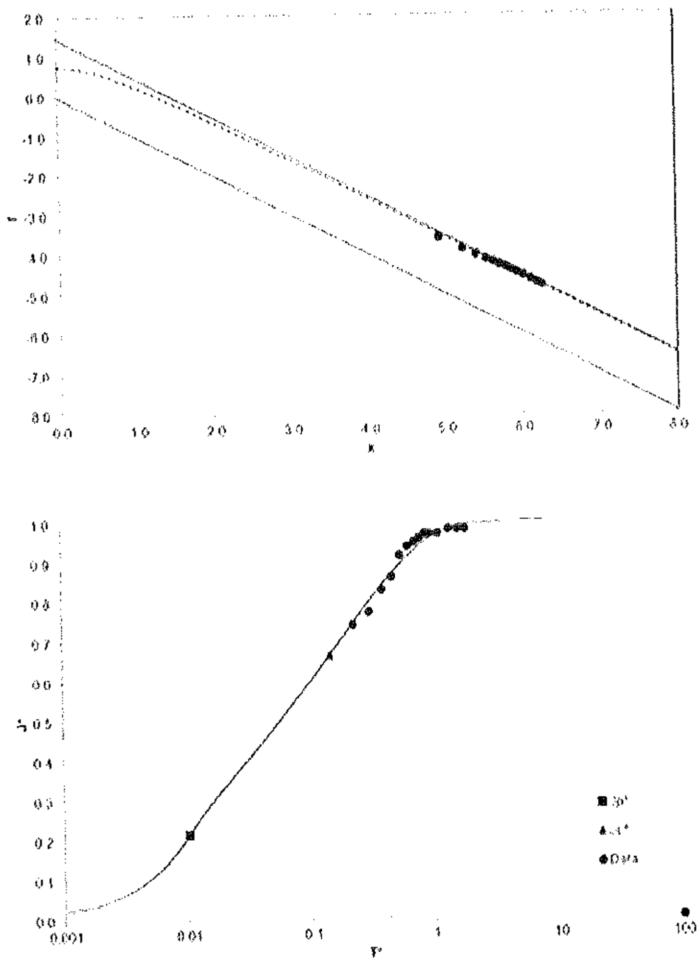


Figure 25. Jet erosion test (JET) comparison graph showing the observed values collected in the field to the three JET solutions.

Upon visually inspection of the results produced from the spreadsheet tool the Scour Depth Solution was used to estimate erosion parameters. Based on this solution, the erodibility coefficient (K_d) was estimated to be 32.0 $\frac{cm^3}{N-s}$ and the critical shear stress t_c was estimated to be 3.86 Pa. The wave height that would begin detachment erosion at our study bank was estimated using linear wave theory as described earlier. These calculations resulted in a 3.1-inch wave to be required for the beginning of soil detachment at the study bank. It is important to note that this does not necessarily mean that significant erosion would occur at this wave height, but this wave height could begin to mobilize some sediment. It does also not account for erosion that may occur from mass wasting of wet soils, especially during periods when the reservoir level is dropping.

4.3.2.2 Comparison to Long-term Estimated Wave Heights

To fully understand and estimate long-term erosion process at the study bank, historical wind speed data from 06/2002-03/2021 for the Norman Oklahoma, Mesonet Weather Station were used to estimate predicted fully formed incoming wave heights on our study bank based on wind speed. During this period, the average wind speed out of the Southeast to Southwest directions was 8.9-mph with a standard deviation of 4.94. Figure 26 is the resulting histogram from that data period.

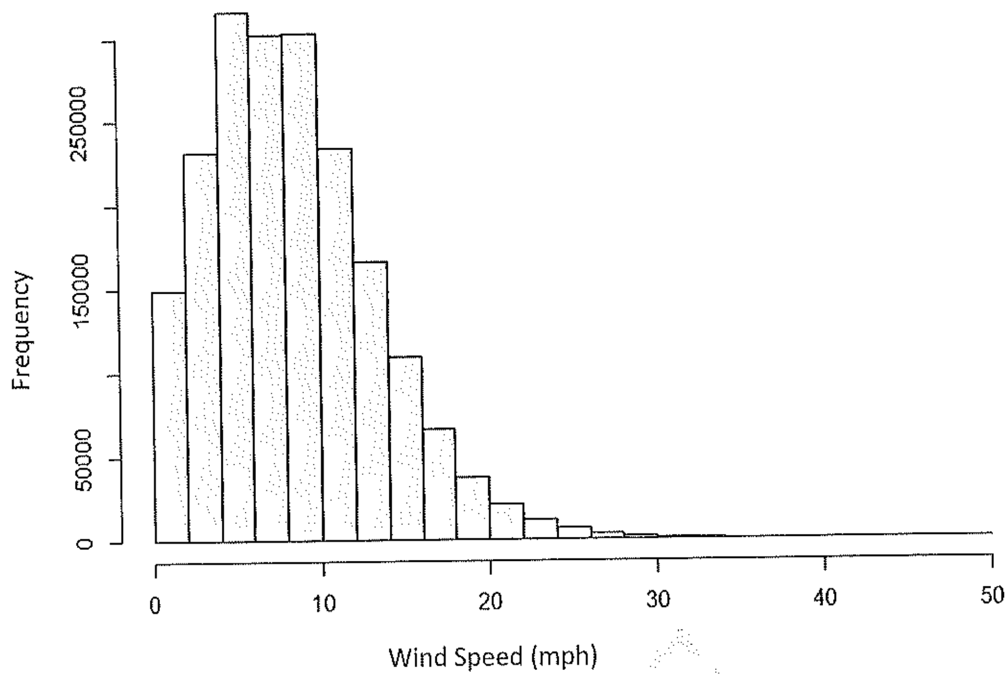


Figure 26. Histogram showing the historical wind speed and the frequency each one occurred for winds from the Southeast to Southwest. (Source: Norman, Oklahoma Mesonet Site)

The 5-minute wind speed data over the past 19 years from the Norman, Oklahoma Mesonet site (https://www.mesonet.org/index.php/sites/site_description/nrmn) were used to predict the fully formed wave height those winds speed would produce at the study location by using the empirical relationship described in section 2.3.1. Table 9 demonstrates the percentage of waves in the range less than 3.1 inches with and without a FWB, using the trendline equation of the data shown in Figure 23 (outgoing wave height = 0.2717*[incoming wave height]). Adding our floating wetland water system will reduce 96% of the waves hitting that shore to a height that is less than what is required.

Table 9. Percentage of waves in various height ranges with and without floating wetland breakwaters, based on wave height estimations for 5-minute wind speeds from the Norman, Oklahoma Mesonet site (https://www.mesonet.org/index.php/sites/site_description/nrmn)

	No Wavebreak	With Floating Wetland Breakwater, 11 Pipes, 3-ft Length [Field]
Incoming 5-minute Average Wave Height to Give resulting outgoing wave (in), estimated from regression	Percentile	Outgoing Wave Height (in)
3.1	66%	0.8
11.4	96%	3.1
13.0	97%	3.5
47	100%	13

Additionally, the wave reduction potential of these FWB systems, the maximum southerly wind speed recorded between June 2002 and March 2021 was 79 miles per hour (mph) on July 30, 2003, which would result in a wave height of approximately 1.2 meters or 47 inches. Based on the trendline equation, if the FWBs were in position, they could have potentially reduced that wave height to approximately 13 inches. While this is outside the tested range of our system, if the relationship still holds it does give an approximation of the reduction potential of these systems in high winds. In addition, the top 3% of all waves that hit the bank are reduced to an average height of less than 13 inches in height when our system is implemented.

4.4 Discussion Comparing All Three Scales

4.4.1 Wave Transmission Coefficient Comparison

The wave-height reduction results from this study were compared to those of other studies on floating breakwaters. Wave height reduction is often calculated using the wave transmission coefficient, K_t. The wave transmission coefficient is calculated by the transmitted wave height or back height divided by the incident or front height. The ranges of wave transmission coefficients found in the studies of Neelamani (2018), Uzaki (2011) and Ozeren (2011) were compared to those found in this study at the prototype scale and at the 1:8 scale as shown in Table 10.

Table 10. Range of wave transmission coefficient values (K_t) for floating breakwaters on other studies and the floating wetland breakwater designs investigated in this study.

	K_t range			
Source	**Prototype scale**	**Model scale**	**Field Scale**	**Description**
Neelamani (2018)	0.6 - 0.8	NA	NA	Pontoon floating breakwater with varying skirt wall sizes
Uzaki (2011)	NA	0.3 - 1.0	NA	Steel pontoon floating breakwater with trusses
Ozeren (2011)	0.2 - 0.9	NA	NA	Cylindrical floating breakwater
Webb (2014)	NA	0.4-1.0	NA	Biohaven floating wetland breakwater without plants
FWB [0.0 ft, 0 pipes]	0.5-1.0	0.7-0.9	NA	Floating Wetland Breakwater with no ballast
FWB [1.0 ft, 11 pipes]	0.5-0.9	0.3-0.9	NA	Floating Wetland Breakwater with pipe ballasts
FWB [2.0 ft, 6 pipes]	0.3-1.0	0.3-0.7	NA	Floating Wetland Breakwater with pipe ballasts
FWB [2.0 ft, 11 pipes]	0.4-0.8	0.4-0.9	NA	Floating Wetland Breakwater with pipe ballasts
FWB [3.0 ft, 11 pipes]	0.3-0.8	0.5-0.8	0.2-0.5	Floating Wetland Breakwater with pipe ballasts

The ranges of wave transmission coefficients found in this study are similar to those found in other studies. The maximum wave transmission coefficients are also similar across studies, except for the study by Neelamani. This suggests that the FWBs used in this study exhibit similar or better performance compared to non-wetland floating breakwaters from these studies. In addition, the field implementation of our chosen frame design with 11 pipes that are three foot long exhibited the best, consistently low wave transmission values of any reported study.

4.4.2 Comparisons of the Implemented Design at Three Scales

The wave height and energy density reduction from the implemented design to 11 pipe ballasts that were each three foot long for each 10-ft section is shown in Figures 27 and 28, respectively. These results suggest that, even when attempting to account for all similitude-related variables, model simulations are probably a conservative estimate of wave height and energy density reduction. However, these results appear to be predictable, so if one knows the relationship of the results at the various scales then utilizing scale models can still be useful for predicting performance when implemented in the field. Further testing in additional locations would be required to verify this conclusion.

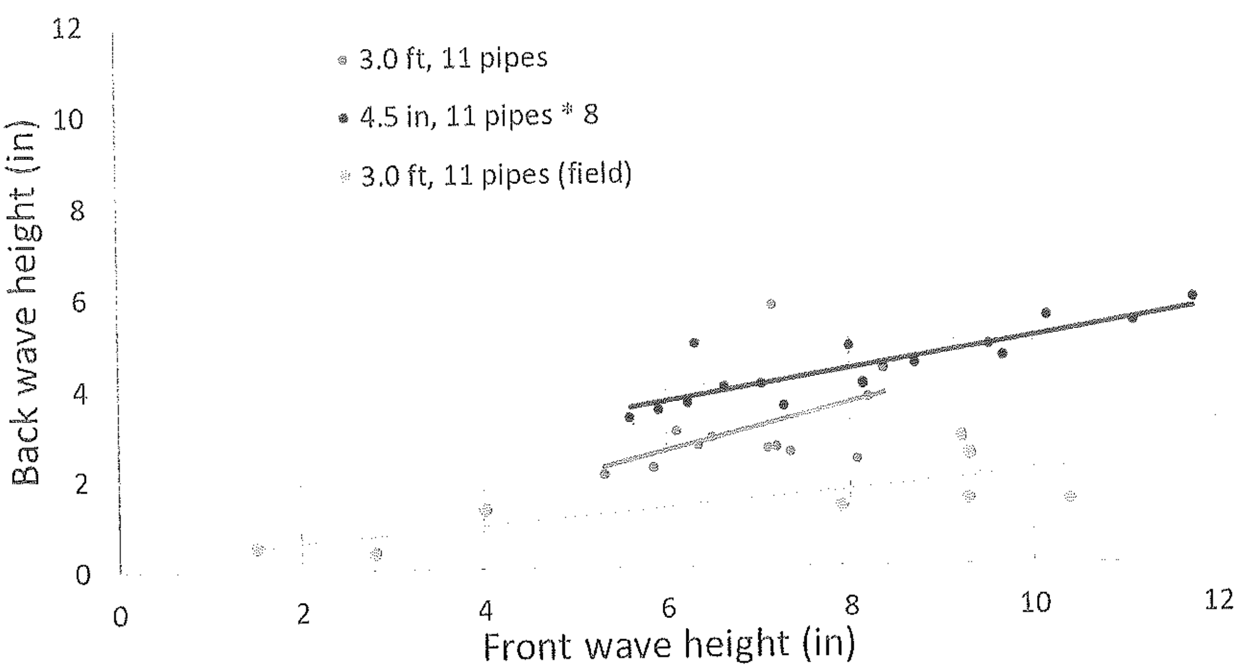


Figure 27. Comparison of wave reduction caused by floating wetland breakwaters for all three scales of this study for the implemented design [full-scale mesocosm (blue), laboratory scale (red), and field (yellow)], which had 11 ballast pipes that were 3 feet long.

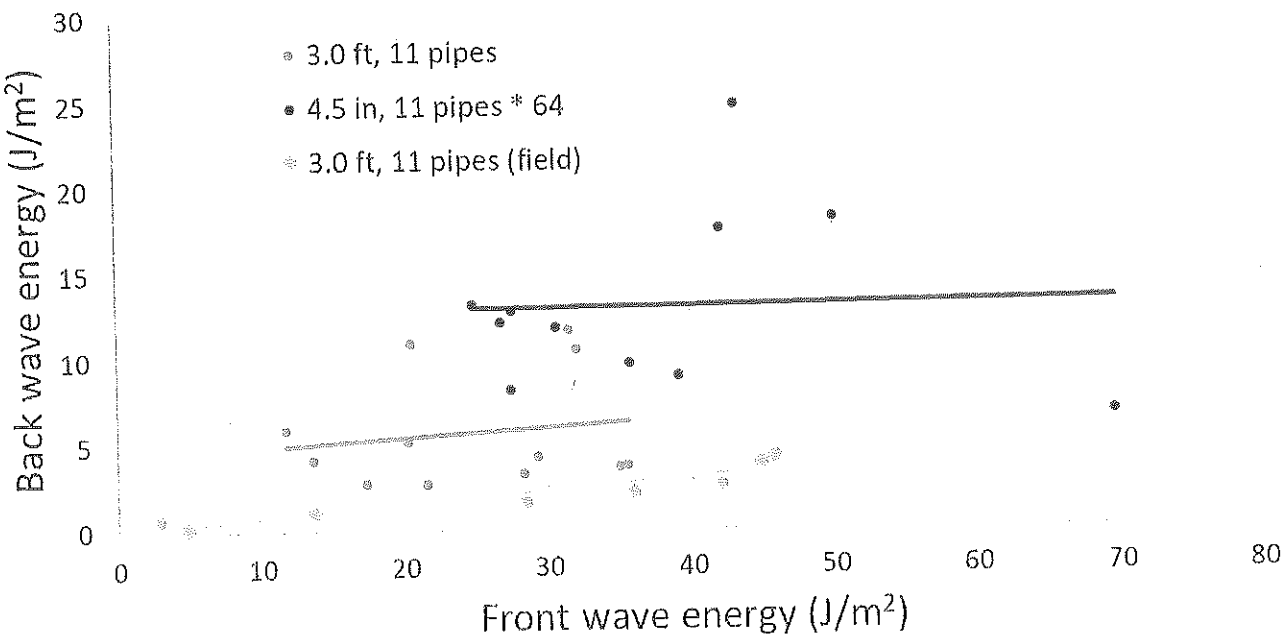


Figure 28. Comparison of wave energy density reduction caused by floating wetland breakwaters for all three scales of this study for the implemented design [full-scale mesocosm (blue), laboratory scale (red), and field (yellow)], which had 11 ballast pipes that were 3 feet long on each 10-foot section.

4.5 Opportunistic Biological Monitoring

4.5.1 Fish Surveys

Two fish surveys were completed around both at the location of the FWBs and the control site further to the West. With assistance from Steve O'Donnell with the Oklahoma Department of Wildlife Conservation, two electrofishing sampling trips were completed at the FWB and a control site to compare the different populations of fish inhabiting each area. Table 11 shows the results of the first sampling trip completed in November of 2019. The control site for these samples was from a location directly to the east of the floating wetland installation in Lake Thunderbird, approximately the same distance from the shore; it is open water, 2-3 meter in depth, with little to no submerged structures. A notable difference between the two locations is the population of Largemouth Bass (*Micropterus salmoides)* at the FWBs compared to the control site. Considering that Largemouth Bass are commonly concentrated in areas with submerged structures including vegetation, sunken trees, and rocks, the FWBs provide a quality habitat for this ever-popular sport fish (Claussen, 2015). Additionally, species such as the White Crappie (*Pomoxis annularis)* and Blue Gill (*Lepomis macrochirus)* that tend to congregate around submerged structures were also found in more abundance around the FWBs. The control site used in this study is essentially open water, 2-3 meter in depth, with little to no submerged structures which is represented by the fish collected there. Most notably is the higher presence of Gizzard Shad (*Dorosoma cepedianum)* and Silverside (*Menidia beryllina)*, schooling bait fish that prefer open water (Miller, 1960). Furthermore, open water predatory fish, such as the White Bass (*Morone chrysops)* and Saugeye (*Sander canadensis x vitreus)* were collected at the control site but did not appear around the FWBs.

The second fish survey (Table 12) was completed in August 2020 and showed similar results to the initial fish survey. Largemouth and other fish that congregate around submerged structures being present at the FWBs and more fish that tend to open water on the control site. It is important to note that the second survey was done in the late summer where the water temperatures were still relatively warm, meaning that some fish may have still been in the deeper, cooler water and not moved to the shallower water around the frames at this time. During the 2020 fish survey a school of gizzard shad swam across the path of the boat, so after the first 40 Gizzard Shad collected it was decided that no more were required to get a comprehensive example of the type of fish present at each location. FWBs show promise as a suitable habitat for many different types of fish species. They offer a recreational aspect to the system as fishermen may be drawn to the area in search of that prized sportfish. With FWBs continuing to show promise as wave breaks, and with the added benefit of fish and wildlife habitat to an area with severely eroded banks adds to the restoration potential of these systems. It is also expected that after the plants are established they will attract an even wider diversity of fish, as has been seen in other studies.

Table 11. Fish survey results from the floating wetland breakwater and control site, completed in November 2019.

Lake Thunderbird Fish Survey Results (2019)					
Floating Wetland Breakwaters (FWBs)			Control		
Species	**Count**	**Mean Length (mm)**	**Species**	**Count**	**Mean Length (mm)**
Bluegill	2	158	Bluegill	0	0
Channel Catfish	1	372	Channel Catfish	0	0
Common Carp	1	508	Common Carp	1	660
Flathead Catfish	0	0	Flathead Catfish	1	710
Gizzard Shad	2	223	Gizzard Shad	6	216
Largemouth Bass	9	351	Largemouth Bass	2	450
Silverside	2	76	Silverside	7	51
Saugeye	0	0	Saugeye	2	272
White Bass	0	0	White Bass	6	216
White Crappie	1	234	White Crappie	0	0
Total	21		**Total**	18	

Table 12. Fish survey results from the floating wetland breakwater and control site, completed in August 2020.

Lake Thunderbird Fish Survey Results (2020)					
Floating Wetland Breakwaters (FWBs)			Control		
Species	**Count**	**Mean Length (mm)**	**Species**	**Count**	**Mean Length (mm)**
Bluegill	1	147	Bluegill	0	0
Channel Catfish	1	290	Channel Catfish	0	0
Gizzard Shad	15	185	Gizzard Shad	40	184
Largemouth Bass	2	329	Largemouth Bass	0	0
White Bass	2	250	White	1	250
Total	25		**Total**	41	

4.5.2 Plant Monitoring

In limited opportunistic monitoring, plants in PolyFlo maintained their greenness better than plants in the coir mattresses during a two-month period in September and October 2020 (Figure 29), as measured using NDVI values measured using a GreenSeeker at a constant height of 2.5 feet above the frames over time. These data confirm the visually weekly or sometime daily inspection of the FWBs, where the PolyFlo appeared to hold and protect the wetland plant species better than the coir during this period.

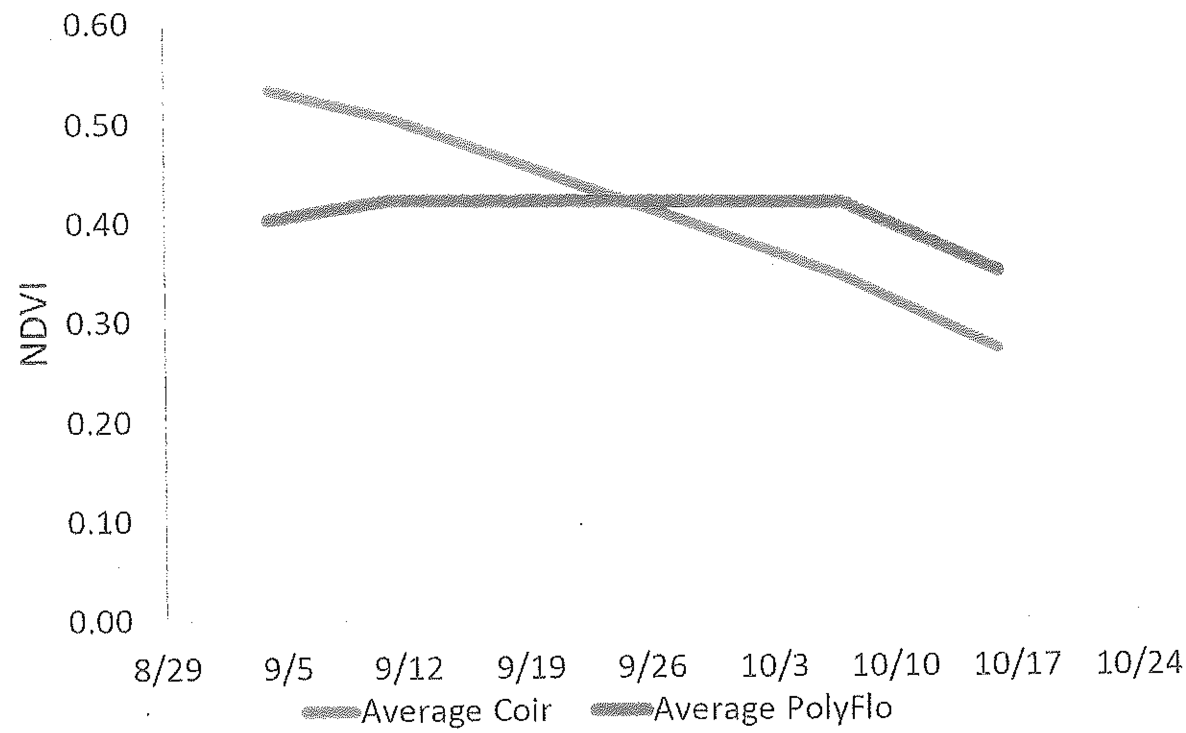


Figure 29. Average Greenseeker normalized difference vegetation index (NDVI) values measured at a constant height above floating wetland breakwater frames in September and October 2020.

4.6 Cost Analysis Comparison to Other Best Management Practices

BMPs that have traditionally been utilized to stop shoreline erosion include rip rap, retaining walls, and living shorelines. Biohaven has also developed a floating wetland breakwater with a median k_t of approximately 0.25 (Webb, 2014). Utilizing approximate material costs for each of these materials, in addition to the results from this study, we have compare the one-time materials cost and cost per day for no erosion for each of these BMPs (Table 13). The results show that the floating wetland breakwaters compare favorably with all these BMPs, while also providing additional ecosystem services compared to rip rap and retaining walls, and providing 18% more no-erosion days compared to Biohaven.

Table 13. Comparison of one-time materials cost and cost per day for no erosion over an assumed 20-year design life for various best management practices. These calculations do not consider inflation.

Best Management Practice	Material Cost per 10 ft section	Cost per Day of No Erosion over 20-yr Design Life *** ($/day/ft)
Rip Rap	$1,000-$22,000	$0.013-0.30
Retaining Walls	$3,800-$17,000	$0.052-0.23
Living Shoreline	$1,000-$5,000	Not Determined
Biohaven Floating Wetland Breakwater	$2,700	$0.047 (78% of the days; estimated from the median k_t of 0.25 in Webb, 2014)
Floating Wetland Breakwater [11 pipes, 3 feet]	$3,200	$0.046 (96% of the days), not including shoreline plant growth benefits which would also decrease shoreline erodibility

Rip-rap Cost: various internet sources
Living Shorelines Cost Source: https://www.fisheries.noaa.gov/insight/understanding-living-shorelines ; reduction of erosion days cannot be estimated
Concrete Walls Cost Source: http://southatlanticalliance.org/wp-content/uploads/2016/04/17-Hoffman-The-Costs-of-Shoreline-Stabilization.pdf
Biohaven FWB Cost Source: Company quote; Percent wave reduction calculated based on Webb, 2014
** NOTE: Preliminary estimation that does not include installation, maintenance or time value of money; FWB costs should be reduced significantly with roto-mold

5 Lessons Learned and Design Alterations

Utilizing floating wetlands as a wavebreak in freshwater reservoirs is an innovative concept, and as a result, throughout the implementation process, many lessons have been learned. Unexpectedly, 2019 turned into a year of mostly trial and error with the floating wetland breakwaters, due to a period of much greater rainfall than is typical for the area in the week immediately following installation. Specifically, the Oklahoma Mesonet station in Norman received 11.34 inches of rainfall in April 2019, while the previous two years received 4.18 and 2.05 inches, respectively. These rain events caused Lake Thunderbird to rise approximately six feet according to COMCD, significantly higher than normal water level in the reservoir and inundated the floating wetlands. As a result, design modifications were made for the 2020 implementation to allow the floating wetlands to function more efficiently. These changes included (1) changes to the planting media design, (2) comparison of coir and Polyflo media during the 2020 implementation, and (3) adding cross supports to the frames for better initial support of the media and plants.

Changes to the plant media design were also made to increase their stability in the frames and provide additional protection for juvenile plants. To increase the stability of the Polyflo in the FWBs, which is a biological filter media designed to have high surface area for beneficial bacteria colonization as well as being durable and UV resistant, safety netting was wrapped around the plant media to create a "burrito" like system. The safety netting was then fastened to the frames themselves, allowing the plant media to be suspended within the FWBs. Figure 30 contains an example of one of the design modifications made to increase their stability in the FWB media.

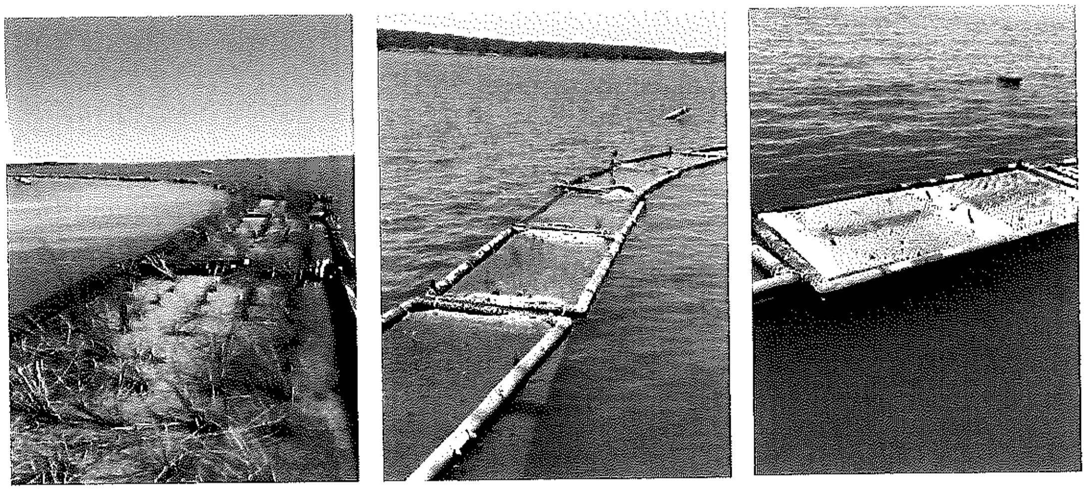


Figure 30. Evolution of floating wetland media design from initial planting and installation (left) to the damaged wetland frames (center), to finally the design modifications (right) to make the Polyflo more stable in the frames.

In addition to the Polyflo modifications, 10 of the 20 frames were outfitted with coir mattresses for the plant media in 2020 so that we could compare the coir mattresses to the PolyFlo burrito media. Coir is natural coconut fiber typically extracted from the outer husk of a coconut. Coir mattresses been implemented successfully in wetland restoration projects (Steve Patterson, personal communication). Figure 31 shows the process of creating the coir mattresses from shredding the coir bails to stitching the mattress together. These coir mattresses were then positioned, fastened, and planted in the FWB frames. Figure 32 shows the process of getting the mattressess situated in the frames and final attachment to the frames. As previously described, the Polyflo ultimately performed better at keeping plants alive (with our limited, opportunistic data collection).

Figure 31. Coir mattress production process.

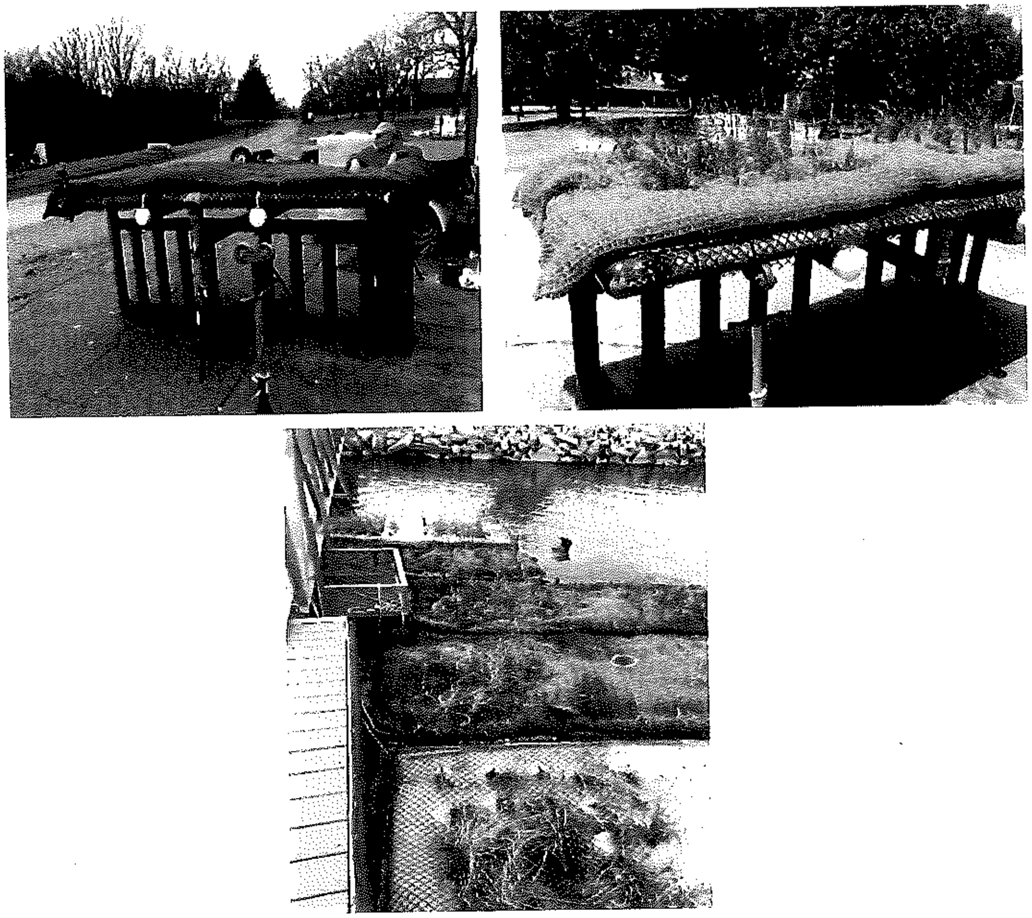


Figure 32. Demonstration of situating and planting the coir mattresses in the frame (top row), along with the frames positioned in the water (bottom image). Photos taken by Maxwell O'Brien.

Along with the new plant media design considerations, cross-support pipes were added to the floating frames themselves to provide additional structure for the plant media. The decision to add the cross supports was made because the original design did not keep the plant media structure high enough out of the water when water levels rose after planting, and resulted in the loss of the original plants along with the damage depicted in Figure 30 (center). Figure 33 shows a schematic that highlights the cross braces that were added to the original frame design. The cross braces were constructed using polyethylene pipe from the original frame construction process. The braces were filled with insulating spray foam sealant and then capped with PVC caps prior to being fitted to the original FWB frames. It is important to note that these cross braces were added to the original design solely for the purpose of supporting the plant media and not to provide any additional wave break potential.

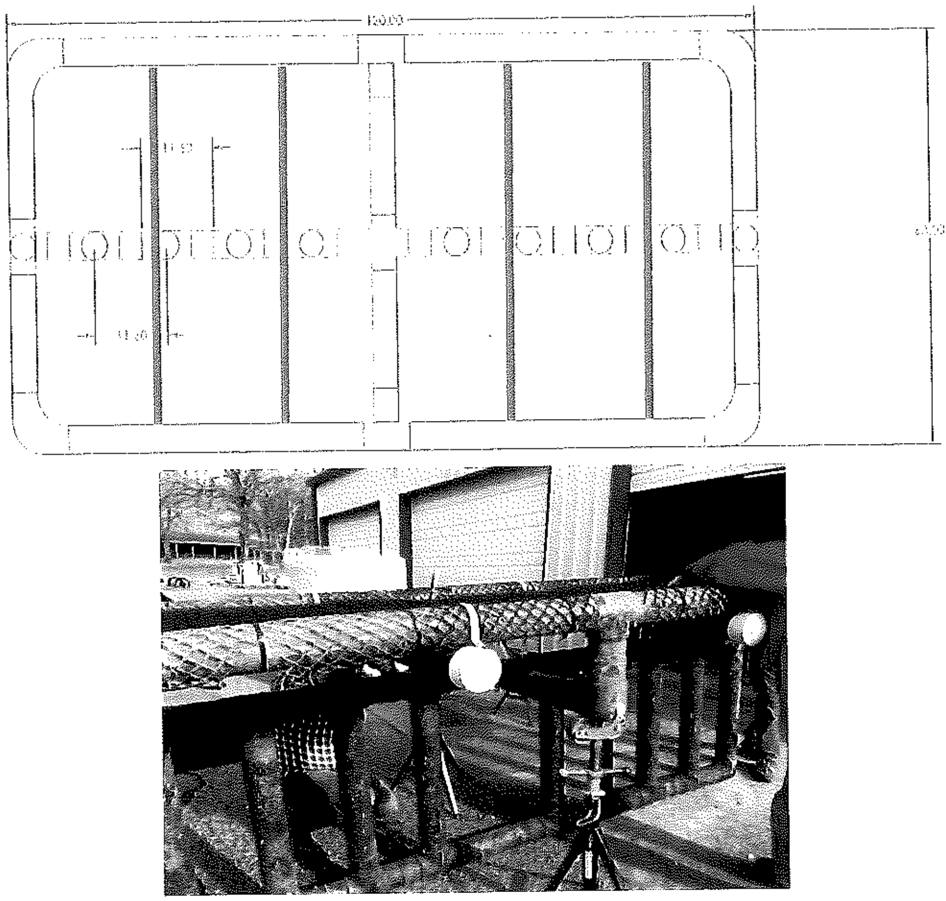


Figure 33. Top view (top) of the cross-brace modifications (blue) made to the original floating wetland breakwater design. Cross braces seen being attached to the floating wetland breakwater fram in the bottom image. Photo taken by Maxwell O'Brien.

6 Recommendations for Future Work

6.1 Media and Plant Establishment

While the primary objective of this study was to quantify and optimize the wave height and energy reduction potential of these systems, we also collected opportunistic measurements regarding plant establishment to best allow the FWBs also function as your traditional floating wetland habitat. Throughout this study, whether it was from planting delays caused by procurement issues (2019) and COVID-19 halt to research (2020), extreme weather conditions, plant media damage, or vandalism, maintaining a thriving plant community on the FWBs was challenging. The modified frame and media design in 2020 that included the PolyFlo media and reworked frame and media design appeared to give the plants more support and they survived better. Along with the extra support, the planted frames were tethered around the boathouse at COMCD for approximately two weeks in spring 2020 to allow the aquatic vegetation to partially mature in the plant media. Prior to repositioning the frames back at their location out in the reservoir we noted what appeared to be healthy plants with roots growing through the plant media and into the water column seen in Figure 34. However, once the frames were repositioned out in the lake and the plants were exposed to all the conditions including wind, boat traffic, and even the reservoir freezing over, the plants on the frames did not have the opportunity to fully establish. For future deployment of FWBs, it is recommended to allow the plants to fully mature in their respective frames in a cove or other protected area, potentially for a full season, before moving them to a location with high wind speeds and wave action.

Figure 34. Roots from Juncus Effusus growing through PolyFlo media prior to field deployment in 2020.

6.2 One-piece Frame

The FWB frames used in the field portion of this project were constructed of PVC pipe that was welded together at each joint. After construction, each frame was towed into place behind the boat from the boat dock to the installation location. During this process, but unknown to us at that time, it appears that small leaks were caused in the joints at the locations of the PVC welds that were caused by the force of the water on the ballast pipes as it was towed through the water. This caused some of the frames to sit lower in the water than expected, which was then exacerbated by the extremely high water that occurred within a week of installation. To fix this issue, the research team proposes to utilize rotation molding for frame construction in the future. Rotational molding involves a heated hollow mold a charge of shot weight of material and then slowly rotated. This causes the softened material to disperse and stick to the walls of the mold, creating a one-piece plastic mold in the desired shape (source:

https://en.wikipedia.org/wiki/Rotational_molding). This will allow for increased ease and speed of transport of the frames from one location to the other.

6.3 Wave Measurement

During the project, multiple techniques for measure wave heights were utilized ranging from technical and complex (using an ADCP specifically designed to measure ocean waves) to simple (manually measuring wave height from GoPro video of the waves passing by a staff gage). Each of the techniques had their pros and cons, but our experience was that the simplest method of using a GoPro video of the waves passing by the staff gage was the most reliable and efficient. In addition, the ADCP we utilized, which was the only one that could be afforded on our budget, was designed for ocean waves and had problems measuring the height of small waves such as was found on the backside of the FWBs (this was not known by the company when it was purchased).

7 Summary and Conclusions

This project was able to meet all of its objectives and has advanced the understanding of utilizing FWBs to reduce shoreline erosion. Investigations at three scales—full-scale controlled mesocosm, laboratory-scale controlled mesocosm, and field scale, were completed. Through the full-scale controlled mesocosm study at the ARF on the University of Oklahoma campus, we demonstrated that a floating wetland frame with 11 pipe ballasts that were each 3-ft long for every ten feet of length provided the most cost-efficient wave energy reduction amongst the designs that were investigated. Furthermore, a companion laboratory-scale investigation concluded that, generally, FWB performance could be predicted utilizing scale models as long as similitude relationships were accounted for (especially force similitude, which is the hardest to achieve on scale models). The field implementation in Lake Thunderbird proved to have the best reported, consistent wave reduction not only amongst our designs, but also compared to available transmission coefficients reported in available literature for other breakwater designs. Additionally, the materials cost was shown to be competitive related to other traditional and bio-engineered practices for reducing shoreline erosion.

As part of the research project we were able to identify design improvements that can be implemented going forward including (1) utilizing PolyFlo media with cross braces for the best integrity of the media in the FWBs; (2) if possible establish the plants in a cove or other protected area for one growing season before implementing in a location with large waves; (3) a rotational mold of the FWB frame would be useful so that there are not seams that can leak on the frame; and, (4) if monitoring is required, simple manual measurements using a GoPro and and stage gage may be the most efficient and reliable mode of measuring wave heights and periods.

This of innovative concept of utilizing FWB with ballasts to optimize wave reduction and reduce shoreline erosion design has shown promise to simultaneously function as a floating wetland and a wave break. Our team sees this design as a cost-effective alternative for reducing shoreline erosion in areas with moderate erosion, which will allow nature time to heal the shoreline before moving the system to the next location.

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Item C.2.

OKLAHOMA
Water Resources Board

Lake Thunderbird 2020 Water Quality

Curt Dikes
October 7th, 2021

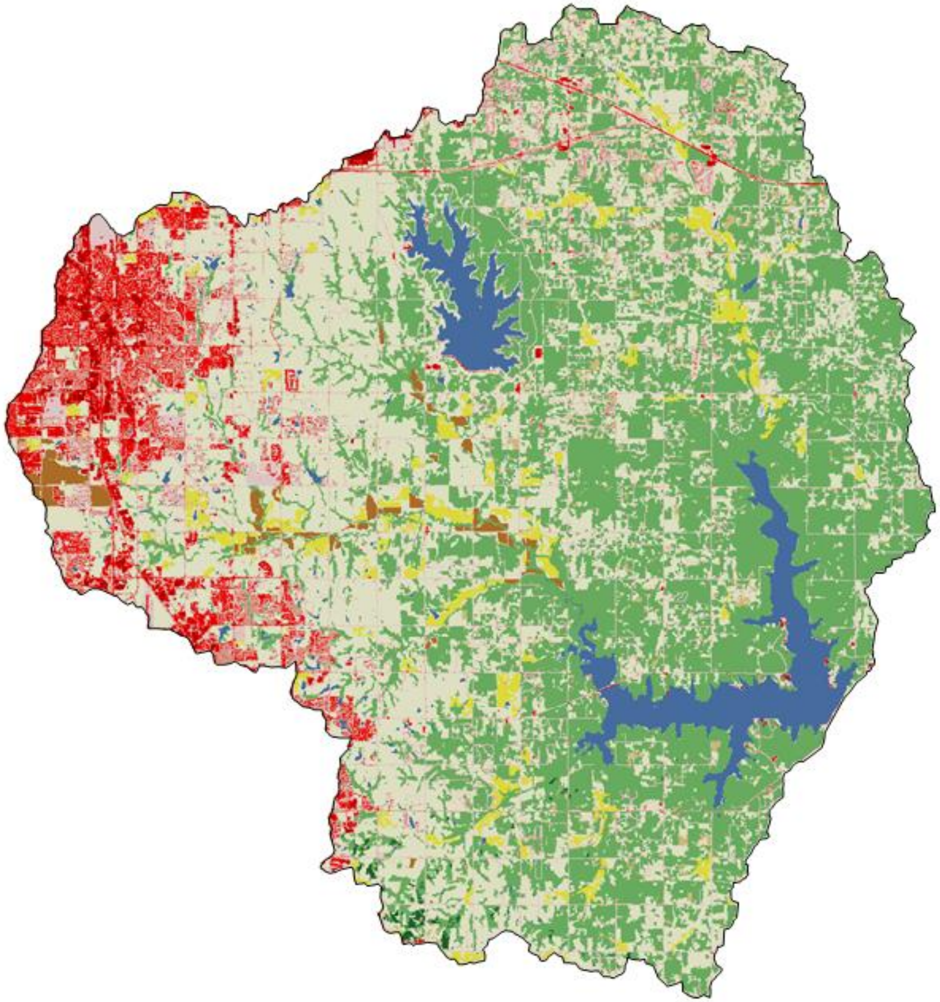
Outline

- Watershed Overview
- Updated Bathy – BOR
- Water Quality Results

Updates:

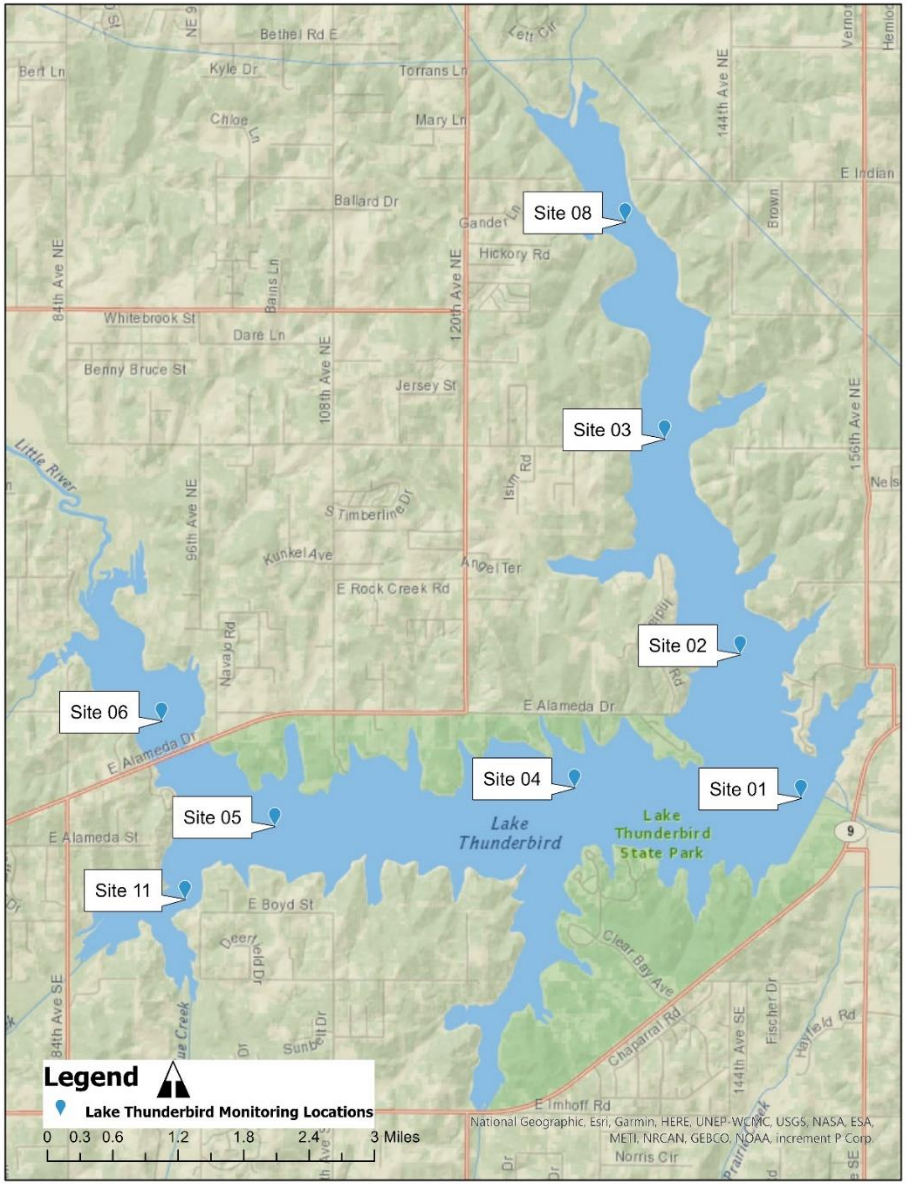
- 20 Year Trends
- Internal Loading

Thunderbird Watershed



› Continued development underscores need for LID and BMPs

OKLAHOMA
Water Resources Board

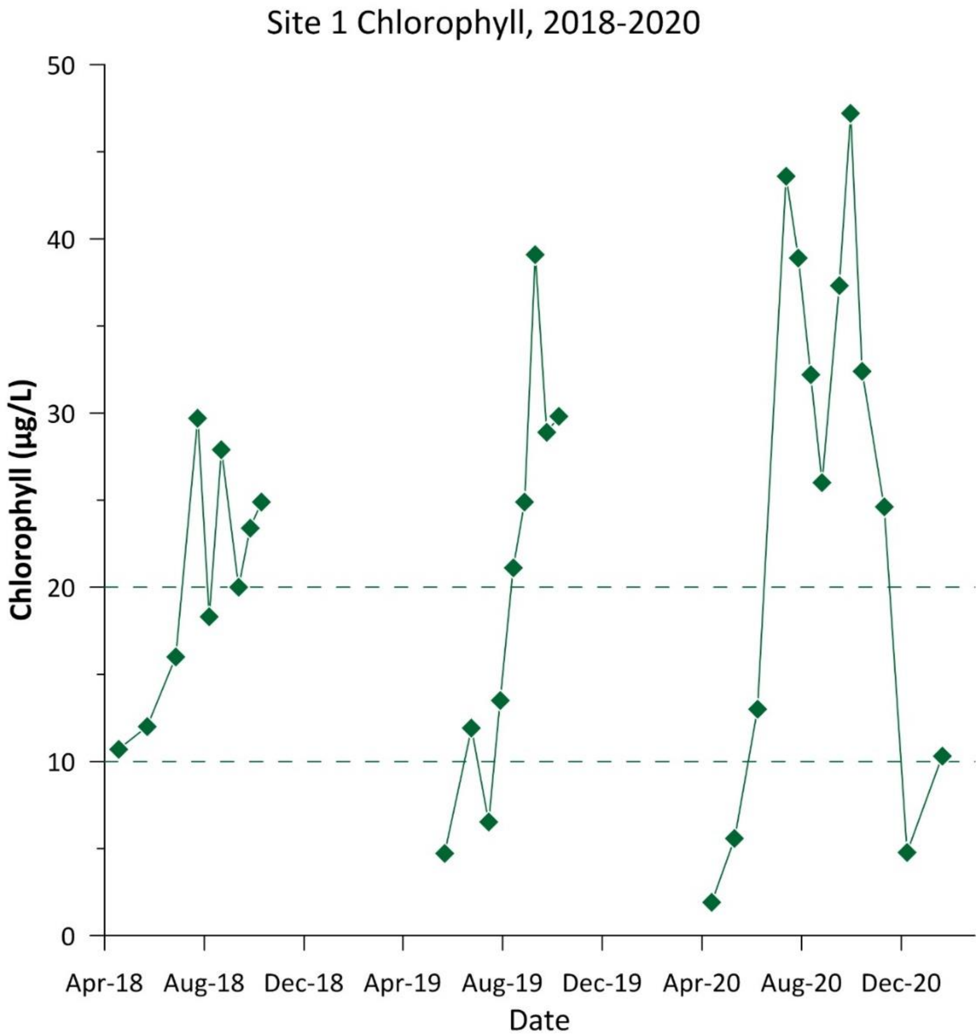


› Updated bathymetric data, 2015 Bureau of Reclamation

- 5,556 ac, +117 ac
- 105,278 AF, (560)

- Total Volume loss of 11%
  - › 50 yr. sedimentation rate of 428 AF/yr.

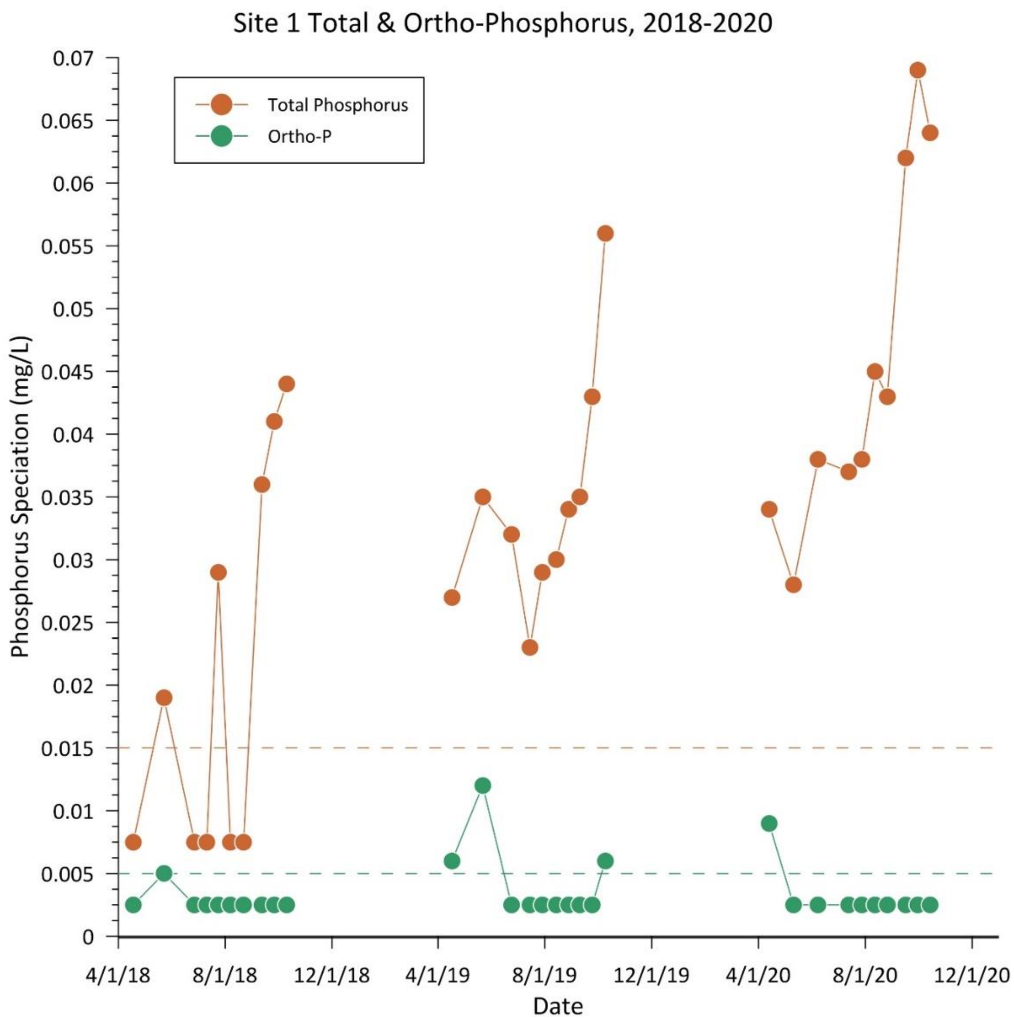
Chlorophyll



› Chlorophyll a
- ↗ Increased
- Lake wide avg, 30.75 µg/L
- 3x SWS criteria, 10 µg/L

› Taste & Odor
- 75% increase over 2019
- MIB & Geosmin

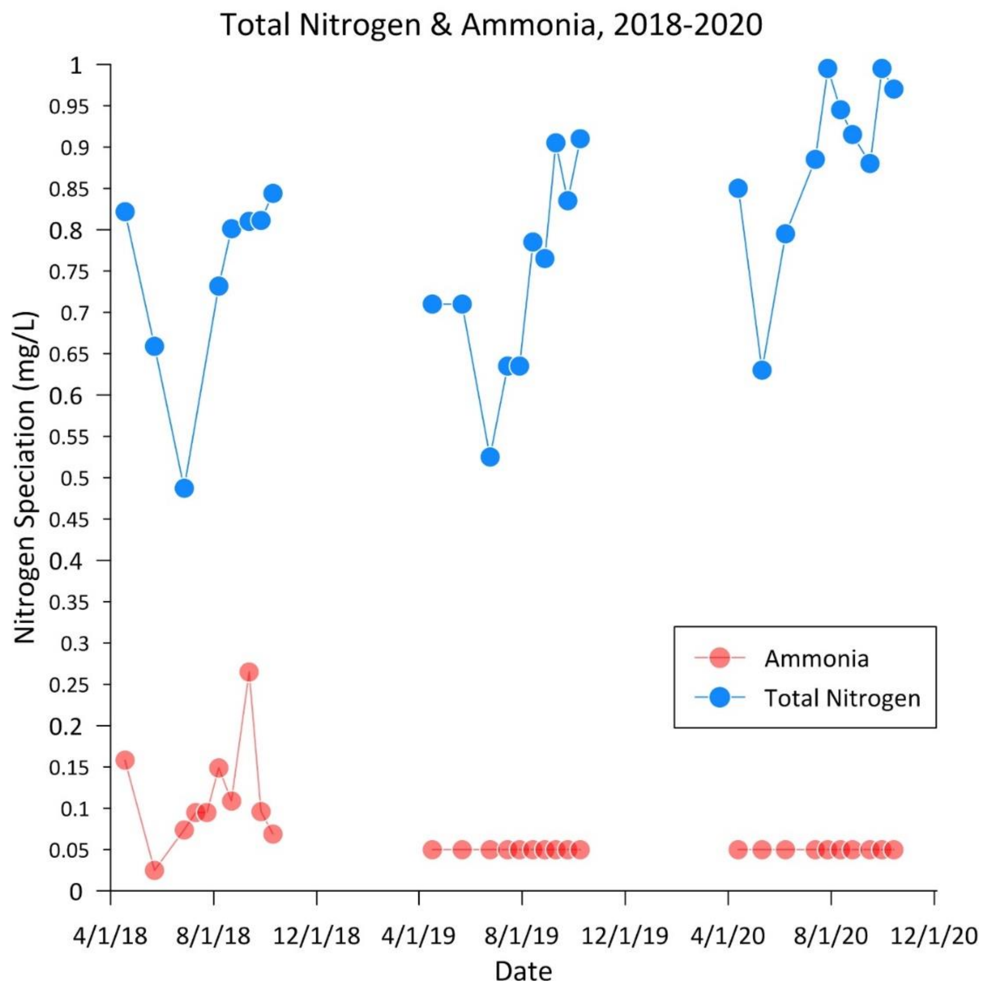
Phosphorous



› Total Phosphorus

↗Increased

Nitrogen



› Total Nitrogen
↗Increased

Turbidity

- Turbidity
  - Improvement, sort of
  - 20.01 NTU
  - 10 yr. avg., 24.40 NTU
  - Still fails to meet criteria due to riverine sites exceeding OWQS

2020 Lake Monitoring

- Data collected in 2020 fails to meet OWQS criteria for chlorophyll and turbidity
- High levels of nutrients from external and internal loading continue to drive algal growth

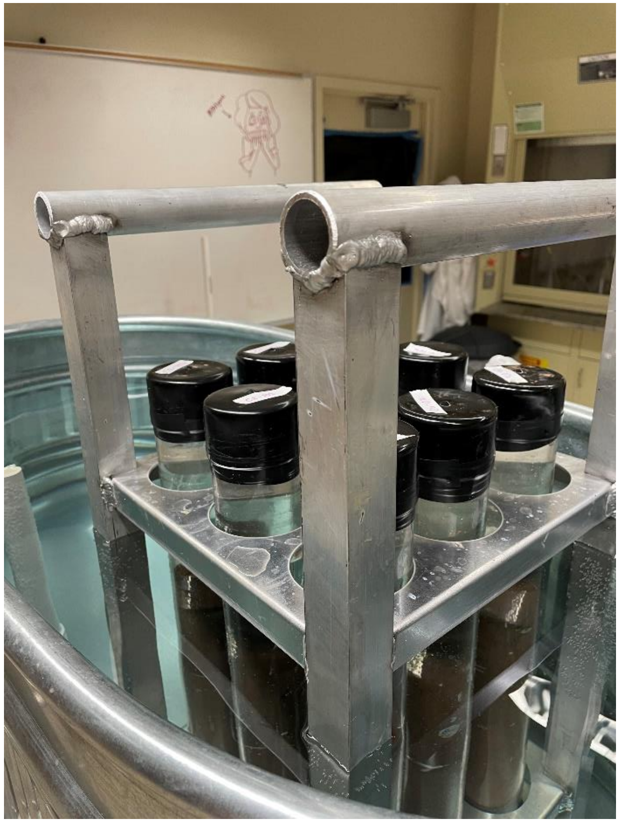
20 Year Trend Update

- Majority of Exploratory Data Analysis completed, including partial draft
- Preliminary model development for trend analyses underway
- Finalizing Trend Models for different parameters in October
- Draft to include BMP options

Internal Loading

Baylor University

- Nine sediment cores, July 26th
  - Three representative subgroups
    - Oxic
    - Hypoxic
    - Anoxic
- Bubble with custom gases to simulate representative conditions
  - Samples collected for
    - Dissolved Inorganic Phosphorous
    - Dissolved Inorganic Nitrogen
  - Results analyzed and graphed using linear regression, slope represents release or consumption from sediment



- Initial results expected December 2021

Recommendations

- ❑ Nutrient sampling at all sites
  - ❑ Minimize data gaps
- ❑ Incorporate results from Trends & Internal Loading studies to guide decision making
- ❑ Implement in-lake and watershed level BMPs
- ❑ Continue active leadership role within watershed

QUESTIONS?

- Curt Dikes – Lakes Monitoring Specialist
  - curt.dikes@owrb.ok.gov
  - 405.530.8929 office
  - 405.620.7219 cell

OKLAHOMA
Water Resources Board

Thank You

OKLAHOMA
Water Resources Board

Lake Thunderbird Water Quality

2020 Final Report

Submitted to

Central Oklahoma Master Conservancy District

October 1, 2021

Submitted by

Oklahoma Water Resources Board

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Executive Summary

Lake Thunderbird is a multi-purpose reservoir located in the Cross Timbers Ecoregion of south-central Oklahoma in Cleveland County. It serves as the terminal reservoir for a largely agricultural 256 square mile watershed. Constructed by the Bureau of Reclamation, Lake Thunderbird began operation in 1966. The lake boasts a large state park with many recreational opportunities including two marinas, multiple campgrounds with recreational vehicle sites, two swim beaches, multi-use trail systems, and a nature center. The lake itself is also a source of recreational activities, including a large boating presence, swimming, kayaking, jet skiing, and fishing. Under the authority of the Central Oklahoma Master Conservancy District (COMCD), Lake Thunderbird also serves as a major drinking water supply to three large metropolitan areas - Del City, Midwest City, and the City of Norman. COMCD has contracted with the Oklahoma Water Resources Board (OWRB) to monitor the lake for a variety of water quality parameters over the past twenty years. In 2020, monitoring was conducted to continue identification of any water quality concerns and an assessment of water quality standards. Assessment of the Supersaturated Dissolved Oxygen System (SDOX) efficacy was not part of 2020 monitoring and reporting as in years past.

In 2020, OWRB documented a typical thermal stratification pattern in the lake with the onset of stratification occurring in June and mixing in late September. The hypolimnion experienced anoxic conditions throughout the summer sampling season; the metalimnion also experienced anoxia from June to mid-September. While common in the hypolimnion, anoxia in the metalimnion highlights excessive algal growth and large oxygen demand of lake bottom sediments. Nutrient concentrations were high throughout the sampling season, reaching peak levels in late summer. Hypolimnetically stored nutrients also accumulated through the monitoring season because of sequestration below the density gradient, internal release from anoxic sediment, and organic material buildup. Riverine nutrient concentrations were higher than in lacustrine areas, likely due to stormwater inflows and wind mixing through these shallow areas that allow for continuous resuspension.

Chlorophyll, a measure of algal biomass, increased relative to previous monitoring years and remained excessive. In 2020, chlorophyll at Site 1 ranged from relatively low at 1.92 µg/L in April to the peak of 47.2 µg/L in late September. Taste and odor complaints collected by the City of Norman drinking water facility tallied 16 in 2019, but saw a 75 percent increase in 2020 to 28, 12 in July alone. Geosmin and 2-methylisoborneol (MIB), both algal compounds related to taste and odor problems, were also responsible for six complaints between November and December 2020, indicating active algal processes are occurring in winter.

Many stakeholders have a vested interest in Lake Thunderbird and its watershed, including the recently formed Lake Thunderbird Watershed Alliance. Efforts such as the Watershed Based Plan (WBP) (OCC, 2010), the Total Maximum Daily Load (TMDL) study (ODEQ, 2013), and COMCD's support of in-lake management measures and continued water quality monitoring have been implemented for the lake. These plans and actions provide a foundation, which could be the impetus to mitigating poor water quality conditions in this critical waterbody. Additional investigative research is warranted to improve understanding of water quality issues and avenues of potential remediation.

In general, implementation of in-lake and watershed mitigation measures should be implemented in tandem to provide the greatest opportunity to improve water quality. Lake Thunderbird experienced prolonged periods of hypereutrophic conditions in 2020. Additionally, the lake fails to meet designated beneficial uses of Fish and Wildlife Propagation due to turbidity and dissolved oxygen, and Public and Private Water Supply from elevated levels of chlorophyll-a. A modernized comprehensive plan emphasizing both active in-lake and watershed best management practices could help Lake Thunderbird meet water quality standards for turbidity, dissolved oxygen, and chlorophyll-a. Continued exploration of other technologies for in-lake mitigation of water quality are critical to the success of improving water quality at Lake Thunderbird.

Introduction

Lake Thunderbird is a multi-purpose reservoir in the Cross Timbers Ecoregion of south-central Oklahoma in Cleveland County and has extensive history with water quality issues, documented in the long-term dataset from water quality monitoring conducted by OWRB. It continues to be listed as impaired in the latest approved Oklahoma Integrated Water Quality Report for the Public and Private Water Supply beneficial use due to exceedance of chlorophyll-a criterion, and the Fish and Wildlife Propagation beneficial use due to low dissolved oxygen conditions and increased turbidity (ODEQ, 2018). In response to these long-term water quality impairments, OWRB has provided water quality based environmental services for COMCD since 2000 and continues to conduct water quality monitoring at the lake and provide analysis on lake condition. This report presents data and analysis from the 2020 sample year.

In 2010, the COMCD gained funding to implement an in-lake mitigation infrastructure to address various aspects of impairment. An SDOX system was selected and began adding oxygen to the deepest portion of the lake's anoxic hypolimnion near the dam while maintaining thermal stratification. This added oxygen was thought to limit the transfer of nutrients from the hypolimnion to surface waters and decrease the internal load of phosphorus, among other ancillary benefits. After years of operation, the system failed catastrophically in June of 2020 and is no longer operational. For additional information on the SDOX system, please refer to previous Thunderbird Water Quality Reports at www.owrb.ok.gov/reports and click on "Lake Restoration." As such, assessment of the SDOX system is not included in this report.

Sampling Regime

In 2020, water quality sampling occurred from April 13 through October 14. Additional profiles and chlorophyll samples were collected at Sites 1 and 4 in November and December 2020, and January 2021, to aid in understanding winter algal activity after lake mixing. Monitoring was conducted for the parameters listed in **Table 1** at the sites indicated in **Figure 1.** Sites 1, 2, and 4 represent the lacustrine, or open water zones of the lake where consistent summer stratification and an underlying hypolimnion are common features. Sites 6, 8 and 11 represent riverine zones of their respective tributaries. Finally, Sites 3 and 5 represent the transition zones between riverine and lacustrine portions of the lake. All zones of the lake are represented to allow for whole lake analysis, beneficial use assessment, and comparison between riverine and lacustrine zones.

Table 1. 2020 Water quality sampling parameters.

SAMPLE VARIABLES		
General Water Quality		
Chlorophyll-a	Nephelometric Turbidity	Secchi Disk Depth
Nutrients		
Total Kjeldahl Nitrogen (TKN)	Ortho-Phosphorus (ortho-P)	Total Phosphorus (TP)
Nitrate, as Nitrogen (NO_{3-})	Nitrite, as Nitrogen (NO_{2-})	Ammonia, as Nitrogen (NH_3)
	Total Organic Carbon (TOC)	
Profile Parameters		
Dissolved Oxygen (DO) concentration	Dissolved Oxygen % saturation	Temperature
Specific Conductance (SpC)	Oxidation Reduction Potential (ORP)	pH
Environmental Observations		
Air Temp	Wind (Direction/Speed)	Cloud Cover
Precipitation	Wave Classification	Barometric Pressure
Site Depth	Surface SpC	Sample Collection Time

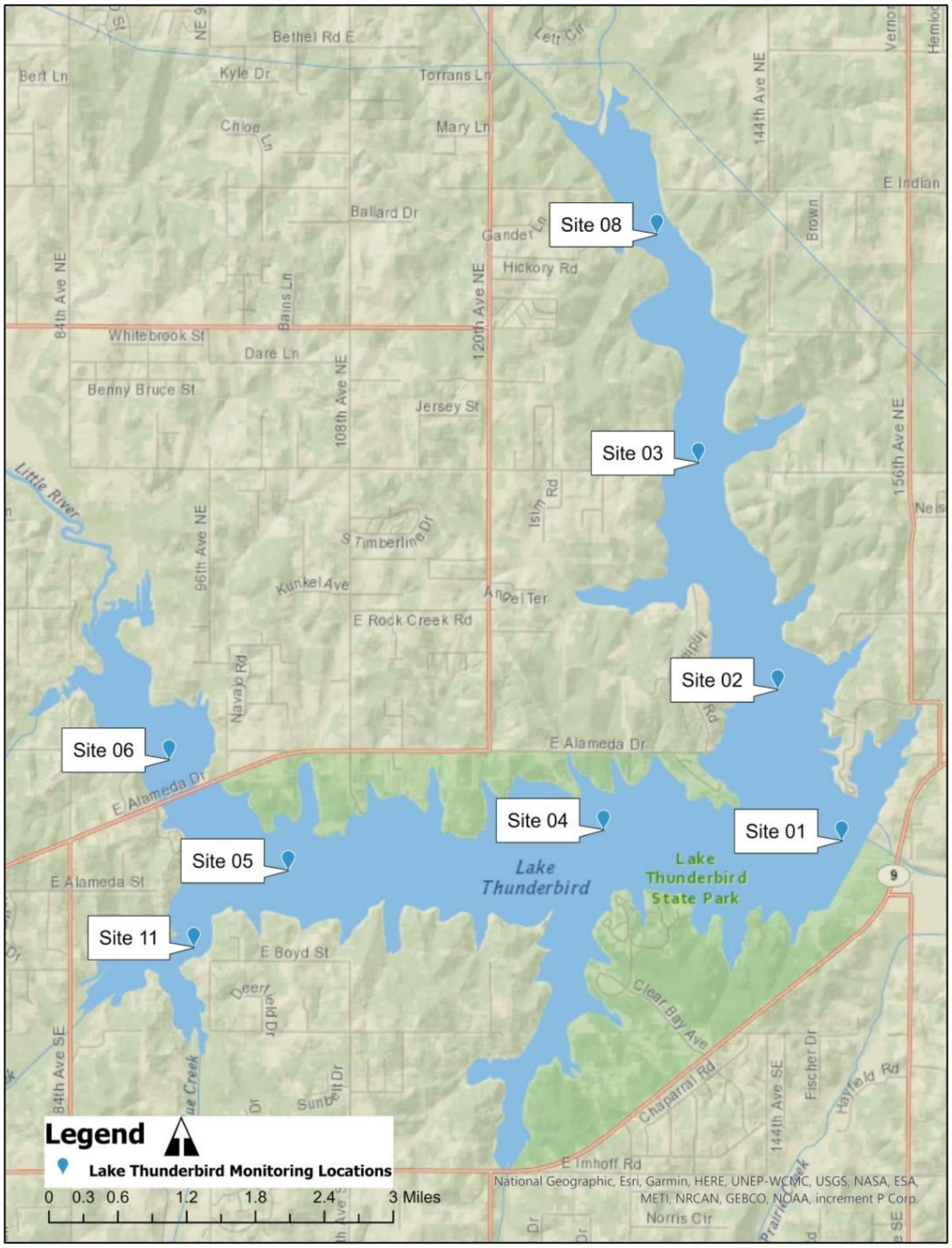

Figure 1. 2020 Lake Thunderbird sampling sites. The lacustrine zone is comprised of Sites 1, 2, and 4. Riverine zones are represented at Sites 6, 8, and 11. Sites 3 and 5 represent the transitional zone from riverine to lacustrine.

Data for water quality indicators were collected following OWRB's standard operating procedures (SOPs) for water quality samples (OWRB, 2018a). Variables such as pH, Dissolved Oxygen (DO), water temperature (°C), Specific Conductance (SpC), and Oxidation-Reduction Potential (ORP) were monitored in-situ utilizing a YSI® multi-parameter sonde. In accordance with manufacturer's specifications and published SOP's, all parameters were calibrated weekly and verified daily with appropriate standards. Measurements were recorded at each sampling station on the lake in the form of a vertical profile. Readings begin 0.5 m below the surface of the water and continue in whole-meter intervals to lake bottom. During periods with anoxic conditions (DO < 2.0 mg/L), an additional reading is taken 0.5 m above the first depth with measured anoxia to narrow down the point of transition. A final reading is recorded 0.2 m above the lake bottom.

Water quality samples were collected utilizing a depth-integrated sampler (DIS) and churn splitter. A DIS is designed to collect a representative sample of the water column to a targeted depth, which is calculated by first measuring the Secchi disc depth (cm) at each site. The Secchi disc depth is doubled to represent the photic, or light penetrating zone of the water column and is the targeted DIS depth. For instance, if a Secchi disc depth is 80cm, the targeted depth for collecting a DIS is 160cm. The DIS is marked every 10cm from 50cm until 200cm. If the doubled Secchi disc depth is less than 50cm, a surface water grab is collected 0.5m below surface. More information on DIS procedures can be found in OWRB's Standard Operating Procedure for the Collection of Water Quality Samples in Lakes (2019).

Other field observations such as Secchi disk depth, surface chlorophyll, and turbidity samples are collected at all sites. Nutrient samples are only collected at the surface of Sites 1, 6, 8, and 11. Additional sampling occurred at Site 1, including surface Total Organic Carbon (TOC) and at-depth nutrient samples collected with a Van Dorn sampler at 4.0m, 8.0m, 12.0m, and 0.2m above the bottom sediment-water interface. More information on Van Dorn sampling can be found in the SOP listed above. Sediment cores were also collected pre-and-post stratification to determine phosphorous release. Environmental conditions were also recorded for each site and can be found in Table 1 below. Nutrient analyses performed on these samples included both a phosphorus (P) and a nitrogen (N) nutrient series, as listed in Table 1.

Watershed

Lakes do not exist in isolation but interact as part of a complex ecosystem contained within a watershed. A watershed is the area of land that drains rainfall and streams to a "pour point," which in Oklahoma is often a reservoir. **Figure 2** presents Lake Thunderbird's Hydrologic Unit Code 8 (HUC 8) watershed, encompassing 256 square miles in the Cross Timbers Ecoregion of central Oklahoma. Lake Stanley Draper lies within the same HUC 8 watershed, but their hydrologic connection to each other is negligible. Lake Stanley Draper is highly managed for Oklahoma City's water supply and does not release downstream.

In 2015, the Bureau of Reclamation (BOR) conducted a bathymetric survey of the reservoir and calculated the top of the conservation pool at 1039.0 feet above sea level (Bureau of Reclamation, 2020). At this elevation, the lake surface area extends to 5,556 acres with a volumetric capacity of 105,278 acre-feet (Bureau of Reclamation, 2020). The BOR concluded that total volume of the lake has declined by 11% since construction in 1965, with an annual 50-year sedimentation rate of approximately 428 acre-feet per year (Bureau of Reclamation, 2020).

Lake Thunderbird is a Bureau of Reclamation multi-use reservoir. Major tributaries to the lake are the Little River to the west, Dave Blue Creek to the southwest, and Hog Creek to the north. The Little River serves as the longest flow path through the watershed, starting in the northwestern portion of the watershed and draining substantial amounts of the City of Moore before entering Lake Thunderbird near Site 6 (U.S. Geological Survey, 2021). Water is released below the dam into the Little River, which has a confluence with the Canadian River roughly 85 miles downstream.

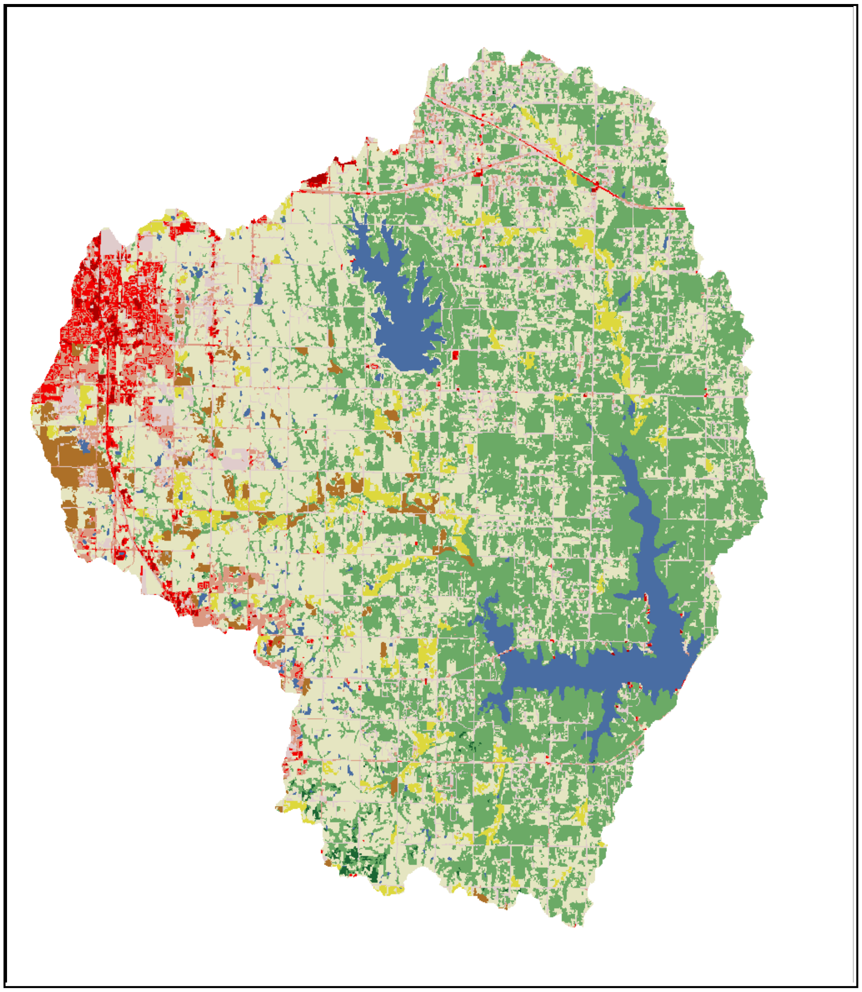

Figure 2. Lake Thunderbird HUC 8 Watershed. (U.S. Geological Survey, 2021)

Land uses in the watershed are important when determining potential sources of nutrients, sediment, or other forms of pollution. **Table 2** presents land use in the Lake Thunderbird watershed. Grasslands and deciduous forest make up over 70 percent of land use and are the dominant categories while developed land makes up roughly 18% of the watershed. The majority of which is in the northwest portion and encompasses portions of Oklahoma City, Moore, and Norman. New land cover data collected in 2016 was made available for this report and the percent change column represents the increase (+) or decrease (-) from previous data collected in 2011.

Table 2. Land Use Acreage in Lake Thunderbird HUC 8 Watershed. (U.S. Geological Survey, 2021)

Category	Acreage	Percent of Watershed	Percent Change
Open water	8,359	5.08%	+0.76%
Developed, open space	12,474	7.58%	-1.82%
Developed, low intensity	9,182	5.58%	+1.24%
Developed, medium intensity	6,080	3.70%	+1.71%
Developed, high intensity	1,376	0.84%	+0.41%
Barren Land	238	0.14%	+0.13%
Deciduous Forest	61,607	37.45%	+2.16%
Evergreen Forest	322	0.20%	-0.03%
Mixed Forest	163	0.10%	
Shrub Scrub	2842	1.73%	
Grassland/Herbaceous	55,237	33.58%	-4.76%
Pasture/Hay	4,926	2.99%	-0.50%
Cultivated Crops	1,533	0.93%	-1.21%
Emergent Herbaceous wetlands	20	0.01%	+0.01%
Total Watershed	164,505	100%	100.00%

Continuing development in the watershed underscores the need for Best Management Practices (BMPs) and opportunities for Low Impact Development (LID) measures that would support greater long-term watershed integrity.

Climate

Knowledge of potential climatological influences is critical when assessing the water quality of a waterbody. The hydrology and physical processes of a given reservoir significantly influence internal chemical and biological processes. For example, stormwater inflow influences nutrient content and composition, sediment loading, sediment suspension, and stratification patterns. In addition, changes in lake volume due to climactic events like rain or drought affect the extent of anoxia in the hypolimnion and alter oxidation-reduction potentials. Anoxia, in turn, influences chemical and biological processes.

Figure 3 provides a graphical representation of Lake Thunderbird's rainfall, elevation, inflow, and sampling dates for calendar year 2020. Annual precipitation at Lake Thunderbird dam in 2020 totaled 30.24 inches, as reported by the United States Army Corps of Engineers (USACE) (USACE, 2021), less than the lake's long-term average of 38 inches (U.S. Geological Survey, 2021). Peak rainfall events correspond to increases in lake elevation. Inflow volumes were significantly lower in 2020 when compared to 2019, leading to the lake experiencing somewhat stable elevations throughout the year, with a low of 1037.76ft and high of 1039.41ft. This becomes important when examining increasing nutrient levels and non-algal turbidity witnessed in the reservoir.

In addition to hydrology, air temperature can influence lake characteristics such as thermal stratification and nutrient availability, which subsequently influences primary productivity, which serves as proxy for algal growth or biomass. **Figure 4** compares monthly mean temperatures in 2020 to the long-term monthly mean using 2002-2020 data from the Oklahoma Mesonet’s Norman station, which is approximately 27 kilometers west of Site 1 at Max Westheimer Airport (Mesonet, 2021). For 2020, monthly mean temperatures were slightly lower than long-term averages, with five cooler than average months, including April-May and August-October. Peak air and water temperature again occurred in July, coinciding with the lake’s strongest stratification. Slight climatological variances from normal were observed in 2020, yet the lake’s typical pattern and duration of thermal stratification was maintained.

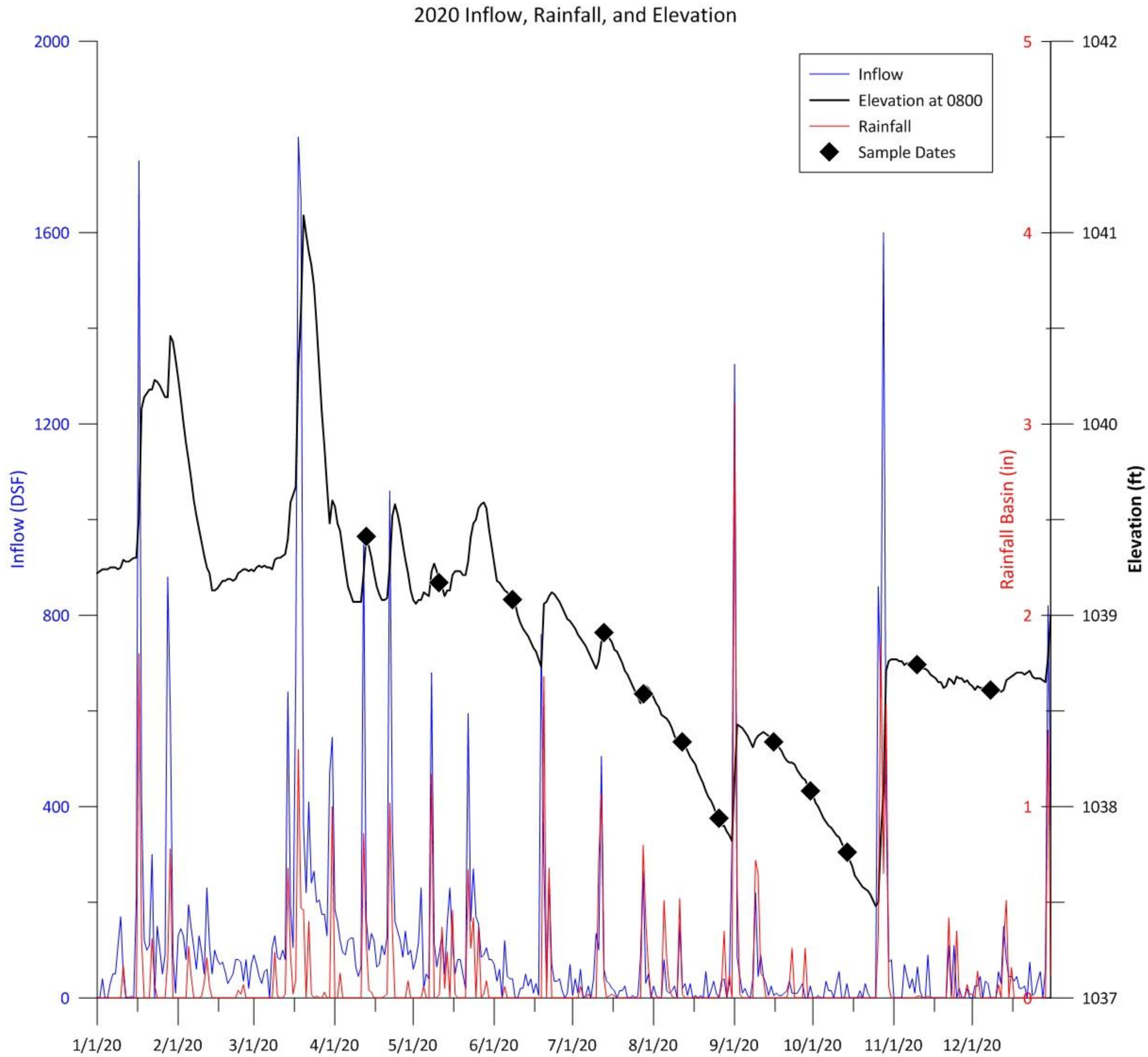

Figure 3. 2020 Inflow, Rainfall, and Elevation Data for Lake Thunderbird, with Sample Dates Indicated.

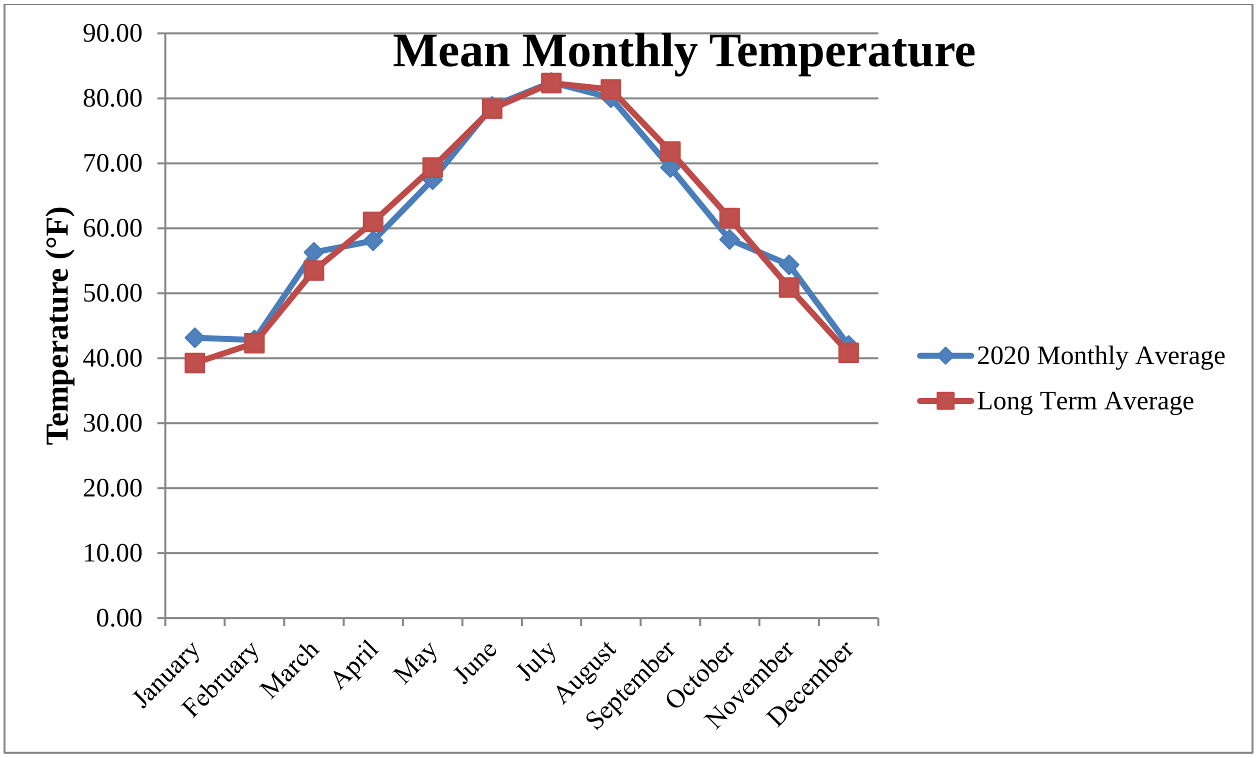

Figure 4. 2020 and Long-Term Average Monthly Temperature at the Norman Mesonet Station. (Mesonet, 2021)

Hydrologic Budget

A hydrologic budget, or water balance, is of considerable importance in water quality analyses and management. A general and simple hydrologic budget equation for a given waterbody can be defined by:

Eq. 1 $$\frac{\Delta V}{\Delta t} = Q_{in} - Q_{out} + PA_s - E_v A_s - W_s$$

Where **V** is lake volume (acre-feet),

$\boldsymbol{A_s}$ is lake surface area (acres),

$\boldsymbol{Q_{in}}$ and $\boldsymbol{Q_{out}}$ are net flows into and out of the lake due to tributary inflows and gated releases,

$\boldsymbol{P}$ is the rainfall directly on the lake (feet),

$\boldsymbol{E_v}$ is the lake evaporation (feet),

$\boldsymbol{W_s}$ is the water exported for water supply use (acre-feet).

In layperson terms, the rate of change in volume of water stored is equal to the rate of inflow from all sources, minus the rate of outflows. The input or inflows to a lake may include surface inflow, subsurface inflow, and water imported into the lake. The outputs may include surface evaporation and sub-surface outputs and water released downstream or exported as water supply from the lake. For Lake Thunderbird, subsurface and groundwater flow is assumed close to calculated error and insignificant, based on the relatively impermeable lake substrate.

The inputs to Lake Thunderbird include precipitation and inflow from the tributaries - encompassing all surface runoff in the basin. Because the USACE reported inflow term includes direct rainfall, we use their reported inflow minus calculated direct rainfall volume as the runoff term for the budget. Precipitation was calculated from the direct rainfall measurement data provided by the USACE. The precipitation contribution to the total inflows is derived by multiplying the daily rainfall amounts by the surface area of the lake on each date, as shown by:

Eq. 2 $$\boldsymbol{Q_p = \mathbf{P} * A_s}$$

Where $\mathbf{Q_P}$ is precipitation,

P is rainfall amount,

and $\boldsymbol{A_s}$ is the surface area of the lake.

Water outputs from Lake Thunderbird include gated dam releases, water supply withdrawals, and evaporation; USACE reports releases and withdrawals. Daily evaporation rates are calculated and reported by the USACE; their calculations relate solar radiation, wind speed, relative humidity, and average daily air temperature to estimate daily evaporation. The OWRB multiplies this rate by the daily average surface area of the lake to give the volume of water evaporated per unit time.

Eq. 3 $$\boldsymbol{Q_e = E_v * A_s}$$

Where $\mathbf{Q_e}$ is evaporation,

$\boldsymbol{E_v}$ is the evaporation rate,

and $\boldsymbol{A_s}$ is the surface area of the lake.

The lake volumes, corrected to elevation, were calculated and the daily differences summed to account for the change in volume for each month. To estimate reservoir volume more accurately, the 2020 water budget used results from the BOR’s 2015 bathymetric survey elevation-capacity tables (Bureau of Reclamation, 2020).

A summary of monthly water budget calculations for Lake Thunderbird is below, where “Total Inputs” is the sum of all the flows into the lake and “Total Outputs” is the sum of all the outflows from the lake (**Table 3**). From Equation 2, the difference between the inputs and the outputs must be the same as the change in volume of the lake for an error free water budget so both input and output terms were calculated then compared. The difference between the inputs and outputs is in the I-O column and the monthly change in volume, calculated as the sum of daily volume changes, is in ΔV column. Examination of the 2020 water budget shows nearly two-thirds of the total inputs to the lake occurred between January and June and is represented in peak inflow and elevation. **Figure 5** provides a visual summary of water gains and losses. Overall, inputs and outputs controlled an equal number of months, however, outputs in the latter half of the year came from water supply withdraw and evaporation rather than gated releases downstream. Inflows were highest in January, March (peak inflow), April and May and largely released downstream until June, where any subsequent inflow was held in the reservoir.

Table 3. 2020 Lake Thunderbird Water Budget Calculations expressed in Acre-feet. Parentheses indicate a negative value. Values taken from USACE, 2021.

Month	Inputs			Outputs				Error Term		
	Inflow	Rainfall	**Total Inputs**	Evaporation	Water Supply	Releases	**Total Outputs**	I-O	ΔV	Error
Jan	9,696	1,156	**10,852**	1,261	925	4,189	**6,375**	4,476	5,611	1,135
Feb	4,702	445	**5,147**	1,477	-	8,840	**10,317**	(5,170)	(5,611)	(441)
Mar	16,717	1,868	**18,585**	2,280	-	13,811	**16,091**	2,494	1,670	824
Apr	10,589	102	**10,691**	2,870	536	10,187	**13,594**	(2,903)	(2,775)	128
May	6,544	1,985	**8,529**	3,584	1,450	3,431	**8,465**	64	1,660	(1,596)
Jun	3,322	1,051	**4,374**	5,258	1,811	647	**7,715**	(3,342)	(1,654)	1,688
Jul	1,911	1,223	**3,134**	4,511	1,989	-	**6,500**	(3,366)	(2,179)	1,187
Aug	1,539	384	**1,924**	4,458	2,000	-	**6,458**	(4,534)	(3,208)	1,326
Sep	2,298	2,026	**4,324**	2,400	1,772	-	**4,172**	152	(532)	(380)
Oct	5,527	2,219	**7,745**	2,340	1,684	-	**4,024**	3,722	3,765	(43)
Nov	922	308	**1,230**	1,741	1,239	-	**2,980**	(1,750)	(544)	1,206
Dec	3,106	1,099	**4,205**	1,397	1,105	-	**2,502**	1,703	2,738	(1,035)
Total	**66,873**	**13,866**	**80,739**	**33,576**	**14,511**	**41,105**	**89,193**	**(8,454)**	**(1,059)**	**3,997**

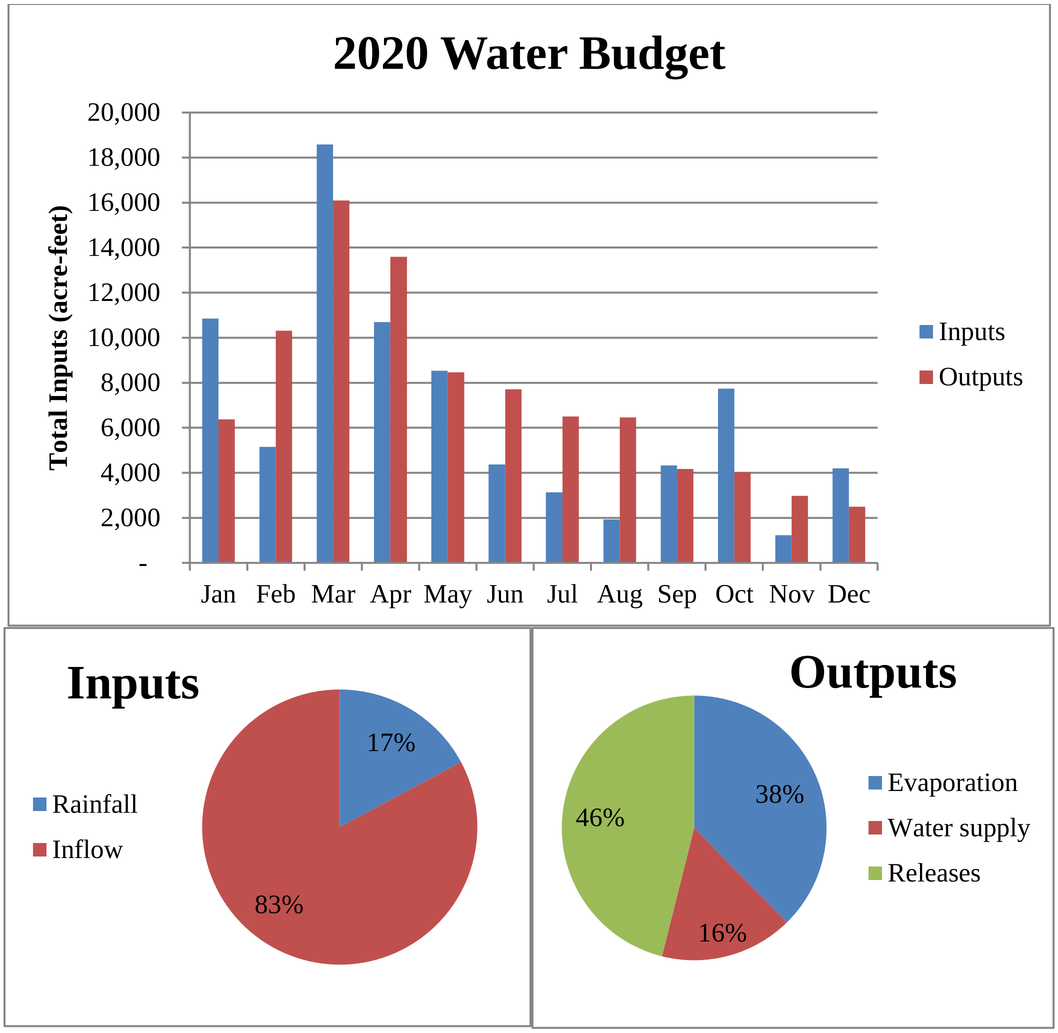

Figure 5. 2020 Lake Thunderbird Water Input and Output sources by month, expressed as the percent of total.

Once a hydrologic budget is constructed, additional features of reservoir dynamics such as hydrologic retention time can be estimated. Tau (T), the hydrologic retention time, is the ratio of lake capacity at normal elevation to the annual exiting flow. This represents the theoretical time it takes a given molecule of water to flow through the reservoir. Lake Thunderbird's water had a T value 1.90 years in 2020. Considerably lower than the average T (1995 to 2020) of 3.47 years. The lower value in 2020 may be attributed to the lowest volume of gated releases since 2017.

Total monthly error is the difference between the change in elevation-based lake volume and change in lake volume based on inputs-outputs. Utilizing 2015 BOR survey data, the 2020 cumulative annual error is 3,997 acre-feet, averaging to a monthly error slightly over 333 acre-feet. Without the updated bathymetry data, the annual error rate increases to 5,234 acre-feet or roughly 436 acre-feet per month. While seemingly negligible compared to overall reservoir volume, this demonstrates an increase in accuracy by reducing the number of unknowns.

According to the bathymetric survey completed by BOR in 2015, the average sedimentation rate below the spillway crest is approximately 428 acre-feet per year since impoundment 1965 (Bureau of Reclamation, 2020). This amount equates to roughly 11% of lost storage as original designed. The potential distribution of deposited sediment has consequences for in-lake processes such as sediment suspension and nutrient flux and is considered high (Reclamation, 2006).

Any groundwater loss and gain to the lake is assumed negligible for this analysis and any actual measurable changes are aggregated into the inflow variable. It is possible to verify the exchange of groundwater (loss or gain) with the lake by performing seasonal groundwater level surveys and reviewing the geology of the area. However, such a survey is a considerable undertaking and is beyond the scope of work for this project.

Water Quality Evaluation

Thermal Stratification, Temperature, and Dissolved Oxygen

Warming of the lake surface throughout spring marks the onset of thermal stratification, which occurs when an upper, less dense layer of water (epilimnion) forms over a cooler, denser layer (hypolimnion). The metalimnion, or thermocline, occurs between the epilimnion and hypolimnion and is the region with the greatest temperature and density gradient (**Figure 6**).

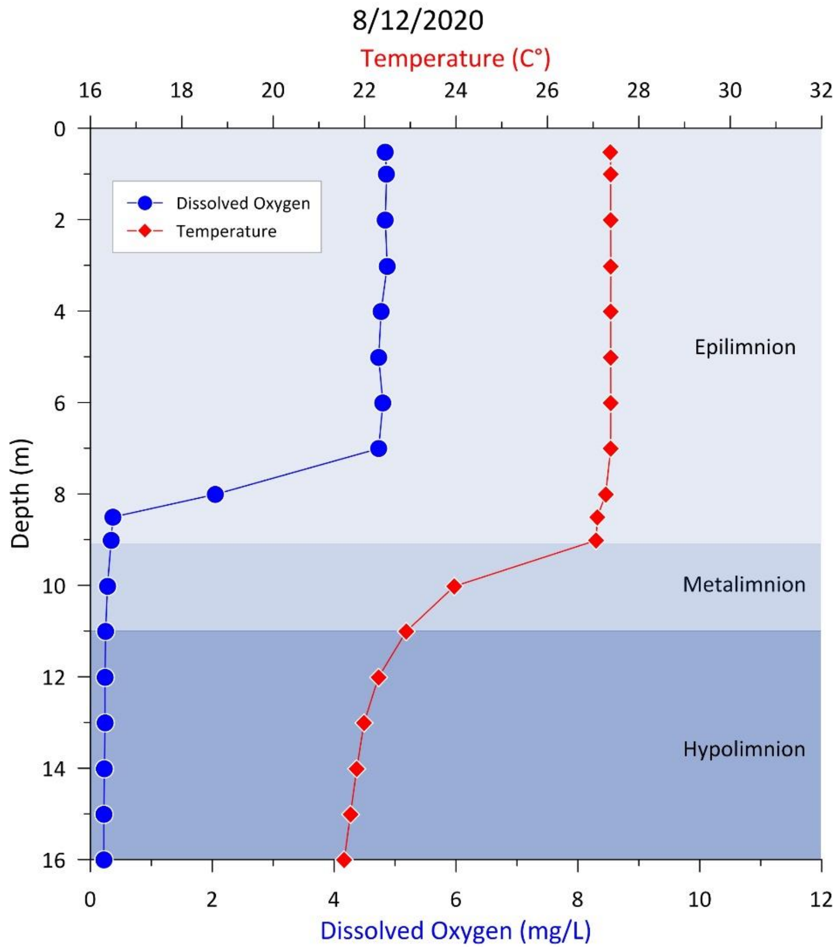

Figure 6. A typical Temperature and Dissolved Oxygen vertical profile for Lake Thunderbird during stratification. Boundaries between the Epilimnion, Metalimnion and Hypolimnion are approximated for illustrative purposes.

Stratification strengthens as the upper, epilimnetic waters warm throughout summer, while the hypolimnion stays cool. Because of these differences, thermal resistance to mixing prevents the epilimnion and hypolimnion from coming in contact during stratification. Thus, ongoing decomposition processes in the hypolimnion deplete dissolved oxygen and it is not replenished. The OWRB has documented this process at Lake Thunderbird each monitoring year since 2000. Stratification and hypolimnetic anoxia are inevitable and common processes across Oklahoma reservoirs, even without the extreme influence of outside forces.

Isopleths are a graphical method to illustrate lake dynamics as they interpolate hundreds of data points into one figure to show variation in measured parameters over depth and time. The isopleths of temperature and DO, while not exact, illustrate the process of thermal stratification and the impact of stratification on DO. **Figure 7** displays all temperature and DO data from Site 1 over the monitoring period. Each line represents a specific temperature or DO value. More vertical lines indicate a completely mixed water column; when lines run horizontally, some degree of stratification is present. On the temperature plot, warmest temperatures are red, graduating to blue as temperature gets cooler, while on the DO plot, the lowest DO values are colored red, graduating to purple at the highest DO. A few profiles of temperature and DO with respect to depth at Site 1 are included to highlight some elements of the sampling season and illustrate lake stratification layers (**Figure** 67). The remaining temperature and DO profile plots from Site 1 are contained in **Appendix B.**

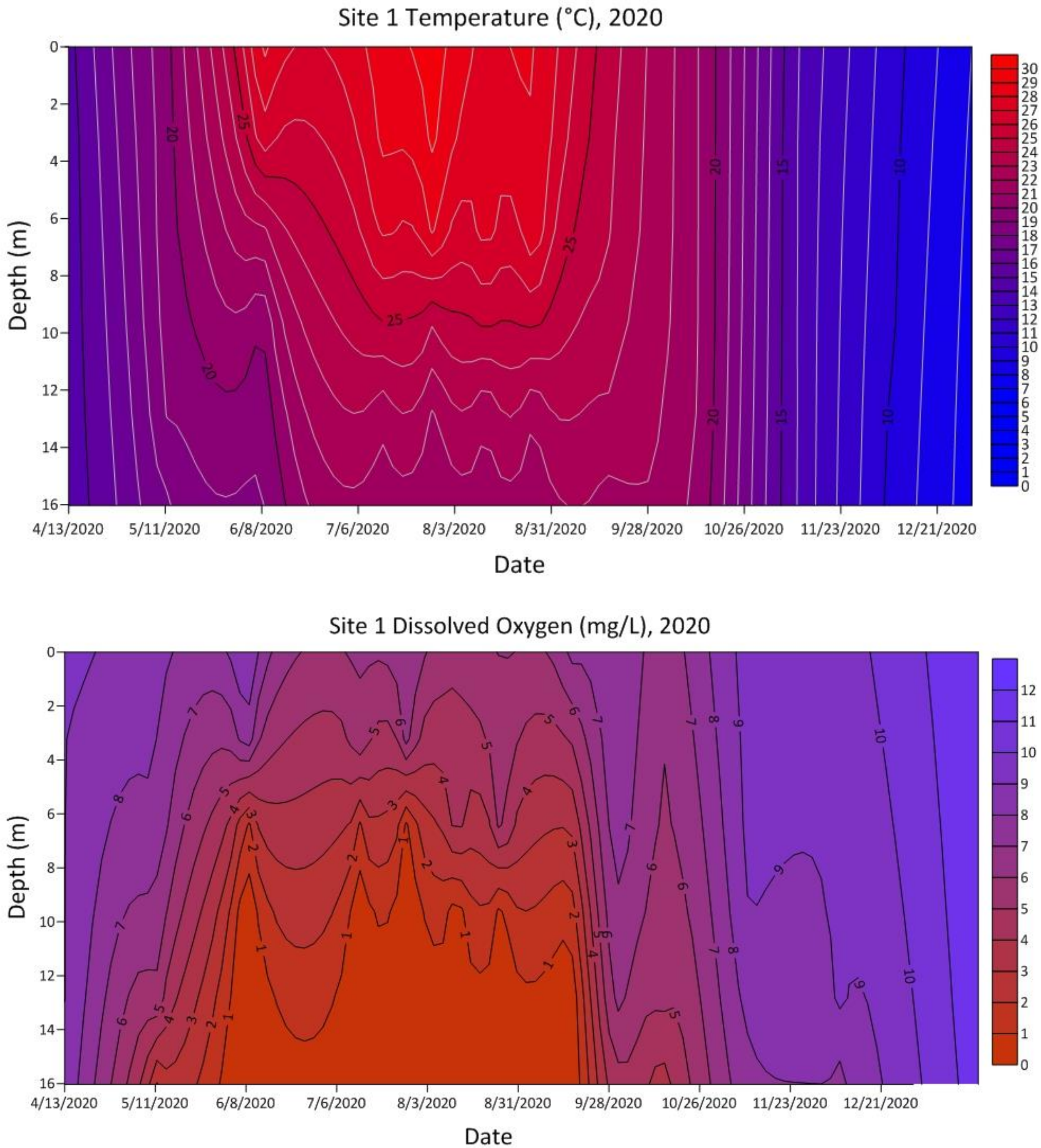

Figure 7. 2020 Isopleths of Temperature (°C) and Dissolved Oxygen (mg/L) versus Depth (m) at Site 1.

Little thermal difference with depth was observed on the first sample date, April 13, 2020, indicating a well-mixed water column. By the second sample event on May 11, 2020, thermal stratification had slightly increased with only a 1.74°C temperature gradient from surface to bottom. By June of 2020, DO dynamics began setting up for the season with mostly anoxic hypolimnetic waters. As the season progressed, epilimnetic warming continued until reaching a peak temperature of 29.177°C on July 28, 2020 (**Figure 8**). Evident at this sampling event is the push of anoxic water upwards, creeping into the metalimnion and dominating the hypolimnion. This is evidence of increased organic load, and a high hypolimnetic water and sediment oxygen demand. Anoxic water in the metalimnion was observed throughout the lacustrine and transition zones during the summer and into September.

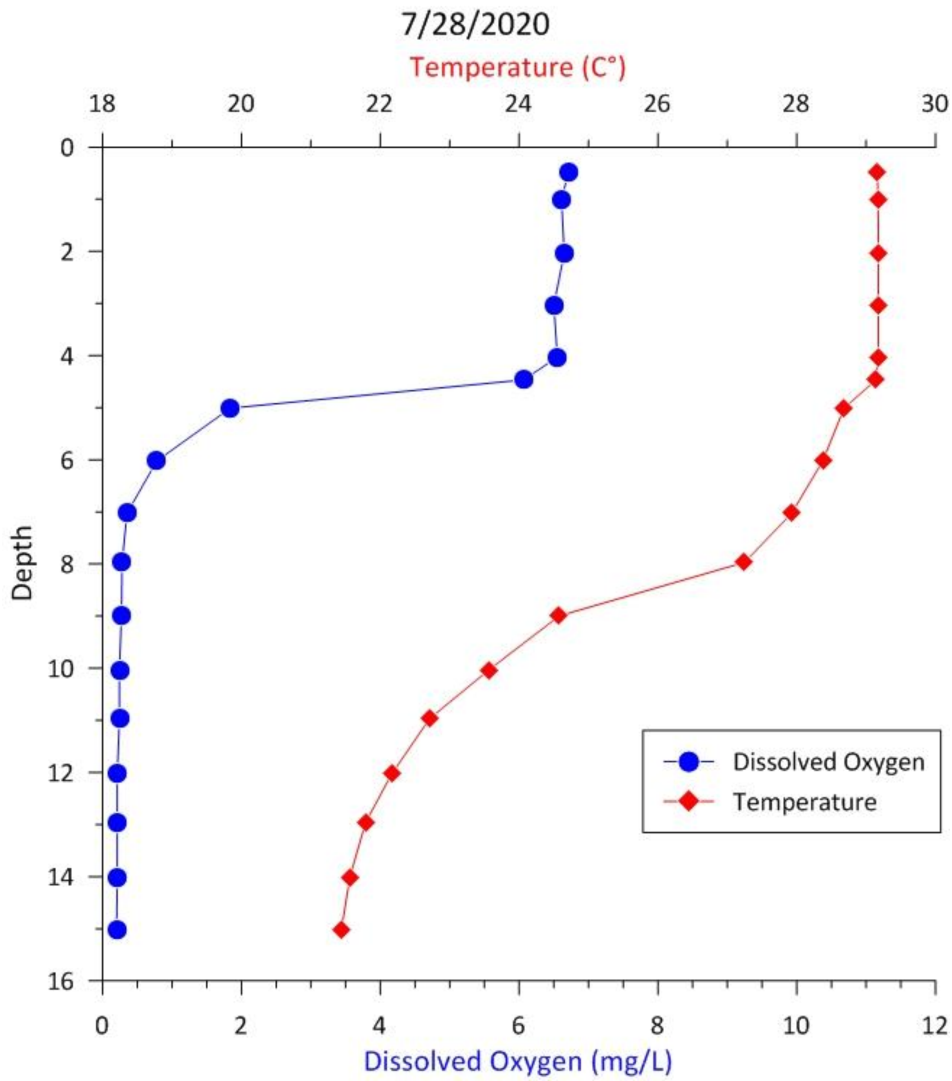

Figure 8. A Temperature and Dissolved Oxygen vertical profile for Lake Thunderbird (July 28, 2020) highlighting a mostly anoxic metalimnion and anoxic hypolimnion.

Epilimnetic water began to cool in September, deepening the epilimnion, although slight stratification persisted with some hypoxia in the hypolimnion. This marks the onset of lake mixing and by the October event, the water column was nearly isothermal (**Figure 9**).

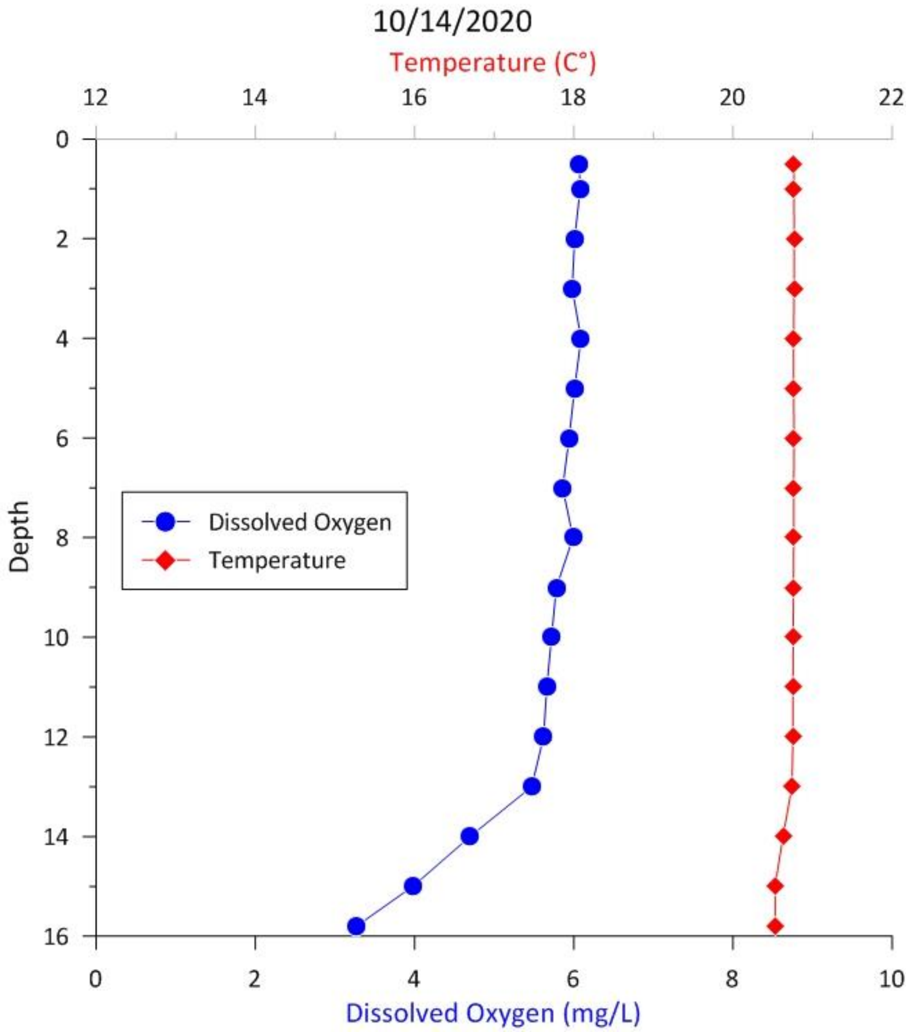

Figure 9. Temperature and Dissolved Oxygen profile at Site 1 for October 14, 2020 showing a nearly isothermal water column.

Metalimnetic anoxia experienced throughout the lacustrine and transition zones on Lake Thunderbird in 2020 is indicative of a eutrophic system, driven by a high organic load created largely by algal growth and die-off. As algal cells die and settle out, hypolimnetic bacteria require an electron acceptor for survival and feed on the dead algae. When strong anaerobic conditions are present, elements other than oxygen function as terminal electron acceptors in the decomposition process, resulting in the release of nutrients and other constituents from the sediment. When mixing events occur, these released nutrients migrate to the surface waters where they can further stimulate algal growth.

Relative thermal resistance to mixing (RTR) calculations inform on the strength or intensity of stratification. This is a unit-less measure of temperature-based density differences, indicating how likely the layers are to mix. RTR calculations aid in determining the size of the epi-, meta- and hypolimnion layers and can be found in **Appendix C**.

pH and Oxidation-Reduction (redox) Potential

Lake Thunderbird exhibited increases in surface pH during the summer months indicating high rates of photosynthesis. High rates of photosynthesis will temporarily elevate pH as carbon dioxide is stripped from the epilimnion, while catabolism of the settling algae depresses pH in the hypolimnion (**Figure 10**). Sinking organic matter in summer months, due to high algal production or influx of organic material from the watershed, stimulates decomposition processes in the hypolimnion, driving pH and ORP down. In general, and as seen in 2020 data, peaks of high epilimnetic and low hypolimnetic pH correspond with peaks in algal productivity.

It is also important to note that, although not documented by our sampling regime, it is commonly accepted that epilimnetic pH has a daily variation of daylight elevation and nighttime lowering. Daily pH shifts follow oxygen concentration driven by algae, daytime photosynthesis, and nighttime respiration. In either case, carbon dioxide is either produced (respiration) or consumed (photosynthesis) faster than replaced via atmospheric diffusion. Without any impinging biological processes such as photosynthesis and respiration, baseline pH for Lake Thunderbird would be the common pH of bicarbonate buffered systems of 8.2.

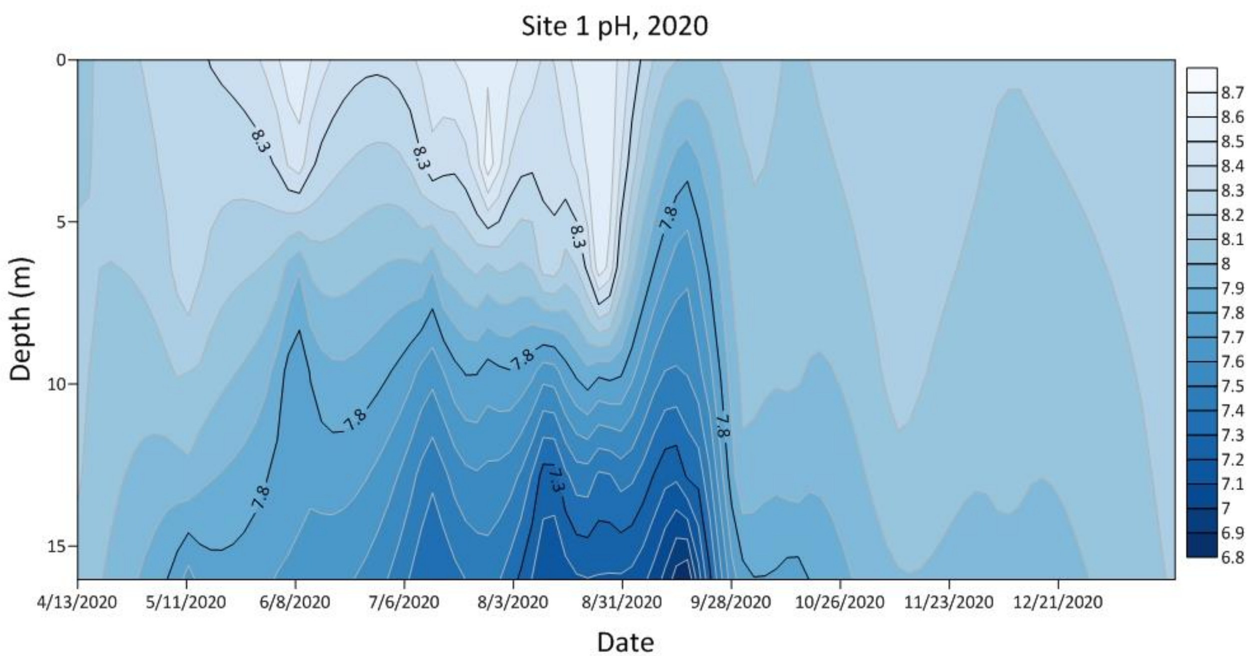

Figure 10. 2020 Isopleth of pH (S.U.) Versus Depth (m) at Site 1.

In 2020, anoxia of the hypolimnion was not observed until the June sampling event **(Figure 7**), and by July, oxidation-reduction potential (ORP) dropped below 200 mV in anoxic conditions (**Figure 11**). Under oxygenated conditions, redox potentials remain highly positive (+300-500 mV) as oxygen is readily available as an electron acceptor during bacterial respiration. Normally, aerobic bacterial communities consume oxygen to the point of hypolimnetic anoxia, the bacterial community then shifts to an anaerobic one that uses nitrate as the final electron acceptor for respiration. During this bacterial community composition shift, the water maintains a relatively positive redox. Generally, as the ORP drops towards 100mV or lower (indicating strongly reducing conditions), sediment-bound phosphorus dissolves into the water column. The duration and extent of strong hypolimnetic reducing conditions are related to the accumulation of these compounds in the hypolimnion. Finally, low ORP conditions slow the oxidation (breakdown) of organic materials such as the contents of dead and dying algal cells providing another source of nutrients to accumulate in the hypolimnion.

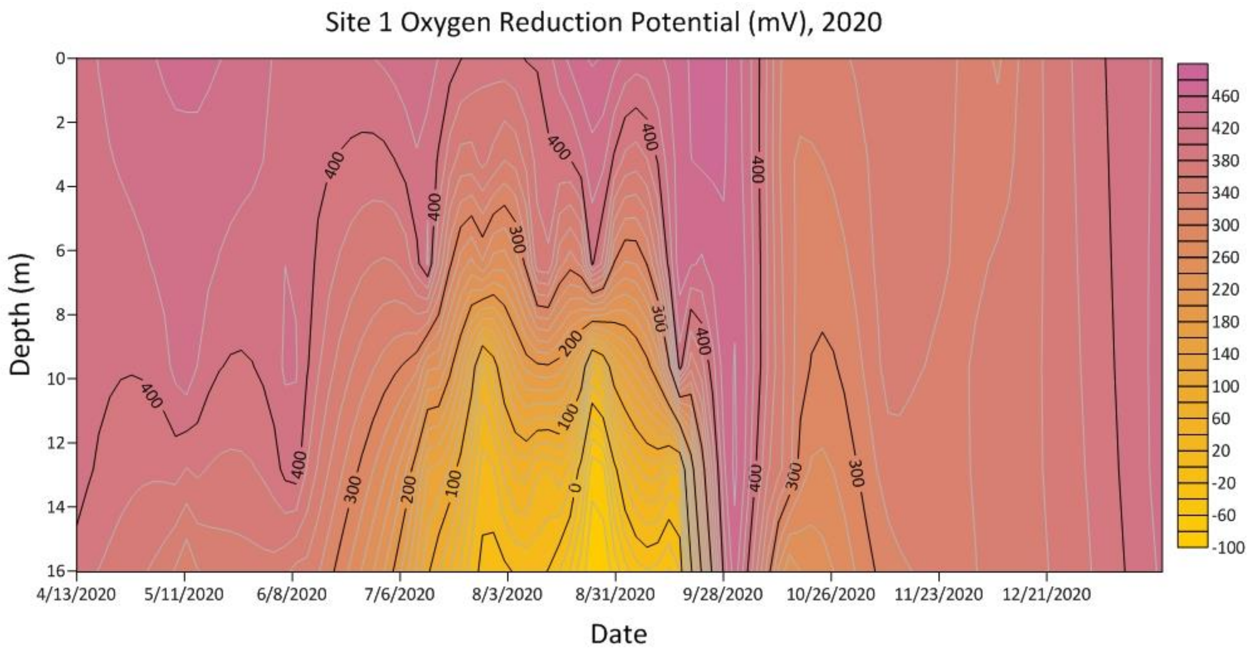

Figure 11. 2020 Isopleth of Oxidation-Reduction Potential (mV) versus Depth (m) at Site 1.

Nutrients

High nitrogen and phosphorus loading, or nutrient pollution, has consistently ranked as one of the top causes of degradation in U.S. waters. In fact, lakes with excess nutrients are 2.5 times more likely to have poor biological health (EPA, 2009). Excess nitrogen and phosphorus lead to significant water quality problems including reduced spawning grounds and nursery habitats for fish species, hypoxic (<4.0 mg/L O_2) / anoxic (<2.0 mg/L O_2) conditions, fish kills, harmful algal blooms, taste and odor problems in finished drinking water, public health concerns related to recreation, and increased organic content of drinking water sources.

Dissolved nutrient concentrations consist of nutrients that are available for algal growth, such as ortho-phosphorus, ammonia, nitrate, and nitrite. High dissolved nutrient concentrations in the epilimnion generally indicate that nutrients are immediately available and therefore not limiting algal growth; while hypolimnetic concentrations are nutrients that could be available for future algal growth, especially during lake turnover in the fall. In general, when both nitrogen and phosphorus are readily available, neither is a limiting nutrient to algal growth, and excessive chlorophyll-a values can be expected. When high phosphorus concentrations are readily available in comparison to low nitrogen concentrations, algal growth may be nitrogen-limited and vice versa.

Site 1 is examined to represent lacustrine nutrient values; additionally, nutrient levels in riverine areas are also examined as nutrient levels vary spatially and seasonally. Nutrient graphs are presented here as a time series across three years to provide context across recent years.

Phosphorus – P

Total phosphorus (TP) is a measure comprised of particulate phosphorus and ortho-phosphorus and represents all phosphorus in the water sample. Ortho-phosphorus (ortho-P) is the bioavailable, dissolved form of phosphorus, used by algal communities for photosynthesis.

Epilimnetic TP was present in comparable levels to previous years through the beginning of the monitoring season before increasing in the late summer and fall. Values ranged from 0.0075 mg/L to a high of 0.069 mg/L in September. Predictably, epilimnetic ortho-P was below the laboratory reporting limit for much of the year, including the summer; this is the height of the growing season where algae will consume all ortho-P (**Figure 12**).

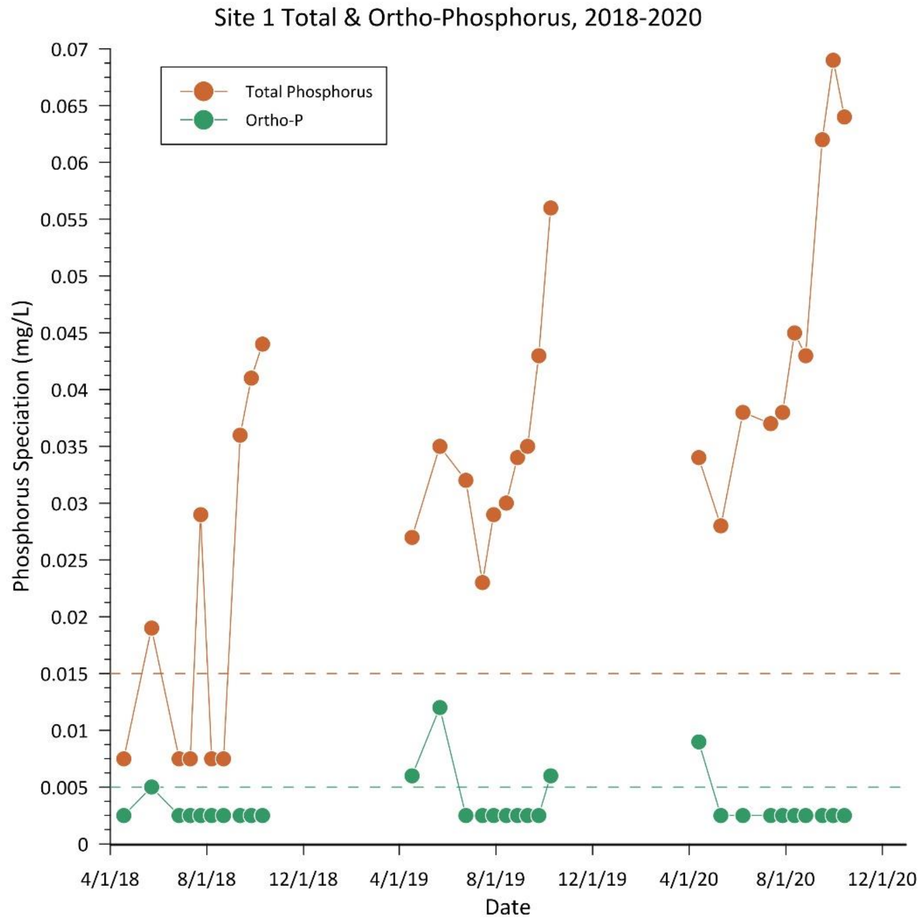

Figure 12. 2020 Surface Phosphorus variables as TP and Ortho-P (mg/L) at Site 1. Most Ortho-P values represent half the laboratory reporting limit of 0.0025 mg/L. Dashed lines represent detection limits for Total Phosphorus (brown) and Ortho-P (green).

Physical characteristics, such as stratification driven by thermal dynamics and DO depletion, influence numerous chemical and biological lake processes. Differences in water temperature and densities keep nutrients sequestered in the hypolimnion where they often accumulate through the season. Anoxic water and reducing conditions in the hypolimnion also create an environment favorable to sediment nutrient release. Hypolimnetic ortho-P accumulated throughout the stratification period, driving increased TP, before a decrease after lake mixing. (**Figure 13).**

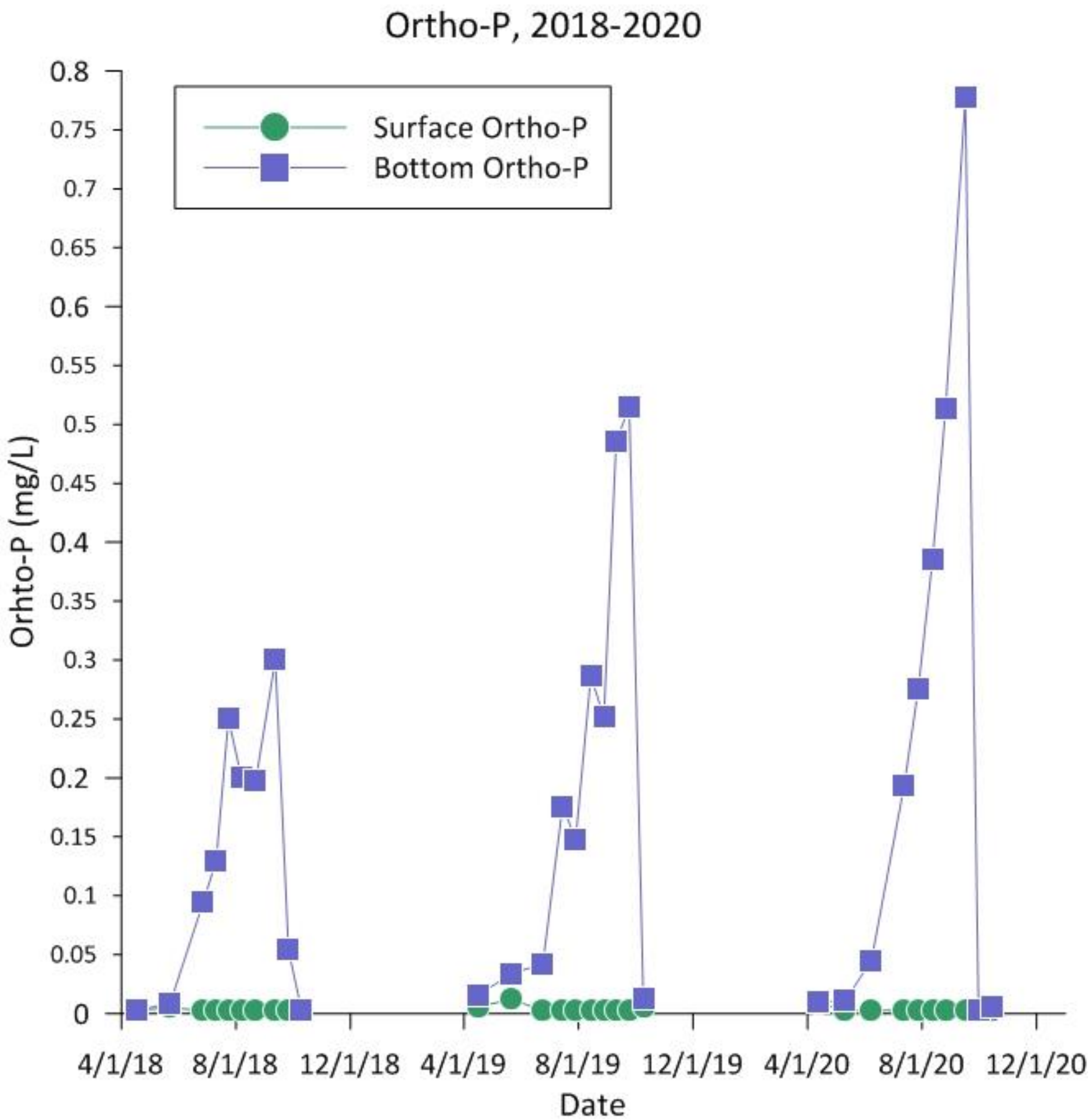

Figure 13. 2020 Site 1 Ortho-phosphorus at Surface and Bottom depth.

Riverine sites are much shallower than lacustrine sites and therefore do not stratify as readily, allowing nutrients to continuously cycle through the water column for algal uptake. Wind mixing drives nutrient and sediment resuspension, throughout these shallow, turbid zones. Lacustrine and riverine sites' nutrient concentrations are often distinct from each other; riverine values are consistently higher than in open water sites (**Figure 12** and **Figure 14**). In 2020, Site 8 and 11 behaved similarly and exhibited TP values slightly higher than the lacustrine sites. Site 6, north of the Alameda Drive Bridge on the Little River arm, had the highest TP value at 0.186 mg/L in April. Peaking early, concentrations remained high all sampling season. The largest inflow of the year was recorded in March and may have contributed to an early influx of phosphorus into the system (**Figure 5).**

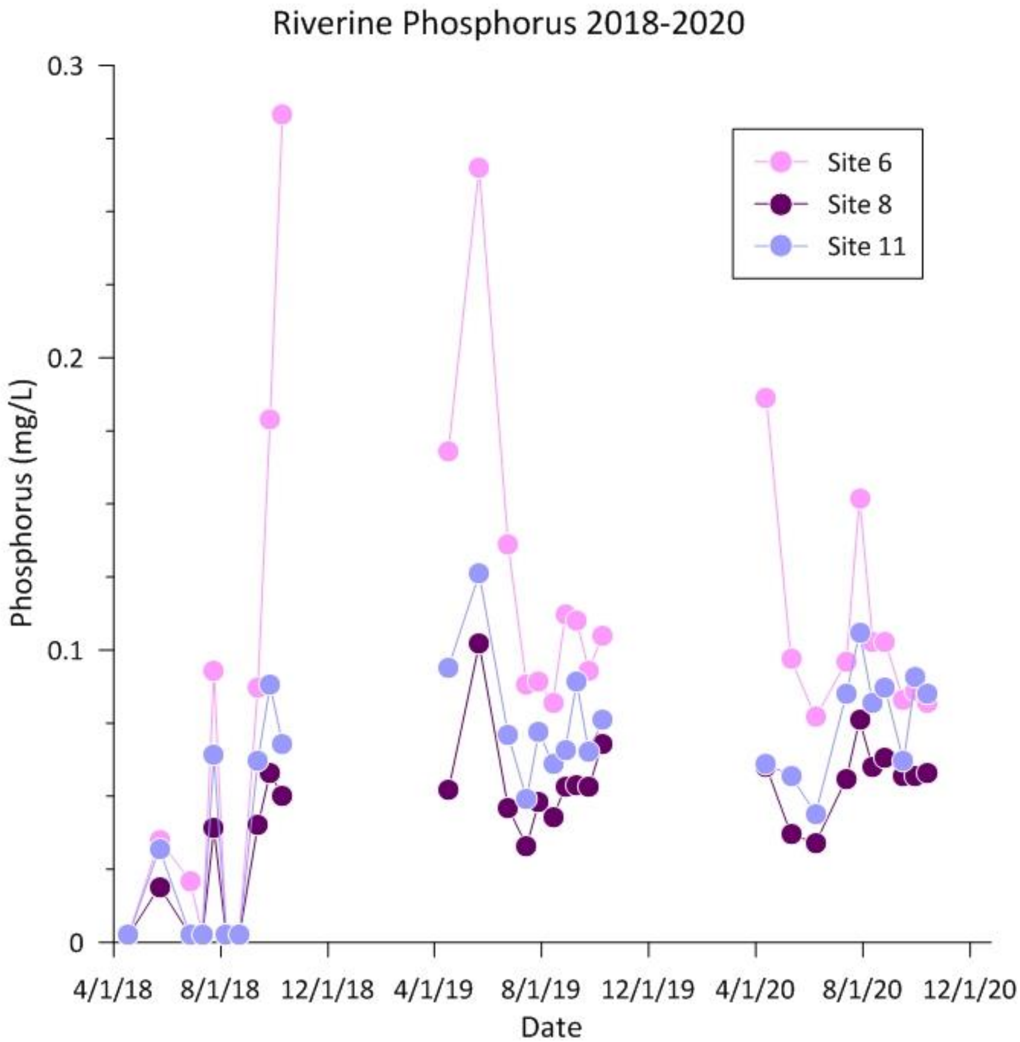

Figure 14. Surface Phosphorus (mg/L) from the three riverine sites, 2018-2020.

Site 1 surface TP and ortho-P values are consistent with those seen in eutrophic and hypereutrophic lakes and shows a slow increase over previous years, as indicated in **Figure 12**. Common in eutrophic systems, the buildup of hypolimnetic ortho-P is evidence of organic material settling from the epi- and metalimnion, in addition to active release from the anoxic sediment (**Figure 13**).

Riverine areas (**Figure 14**) are susceptible to wind mixing and resuspension of sediment and nutrients as they display greater impact from storm and high-flow events, likely driving the early peak in TP in Spring. Site 6 usually exhibits the highest phosphorus concentration, likely due to stormwater bringing in nutrients and sediment from the highly urbanized area upstream. These higher levels of phosphorus represent a greater risk for elevated phosphorus in the main lake body, potentially leading to increased algal growth.

Nitrogen – N

Total nitrogen (TN) is a measure comprised of Kjeldahl nitrogen, nitrate (NO_3), and nitrite (NO_2), representing all organic and inorganic nitrogen compounds in each sample. Values at Site 1 ranged from 0.63 mg/L to 0.995 mg/L, increasing throughout the season and primarily driven by organic nitrogen present in algae (**Figure 15**). Of note is the gradual increase of TN over previous years.

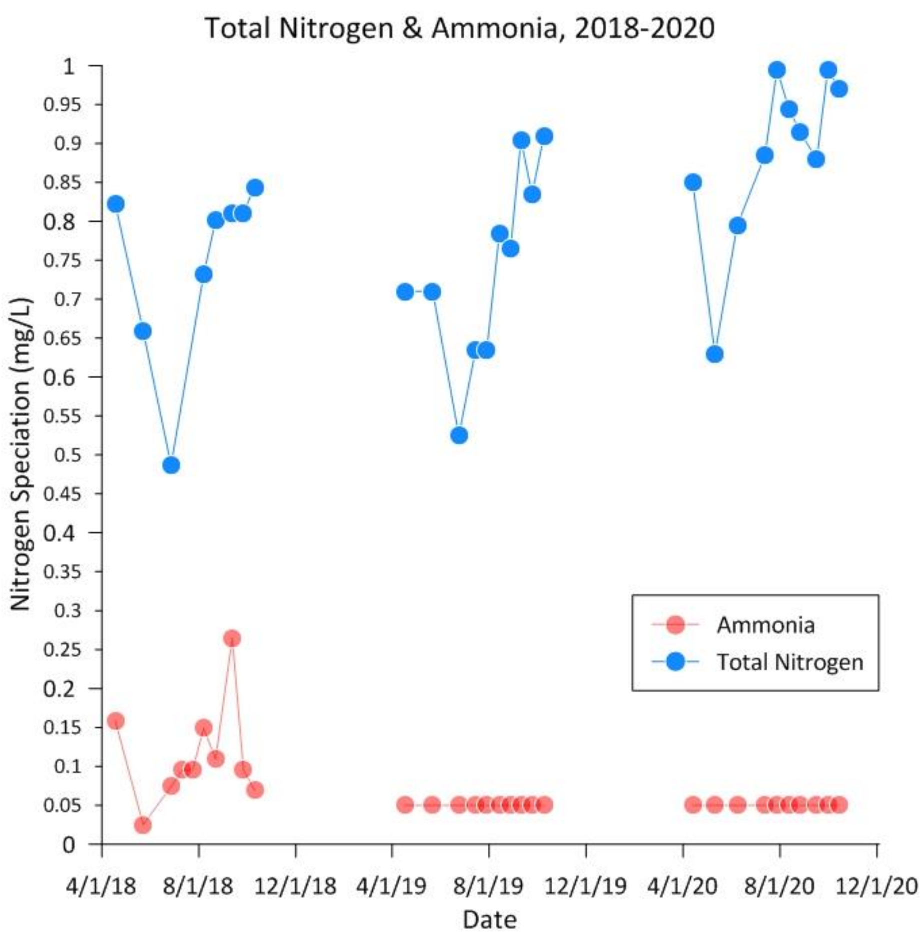

Figure 15. 2020 Surface Total Nitrogen (mg/L) over time at Site 1. Of note, samples in 2018 were processed by a lab with a lower Ammonia detection limit. 2019-present Ammonia samples are present below the detction limit of 0.1 mg/L and are graphed at half the detection limit (0.05).

The typical pattern for Lake Thunderbird surface water has been seasonal increases of Kjeldahl nitrogen with ammonia, nitrate, and nitrite falling below reporting limit in subsequent order. In 2020, epilimnetic nitrate and nitrite fell below reporting limit in June and remained undetectable until briefly making an appearance at the September 16th sampling event (**Figure 16**). It again fell below reporting limit in late September before reappearing in October. This may correspond with lake mixing in the Fall. Ammonia was not detectable at the surface throughout the season, likely due to ammonia being preferentially used by algae and thus follows quick depletion in a eutrophic to hypereutrophic reservoir.

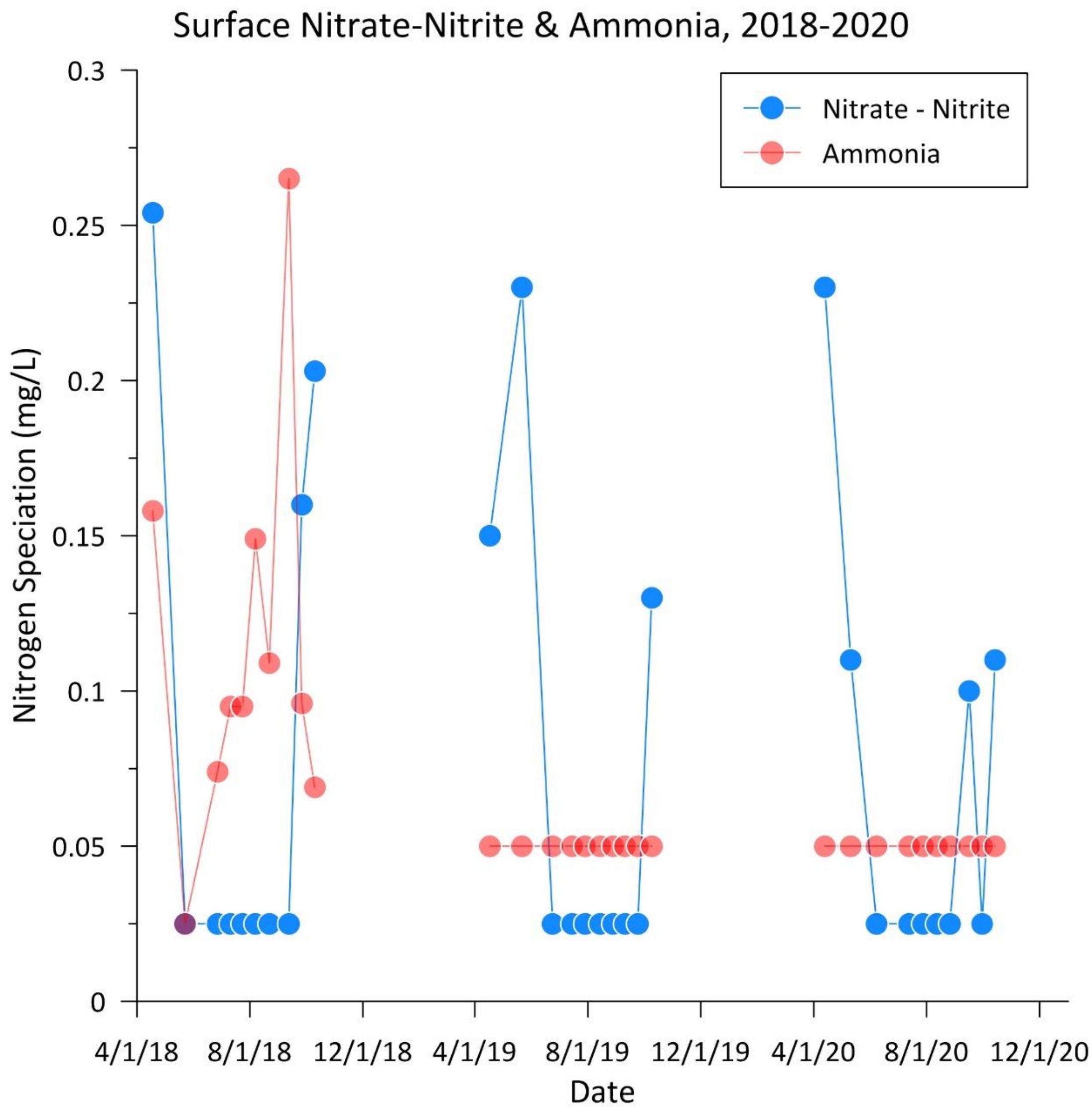

Figure 16. 2018-2020 Surface Nitrate-Nitrite and Ammonia (mg/L) at Site 1. Of note, samples in 2018 were processed by a lab with a lower Ammonia reporting limit. 2019-present Ammonia samples are present below the reporting limit of 0.1 mg/L and are graphed at half the reporting limit (0.05 mg/L).

Hypolimnetic total nitrogen peaked in September, coinciding with hypolimnetic ammonia accumulation. Examination of ammonia distribution with depth and over time showed a general increase of ammonia in the hypolimnion during summer months, when hypolimnetic waters were anoxic, followed by a sharp decrease below reporting limit in the fall (**Figure 17**).

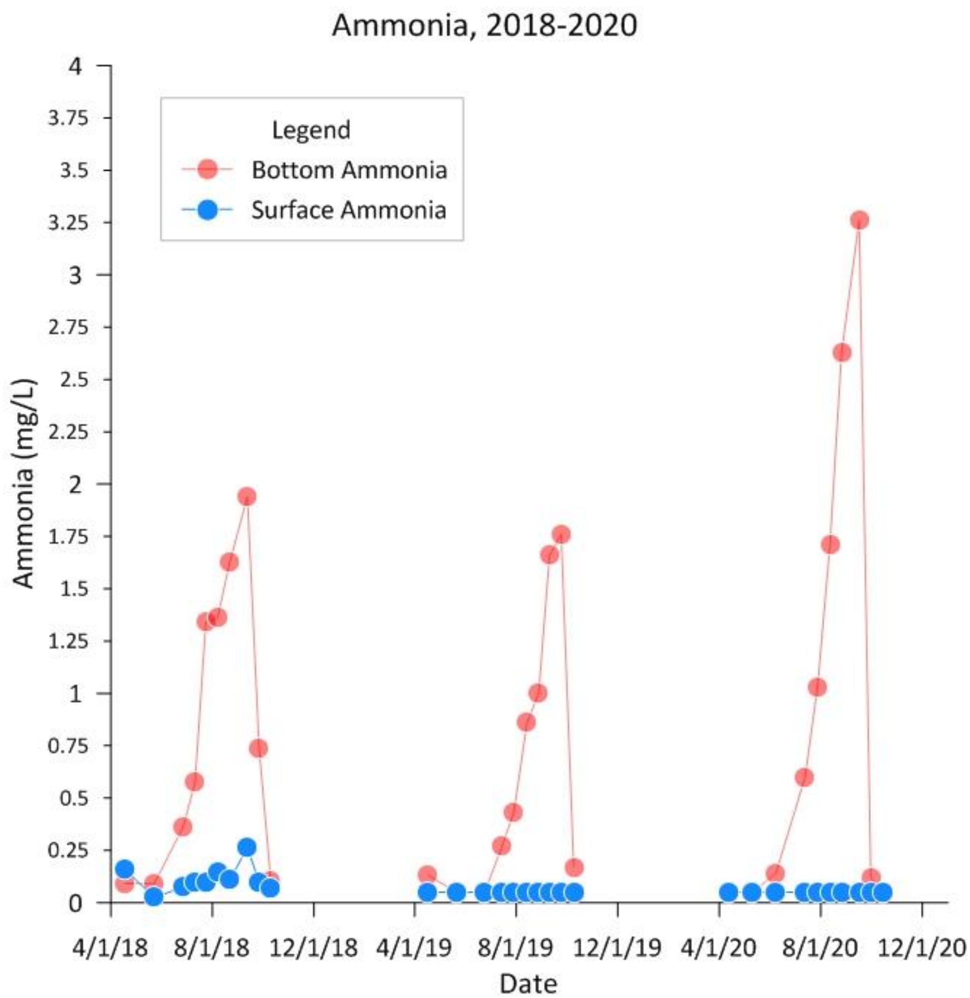

Figure 17 2020 Site 1 Ammonia at Surface and Bottom Depths. Surface ammonia samples are present below the reporting limit of 0.1 mg/L and are graphed at half the reporting limit (0.05 mg/L).

Compared to the lacustrine zone, riverine total nitrogen levels were higher, suggesting the tributaries are an important source of nitrogen (**Figure 18**). Nitrogen in the riverine sites increased throughout the season and generally varied together, except for higher values observed in April at Site 6.

Lacustrine and riverine sites' nutrient concentrations are often dissimilar from each other, as riverine values are consistently higher than those reported in open water sites. In 2020, Sites 8 and 11 behaved similarly and exhibited TN values slightly higher than the lacustrine sites. Nitrogen concentrations followed a similar peak and fall pattern at all riverine sites. Site 6 had the highest TN values lake-wide, peaking early in April at 1.3 mg/L.

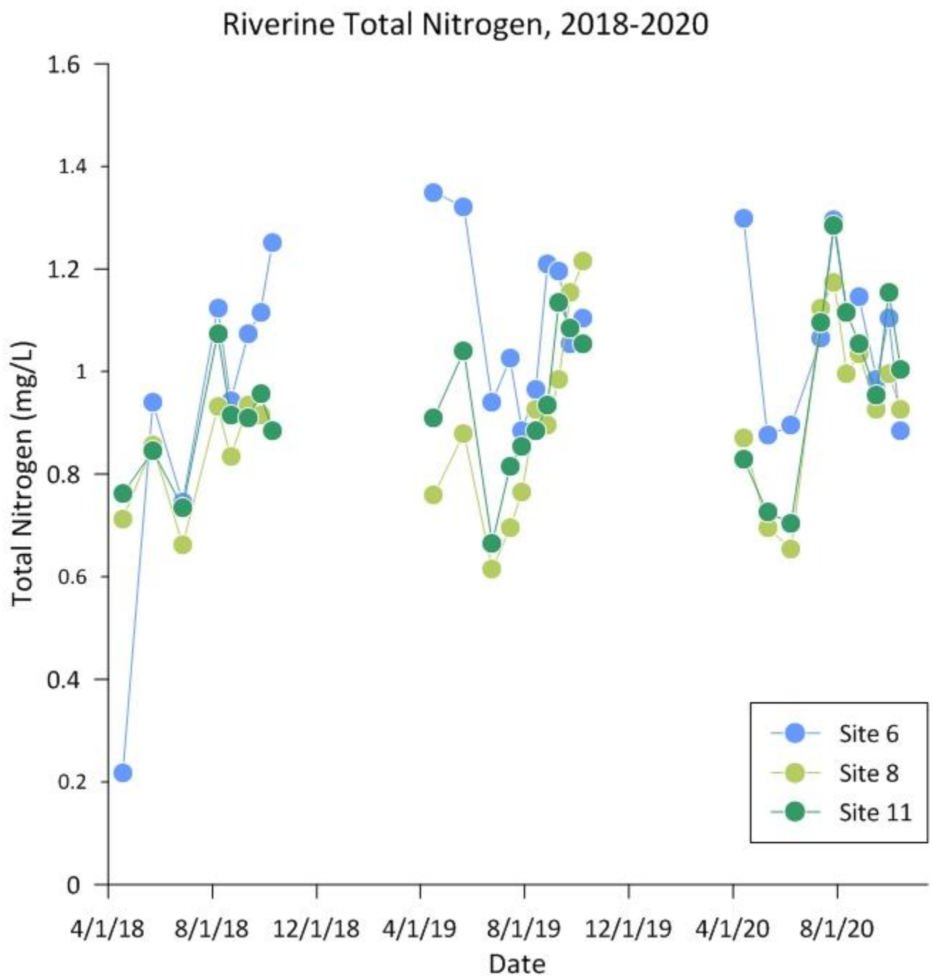

Figure 18. 2020 Surface Total Nitrogen Variables as N (mg/L) from the three riverine sites.

Average Site 1 epilimnetic total nitrogen values were similar to previous years and are in the range of eutrophic reservoirs in Oklahoma. Epilimnetic ammonia was not detected throughout the monitoring season, in contrast to previous years. It is important to note that starting in 2019, the ammonia detection limit increased from 0.05mg/L to 0.1 mg/L with the implementation of a new reporting laboratory. However, this falls in line with biological principles as energetics of nitrogen assimilation by algae orders ammonia first; ammonia requires less energy for uptake, followed by nitrite, nitrate, and finally dinitrogen.

Hypolimnetic ammonia accumulated through the season, due to sequestration by the density gradient and release from lake-bottom sediments. The stepwise breakdown of thermal stratification in the fall mixed the nutrient rich hypolimnetic waters to the surface, decreasing the hypolimnetic concentration (**Figure 19**).

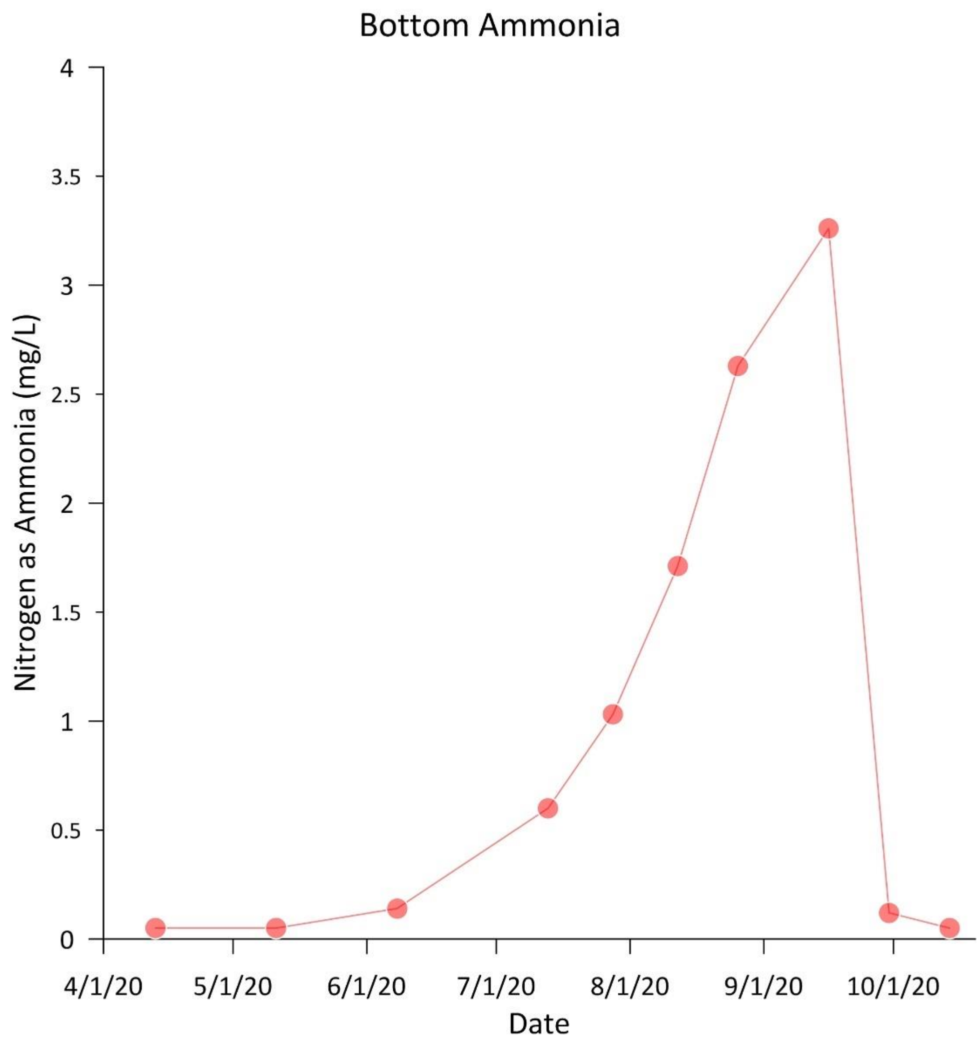

Figure 19. Bottom ammonia concentrations throughout the 2020 sample year.

Riverine nitrogen concentrations peaked at the same time as lacustrine values and were measured as slightly higher than in lacustrine areas throughout the season. Site 6 exhibited the highest nitrogen values, likely attributed to storm water bringing nutrients into this shallow area of the lake.

In general, nutrients behaved similarly to previous years with riverine inorganic nutrients generally greater than lacustrine values, hypolimnetic accumulation of dissolved nutrients such as ortho-phosphorus and ammonia, and seasonal buildup of epilimnetic total phosphorus and nitrogen.

Algae

Chlorophyll-a is a pigment common to all photosynthetic plants and is used as a proxy for measuring algal biomass in aquatic ecosystems. Primary production is a term often associated with photosynthesizing organism, including algae. Algal biomass and subsequently biological production can have several impacts to overall water quality, including ecosystem stability, drinking water suitability, and recreational impacts related to water transparency. Increasing eutrophication in Oklahoma reservoirs has amplified the frequency and severity of blue-green algae blooms, which result in measurable amounts of cyanotoxins in affected waterbodies and can often lead to human health concerns and loss of recreational opportunities. Monitoring for blue-green algal blooms was not included in the scope of this project; however, the detection of taste and odor compounds, Geosmin and MIB, in recent years, confirms presence of nuisance blue-green populations in Lake Thunderbird.

Trophic state is a common designation used to classify lakes and reservoirs according to their level of productivity or algal biomass (Carlson, 1979). The process or rate at which lakes receive nutrients is known as eutrophy. Therefore, trophic state is a measure of a lake's productivity. Recently, Lake Thunderbird's classification has ranged from eutrophic to hypereutrophic, meaning it experiences high to excessively high algae growth. Characteristics of hypereutrophic systems include an anoxic hypolimnion, possible taste and odor issues in finished drinking water, and potential for algal scum and low transparency due to high algal biomass. These concepts will be explored in an upcoming section. Understanding and limiting the pathway for excessive nutrient loading is critical for effective water quality management and delivery of high-quality water.

Algal Biomass

Chlorophyll concentrations vary spatially and seasonally, and therefore, are presented as lacustrine and riverine sites over time. Lacustrine chlorophyll values began the monitoring season at relatively low levels, mostly lower than the 10 µg/L OWQS criterion until June when the lake began to stratify. Warmer epilimnetic waters and a greater amount of sunlight and nutrients lead to increased production of algae during summer months. This is a trend observed each year on Lake Thunderbird as well as others across Oklahoma. Chlorophyll values were relatively similar among lacustrine sites throughout the spring and early summer and all gradually increased (**Figure 20**). After the May 11 event, all lacustrine samples measured above OWQS until December. Interestingly, chlorophyll decreased across all sites in late summer (late August) before rebounding to their peak in September, corresponding with fall turnover.

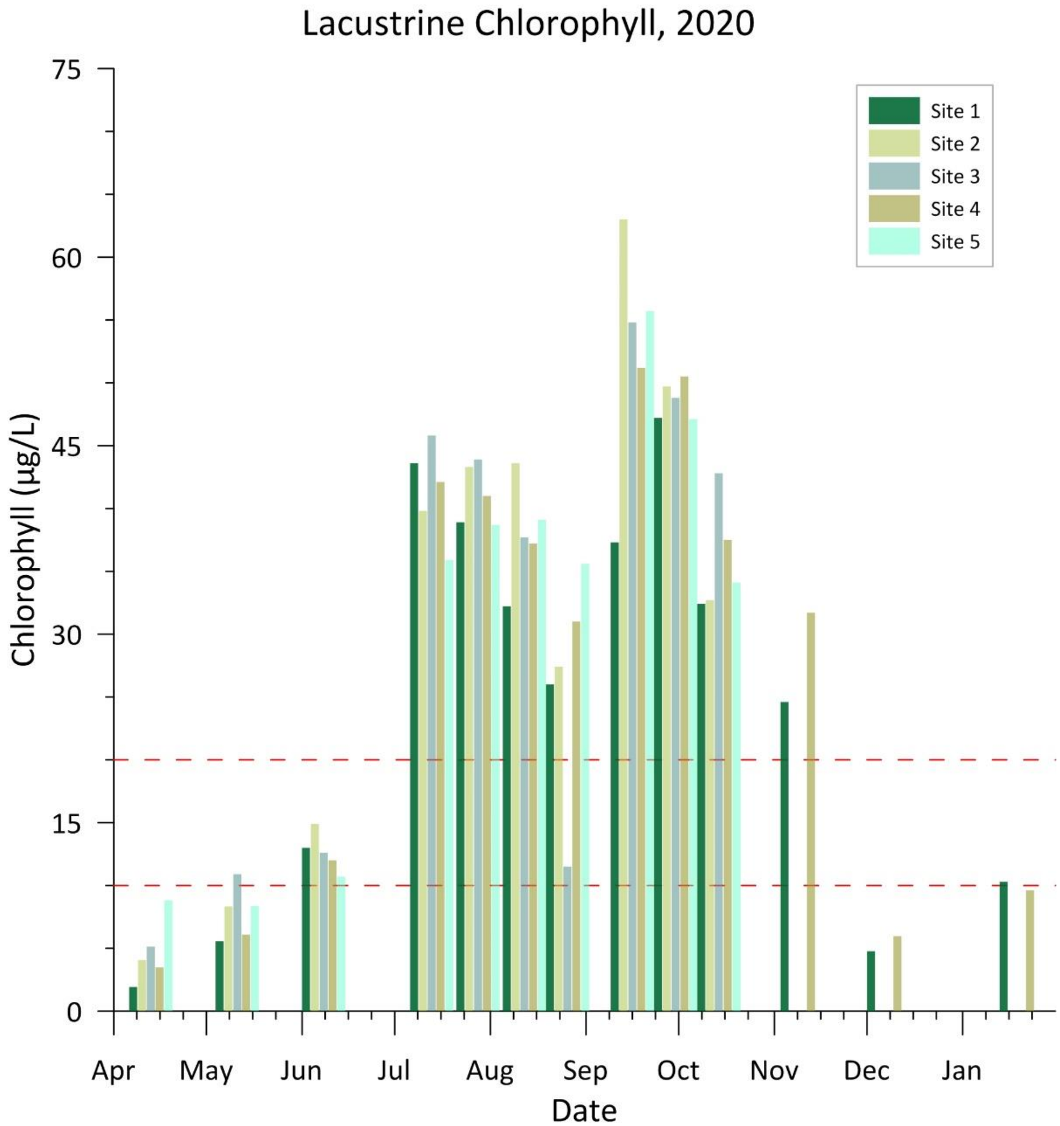

Figure 20. 2020 Lake Thunderbird surface chlorophyll (µg/L) at lacustrine sites. Bottom dashed red line indicates SWS criteria of 10 µg/L. Top dashed line represents values corresponding with a hypereutrophic reservoir.

Chlorophyll in riverine sites followed somewhat similar patterns as lacustrine, although at a higher magnitude (**Figure 21**). All sites started the season at or above the 10 µg/L criterion. Site 8 and Site 11 gradually increased over early summer while Site 6 increased sharply through July. Site 6 receives stormwater from the most urbanized portion of the watershed and may account for such sharp uptick. Peak chlorophyll values occurred in late July and began to subside through August and September before increasing a second time, likely due to influence from upland watershed dynamics. Nutrient availability is greater in riverine areas, providing algae more production potential. Inorganic turbidity is higher in these areas as well, due to inputs from the tributaries and watersheds, which likely suppresses algae from blooming to even higher levels.

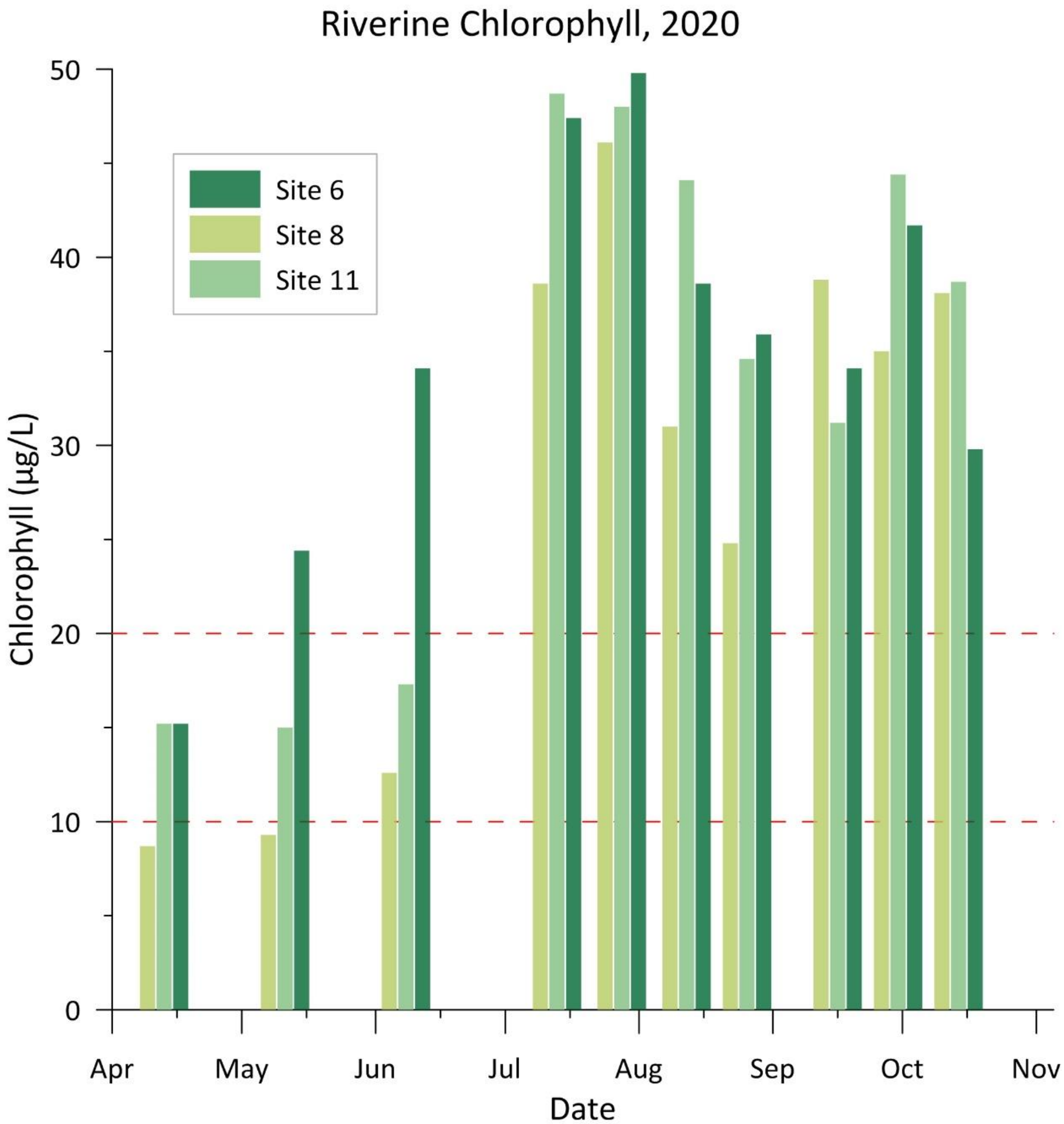

Figure 21. 2020 Lake Thunderbird surface chlorophyll (µg/L) at riverine sites. Bottom dashed red line indicates SWS criteria of 10 µg/L. Top dashed line represents values corresponding with a hypereutrophic reservoir.

Winter monitoring of chlorophyll at Site 1 and Site 4 was new in 2020 and allowed further understanding of winter dynamics. Profile and water samples were collected in November and December 2020 and January 2021. Results show a return of chlorophyll below the 10 µg/L criterion in December rebound to near or above criteria in January 2021 (**Figure 22**). This rebounding effect above OWQS indicates algal activity throughout winter month and may warrant additional monitoring.

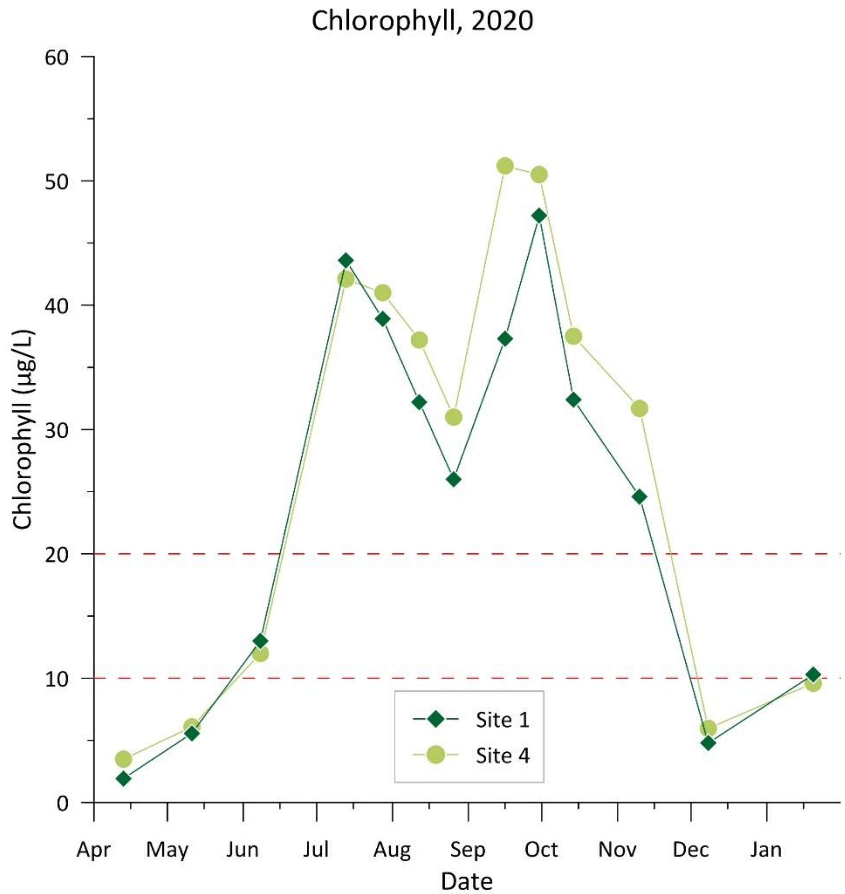

Figure 22. Chlorophyll dynamics throughout the year at Sites 1 & 4. Bottom dashed red line indicates SWS criteria of 10 µg/L. Top dashed line represents values corresponding with a hypereutrophic reservoir. Chlorophyll sampling in November-January 2021 were new in 2020.

Algal Limitation

Understanding causal factors of excessive algae growth is critical in developing effective mitigation measures. To this end, the OWRB has employed a variety of diagnostic tools to examine the relationship between algal macronutrients (light, phosphorus, and nitrogen) and measures of algal biomass.

Nutrients

Phosphorus is desirable as the limiting nutrient for most freshwater systems because under phosphorus limiting conditions, green algae will typically be the predominant algal community. This is opposed to a blue-green algae predominance, which, while less common, can cause a multitude of issues ranging from human health and recreation, to drinking water supply, and fish community structure. A common tool for examining the limiting nutrient relationship is the ratio of Total Nitrogen to Total Phosphorus (TN:TP).

TN:TP ratios are used to predict whether nitrogen or phosphorus is the most likely nutrient to limit algal growth. Dzialowski *et al.* (2005) has divided the molecular ratio of total nitrogen to total phosphorus into three ranges, wherein a TN:TP ratio of less than or equal to 18 indicates a nitrogen-limited waterbody, ratios of 20-46 indicate a co-limitation of nitrogen and phosphorus, and waters having ratios greater than 65 are regarded as phosphorus-limited. In most eutrophic Oklahoma reservoirs, a co-limitation prediction turns out to be no chemical nutrient limitation, because both nutrients are readily available in significant amounts and produce high algal productivity.

Historically, Lake Thunderbird has been in the co-limitation range with both nutrients readily available for algal growth. However, 2020 data shows much of the lake was in the indeterminate zone for much of the year, including the growing season (**Figure 23**).

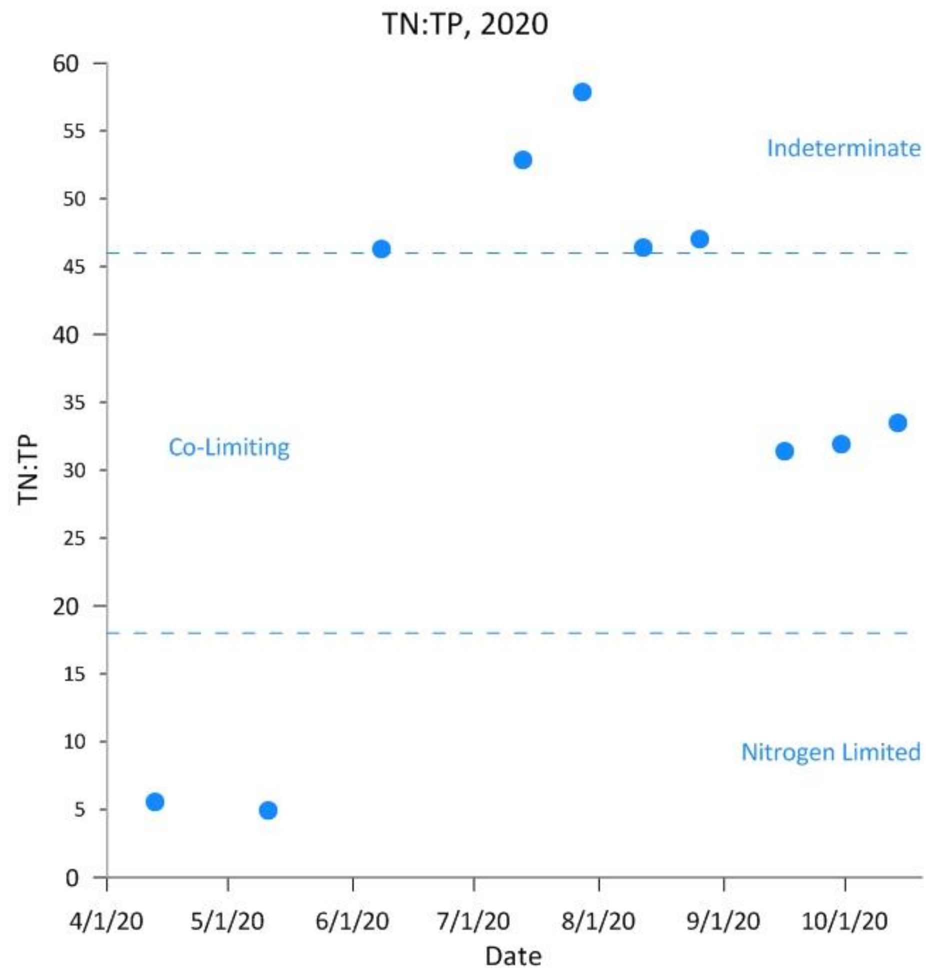

Figure 23. 2020 Lake Thunderbird TN:TP by sample event.

Light

Turbidity and Secchi disk depth are ways of measuring water clarity and amount of suspended particles in a lake. In pristine and natural lakes, Secchi disc depths can measure in several meters. However, in most Oklahoma lakes, it is common for Secchi depth to be less than one meter. Secchi disk depth can provide information on light's ability to penetrate and influence the water's productivity.

In 2020, Lake Thunderbird's non-algal turbidity was calculated to examine its effect on algal limitation using the equation below, derived from BATHTUB model (Walker, 1999). Non-algal turbidity generally describes turbidity associated with material originating elsewhere and was brought in or introduced to the system. This material is often referred to as allochthonous in geology.

$$\textbf{\textit{Eq. 5}} \qquad T = 1/Z_{SD} - 0.025\ Chl\ a$$

Where ***SD*** is Secchi Depth in meters

and ***Chl a*** is extracted chlorophyll a result value in mg/L.

Of the samples analyzed for non-algal turbidity (T) influence on algal growth, 61 percent were found to have a T value greater than one, indicating allochthonous particulates are potentially important and the expected algal response to nutrients is likely low. Meaning turbidity from particles brought into the system is potentially more important in limiting light's ability to drive excessive algal growth, regardless of excessive nutrients in the system.

Five instances in the lacustrine portion of the reservoir had T values below 0.4, which indicates turbidity from allochthonous particles are unimportant and high algal response to nutrients is expected. This follows as the lacustrine portion of Lake Thunderbird traditionally has greater secchi disk depths than riverine portions. Despite the presence of high nutrient concentrations, chlorophyll values were lower than would be expected due to turbidity from non-native particles.

Trophic State Index – TSI

A common method of classifying lakes based on biological response to nutrients is trophic state, which indicates the amount of biological activity sustained in a waterbody at a particular time. Lakes that have high nutrient concentrations and productive plant growth are described as eutrophic, whereas low nutrient concentrations and low plant growth lakes are characterized oligotrophic (Water on the Web, 2004). Lakes that exhibit moderate levels of nutrients and plant growth are termed mesotrophic. Carlson (1977) developed the most widely used biomass based Trophic Status Index (TSI) to classify and describe lakes. The Carlson chlorophyll TSI metric has long been used by OWRB to determine lake trophic status. **Table 4** below presents the various trophic states and associated descriptions.

Table 4. Carlson's Trophic State Categories.

Trophic State	*TSI Value*	*Description*
Oligotrophic	< 40	Low primary productivity and/or low nutrient levels
Mesotrophic	41-50	Moderate primary productivity with moderate nutrient levels
Eutrophic	51-60	High primary productivity and nutrient rich
Hypereutrophic	> 60	Excessive primary productivity and excessive nutrients

This concept has been expanded over time to classify each lake into a particular trophic state based on a series of metrics. These metrics in turn are used to assess biological processes and water quality trends; comparing each metric can shed light on what drives algal growth. Chlorophyll is the most relatable TSI metric, as it is the most direct measure of algal biomass, which is the measure of primary productivity that the trophic state seeks to classify. **Figure 24** displays Lake Thunderbird's TSI (Chl-a) levels at Site 1, beginning the season as oligotrophic and ran the full gamut of trophic statuses, quickly accelerating to hypereutrophic by July and remained into November.

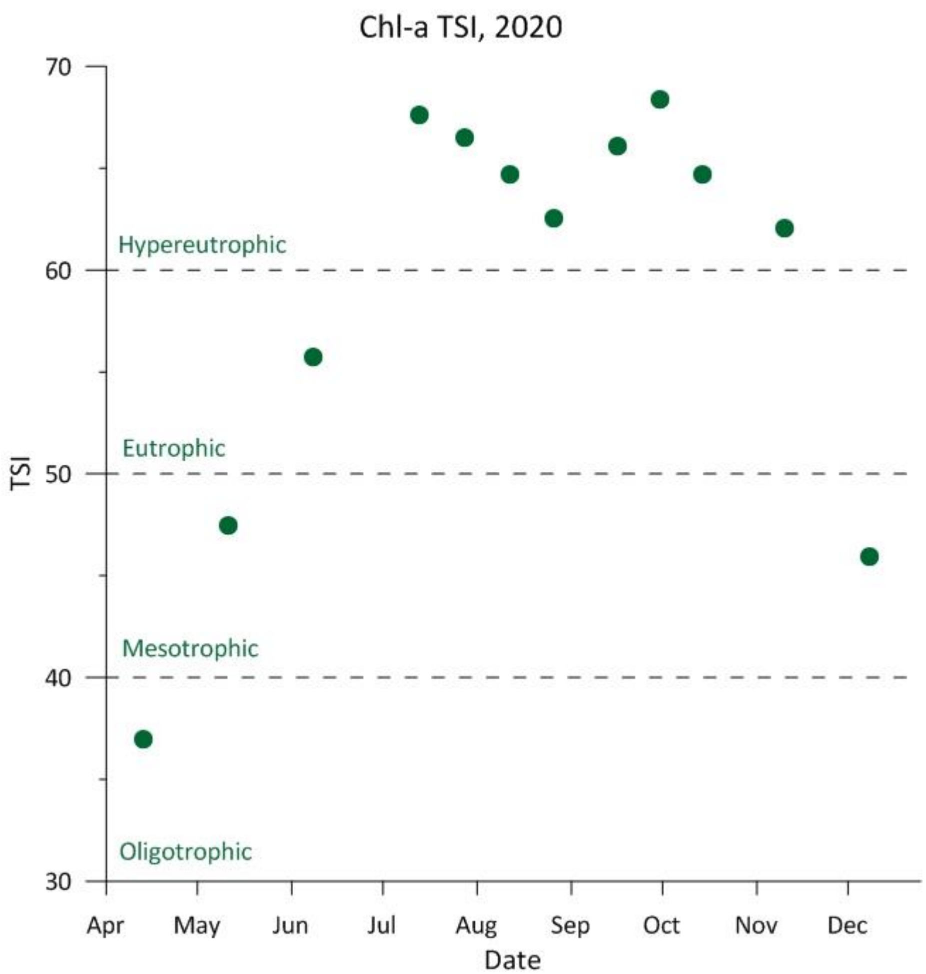

Figure 24. Site 1 Chlorophyll TSI in 2020. Dashed lines represent the divisions of trophic states.

The advancement of lakes toward a eutrophic or hypereutrophic condition is often accelerated by anthropogenic activities that introduce excess nitrogen and phosphorus into lakes. This is commonly referred to as cultural eutrophication.

In a similar pattern as Site 1, TSI (Chl-a) at the riverine sites increased throughout the season and were mostly in the eutrophic and hypereutrophic ranges. Chlorophyll TSI varied between individual sites and were consistent with measured chlorophyll in the system. **Figure 25** displays riverine TSI throughout the 2020 sample year.

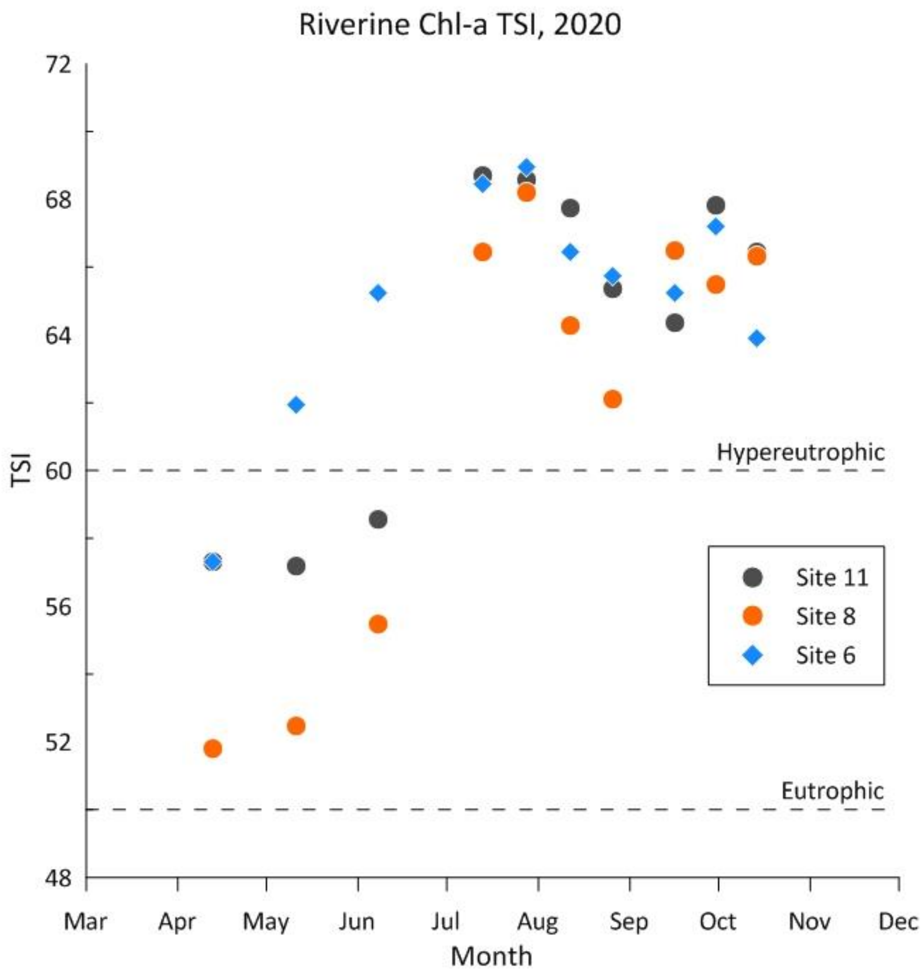

Figure 25. 2020 Carlson's Trophic State Index values for riverine Sites (Sites 6, 8, and 11) for Lake Thunderbird. Dashed lines delineate ranges for trophic states.

Total Organic Carbon – TOC

Total organic carbon (TOC) is a measure of carbon containing compounds present in a water sample, allowing insight to the amount of organic material present. Sources of these organic compounds include soil and plant detritus and to a lesser degree, even carbon present in living material such as bacteria and plankton (Wetzel, 2001). Wetzel presents median organic carbon content for eutrophic lakes as 12.0 mg/L, oligotrophic lakes as 2.2 mg/L, and rivers as 7.0 mg/L (2001). In 2020, Lake Thunderbird surface TOC values at Site 1 ranged from 5.07 to 6.79 mg/L with a mean value of 5.81 mg/L (**Table 5**). TOC is an especially important measure for water treatment plants to inform on potential creation of Disinfection By-Products (DBPs). Chlorine compounds used in disinfection can react with organic matter to creating by-products that could be carcinogenic (TCEQ, 2002). Reducing TOC in the source water could lead to a reduction in treatment cost for finished drinking water.

Table 5. 2020 Lake Thunderbird Total Organic Carbon (mg/L).

Total Organic Carbon (mg/L)	
04-13-2020	5.07
05-11-2020	5.12
06-08-2020	5.7
07-13-2020	6.33
07-28-2020	6.79
08-12-2020	5.67
08-26-2020	5.5
09-16-2020	6.38
09-30-2020	5.87
10-14-2020	5.74

Taste and Odor Complaints

The City of Norman has provided data on the number of taste and odor complaints for the period of record (2000 – 2020) and more recently included taste and odor compound analysis. Annual data has indicated that changes in lake water quality correlates with customer complaints in the final finished drinking water. Consumers at the tap can detect taste and odor causing compounds in extremely low concentrations (~ 5 ηg/L) (Graham et al 2008). Algae produce the majority of taste and odor compounds (T&O) found in Oklahoma reservoirs. The most common drinking water T&O that are problematic are Geosmin and 2-methylisoborneol (MIB). Both of which are produced primarily by Cyanobacteria.

Taste and odor complaints in 2020 exhibited a different pattern from previous years, with relatively few until July, when 12 grievances were registered (**Figure 26**). In past years T&O complaints coincided with lake mixing events, cycling hypolimnetic chemicals into the water column. However, in 2020, Geosmin did not peak until November, while MIB spiked in late August (**Figure 27**). Overall measured annual averages for both parameters where lower than 2019. Additional sampling events were conducted throughout the winter at Sites 1 and 4 to better understand algal and chlorophyll dynamics. Results from October 2020 through January 2021 indicate chlorophyll fell below or near the OWQS threshold of 10 µg/L.

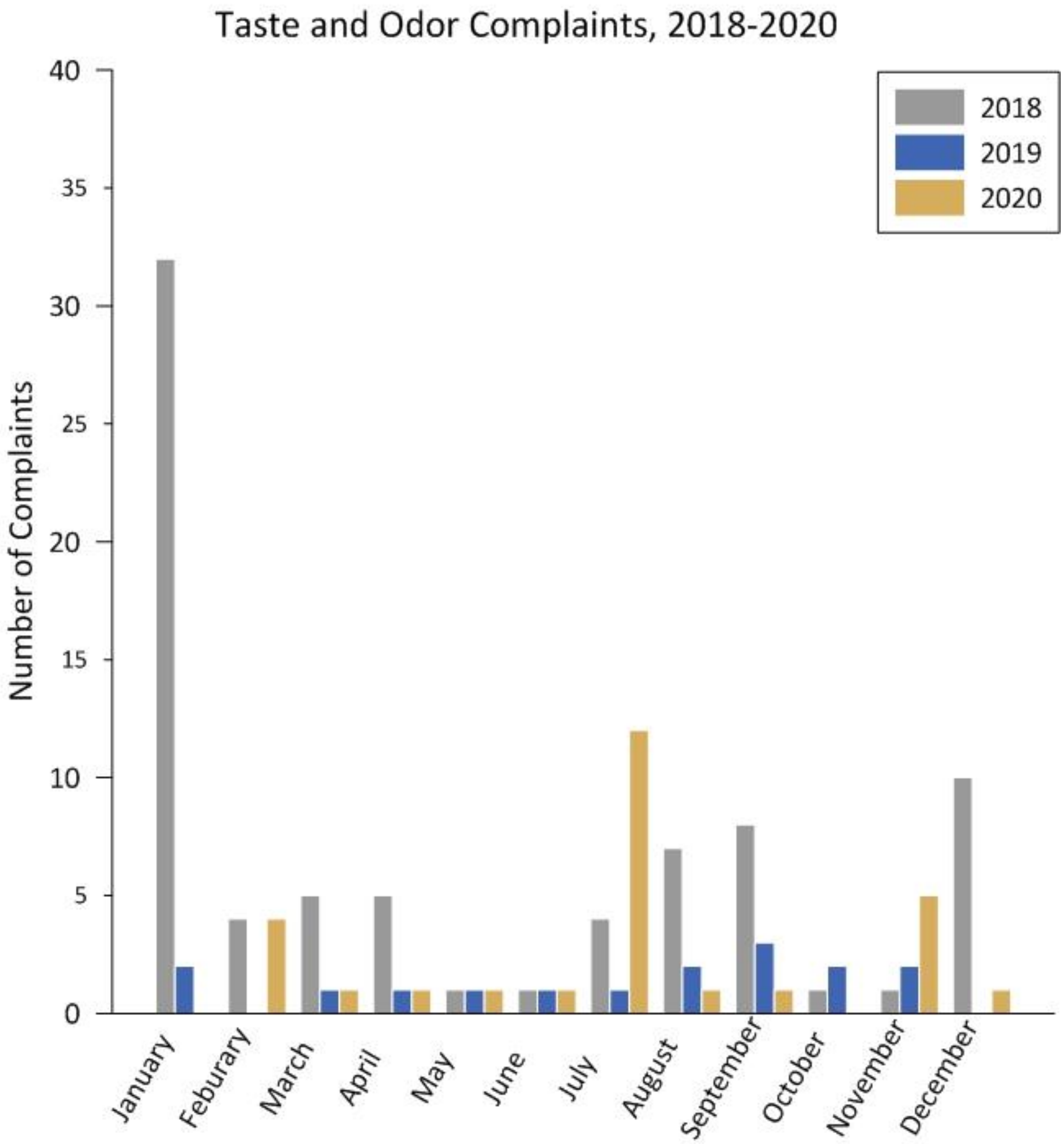

Figure 26. 2018-2020 City of Norman compiled monthly Taste and Odor complaints. Data is from personal communication with R. Croft, City of Norman, March 25, 2021.

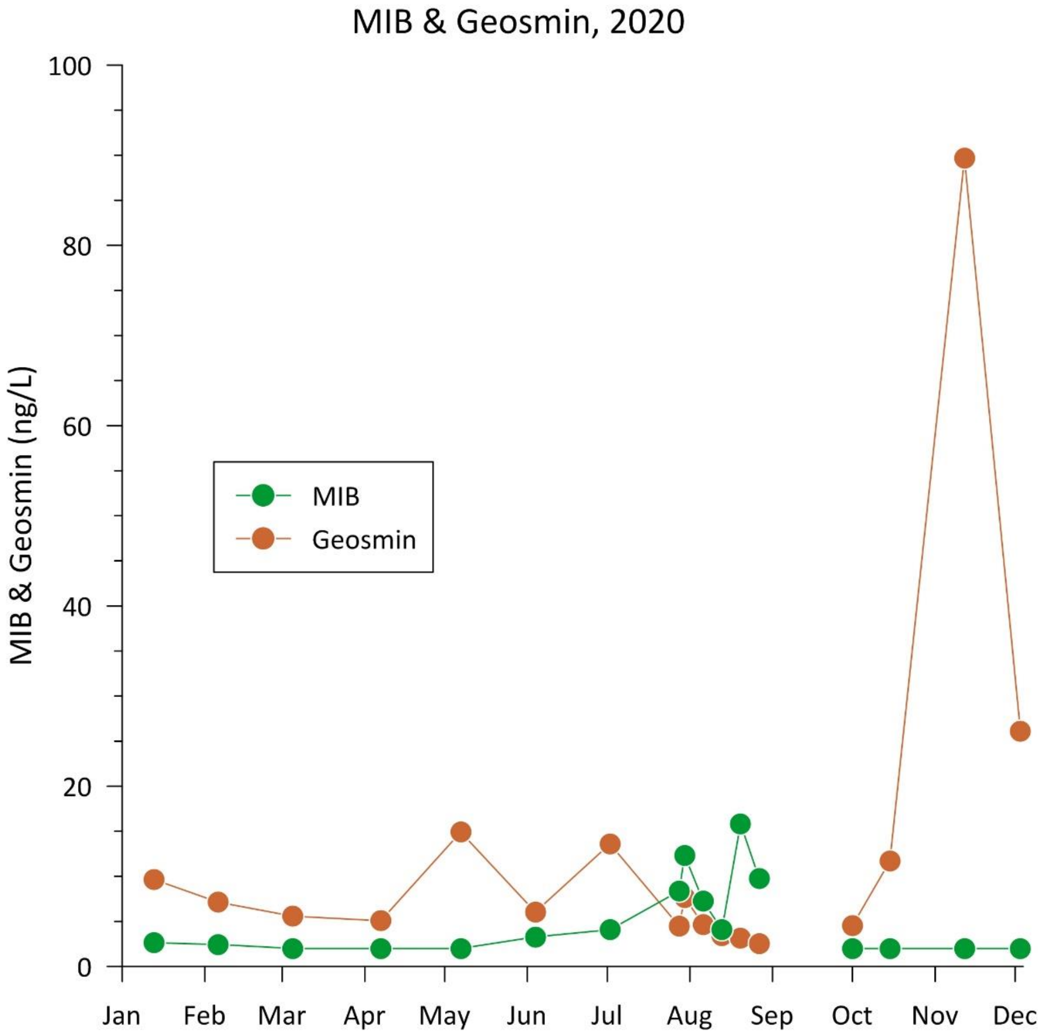

Figure 27. 2020 City of Norman monthly raw water laboratory analysis for MIB and Geosmin. MIB was less than 2.0 ng/L (nanograms/Liter or parts per trillion) March-May and again October-December. Geosmin and MIB were not evaluated in September. Data is from personal communication with R. Croft, City of Norman, March 25, 2021.

Water Quality Standards

All Oklahoma surface waters are subject to Oklahoma's Water Quality Standards (OAC 785:45) and Implementation Rules (OAC 785:46), designed to maintain and protect the quality of waters of the state. Oklahoma Water Quality Standards (OWQS) are rules adopted by Oklahoma in accordance with the federal Clean Water Act, applicable federal regulations, and state pollution control and administrative procedure statutes. Identification and protection of beneficial uses are vital to water quality standards implementation. Beneficial use designations for Lake Thunderbird are Public and Private Water Supply (PPWS), Fish and Wildlife Propagation (FWP), Agriculture, Recreation, and Aesthetics.

Lake Thunderbird is listed in the latest approved Oklahoma Integrated Water Quality Report as impaired due to low dissolved oxygen, excessive turbidity, and excessive chlorophyll (ODEQ, 2018). In order to address these impairments, Lake Thunderbird has undergone Total Maximum Daily Load (TMDL) development by the ODEQ with the resultant report approved by the Environmental Protection Agency (EPA) in 2013. The TMDL analysis requires a 35% long-term average load reduction of total nitrogen, total phosphorus, and total suspended solids from the 2008-2009 watershed load estimates in order to restore the lake's beneficial uses. Implementation of the TMDL is underway and point source and non-point source measures are outlined in the Final TMDL Report (Dynamic Solutions, 2013).

The Oklahoma Water Quality Standards Implementation Rules contain Use Support Assessment Protocols (USAP) for Oklahoma waterbodies. This USAP is the statewide methodology for integrated report water quality assessments (i.e., 305(b) and 303(d) reports). The 2020 water quality data was assessed in accordance with the USAP to evaluate current conditions relative to OWQS attainment or nonattainment. Physical, chemical, and biological data on Lake Thunderbird were used to assess the lake condition and determine if lake water quality supports its designated beneficial uses and are outlined below.

Dissolved Oxygen – DO

Dissolved oxygen criteria are designed to protect the diverse aquatic communities found throughout Oklahoma waterbodies. For warm water aquatic communities, such as Lake Thunderbird, two assessment methodologies apply to protect Fish and Wildlife Propagation beneficial use: surface and water-column/volumetric (OAC 785:46-15-5). Surface water DO criteria for not supporting is a seasonal threshold of 4.0 mg/L during the summer months and 5.0 mg/L in spring and fall. Accordingly, no surface DO readings fell below either thresholds for not supporting in 2020.

Volumetric criteria for fully supporting the Fish and Wildlife Propagation beneficial use has a threshold of less than 50% of the cumulative lake volume measuring anoxic (< 2 mg/L DO). 2020 proved to be a favorable year for dissolved oxygen at Lake Thunderbird with no months exceeding the 50% lake volume criteria. Average percent of oxygenated lake volume between April and December 2020 was over 88%. However, previous reports for 2018 and 2019 sample years highlight occurrences of the lake failing to meet volumetric criteria.

Chlorophyll-a

Oklahoma surface water drinking supplies are vulnerable to eutrophication and communities can experience substantial hardship and excessive costs to treat water affected by eutrophication. Specifically, blue-green algae (cyanobacteria) blooms are considered a principal source of compounds that cause T&O complaints. Blue-green algae also produce several toxic and carcinogenic compounds such as microcystin – a known hepatotoxin that can cause liver damage. The OWQS have provided additional protections from new point sources and protection against additional loading from existing point sources by identifying these at-risk reservoirs as Sensitive Water Supplies (SWS). Lake Thunderbird has this SWS designation and as such, is required not to exceed the long-term average chlorophyll concentration of 10 µg/L at a depth of 0.5 meters. In 2020, the lake wide chlorophyll average in Lake Thunderbird was 30.75 µg/L, with over 84% of samples exceeding 10 µg/L, whereas samples collected in 2019 had a lake wide average of 24.3 µg/L, with 75% of samples exceeding **(Figure 28**). The long-term ten-year lake-wide average is 26.0 µg/L, with 82% of samples exceeding 10 µg/L. Based on these calculations, Lake Thunderbird's beneficial use of Public and Private Water Supply would be considered as non-supporting and impaired with respect to chlorophyll.

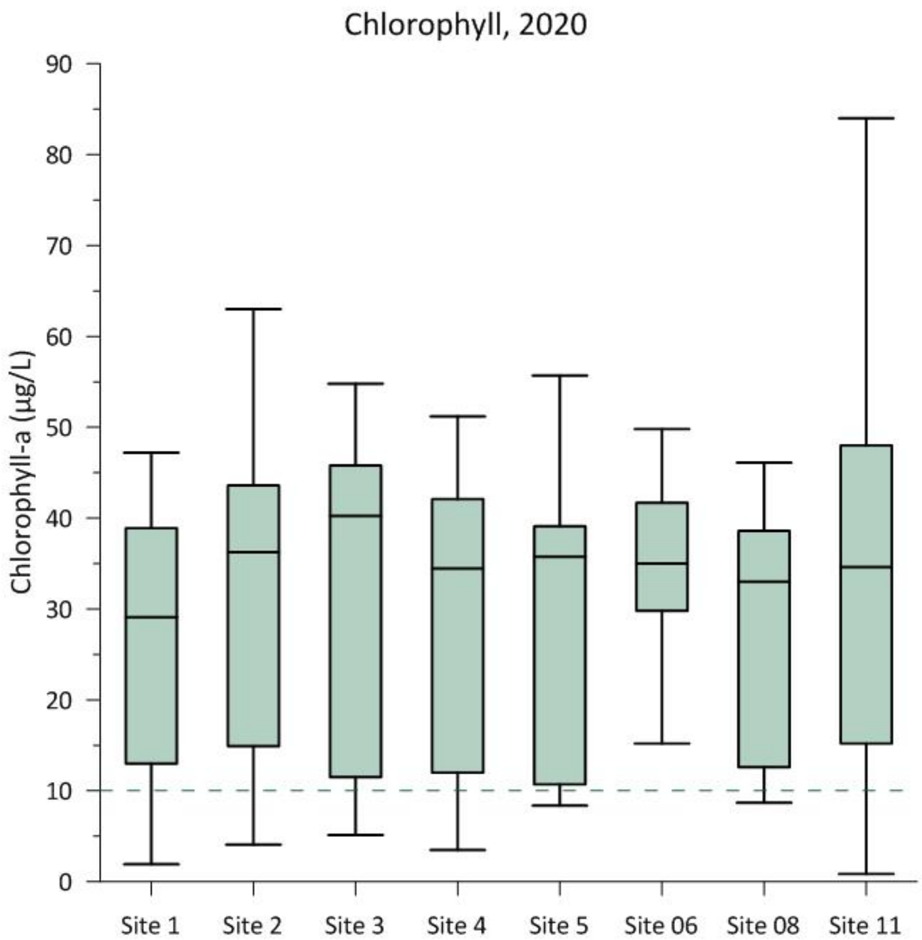

Figure 28. 2020 Lake Thunderbird chlorophyll-a (µg/L) by site. Boxes represent 25% of the data distribution both above and below the median (horizontal black line), and lines (or whiskers) represent the other 50% of the data distribution bounded by minimum and maximum values.

Water Clarity

Turbidity and Secchi disk depth are methods of measuring water clarity and the amount of suspended particles in a lake. Typical Secchi disk depths of eutrophic Oklahoma reservoirs measure one meter or less. In Lake Thunderbird, 2020 secchi disk depths ranged 5 centimeters (cm) at Site 6 to 125 cm at Site 1. Whole lake average of Secchi depth was 48.76 cm, a slight improvement from 2019's average of 49.01 cm. The lacustrine sites had the deepest Secchi depths while the riverine sites had the shallowest, as is typical of Oklahoma reservoirs (**Figure 29**).

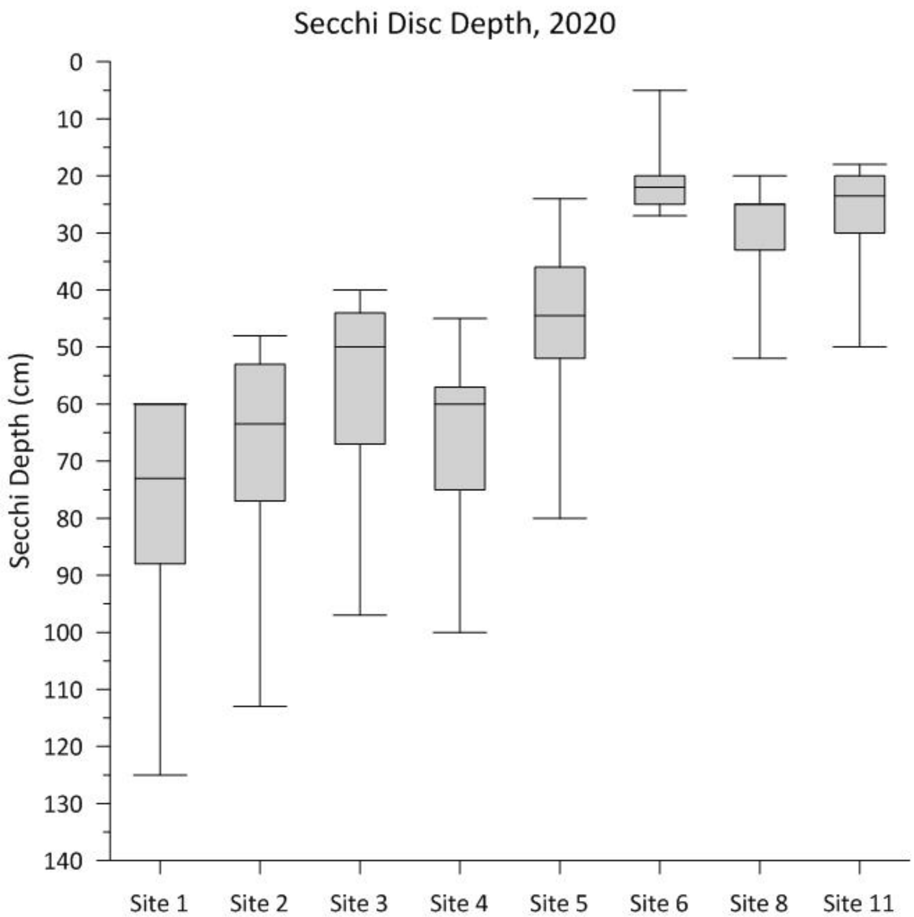

Figure 29. 2020 Lake Thunderbird Secchi Disk Depth (cm) by site. Boxes represent 25% of the data distribution both above and below the median (horizontal black line), and lines (or whiskers) represent the other 50% of the data distribution bounded by minimum and maximum values. Depth starts at 0 to represent the surface of the water.

The OWQS criterion for turbidity for the protection of the of Fish and Wildlife Propagation beneficial use, is 25 Nephelometric Turbidity Units (NTU). If at least 10% of collected samples exceed this value in the most recent 10-year dataset, the lake is not supporting its beneficial use, and is thus impaired for turbidity. For the 2020 sampling season, the lake wide turbidity average in Lake Thunderbird was 20.01 NTU, with 26.3% of the samples exceeding 25 NTU, all of which were in the riverine portions of the lake **(Figure 30**). The long-term, ten-year, lake-wide average is 24.4 NTU, with 26.5% of those samples exceeding 25 NTU. Based on these calculations, Lake Thunderbird is not supporting for the Fish and Wildlife Propagation beneficial use with respect to turbidity.

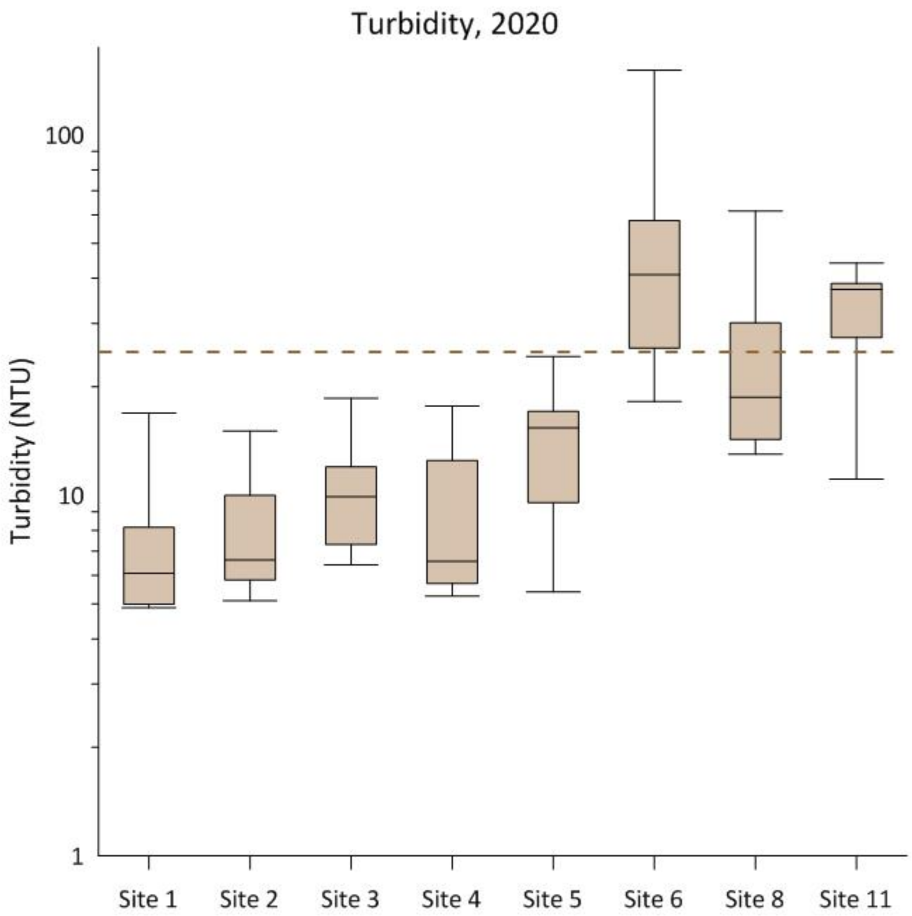

Figure 30. 2020 Lake Thunderbird Turbidity (NTU), by site, on a logarithmic scale. Boxes represent 25% of the data distribution above and below the median (horizontal black line), and lines (or whiskers) represent the other 50% of the data distribution bounded by minimum and maximum values. Dashed line indicates the 25 NTU OWQS for turbidity.

Discussion

Since 2000, OWRB has monitored the water quality of Lake Thunderbird and documented the continued degradation of water quality from cultural eutrophication. As time passes, impacts become increasingly severe. From rapid urban development in the watershed to excessive levels of nitrogen and phosphorus–especially in riverine areas, to progressively higher levels of measurable chlorophyll. All of which contribute and culminate in the loss of beneficial uses.

Climactically, Lake Thunderbird experienced a slightly cooler April-May and August-October than average in 2020. Epilimnetic water temperature peaked in early June. Water level, in terms of elevation, remained rather stable the entire year. Maximum elevation was observed in June and was below normal elevation the remainder of the year. The overall pattern of stratification remained comparable to previous years. Thermal stratification began to set up by the May sampling event, coinciding with a small anoxic volume in the hypolimnion. Indicative of a hypereutrophic system, anoxia was creeping into the metalimnion by July and persisted through the summer until thermal mixing in late September. This recent trend of metalimnetic anoxia underscores the excessive algal growth and high sediment oxygen demand and the need for addressing the water quality impairments in the lake. Reducing conditions in the hypolimnion, indicated by low ORP values, occurred from July to September and encompassed a large volume of water, slowing the breakdown of organic materials. This provides a larger amount of material mixed into the surface water following the disruption of thermal stratification.

Dissolved and total forms of nutrients, primarily nitrogen and phosphorus, were examined with respect to their spatial and temporal trends, as well as their role in limiting algal growth. Total phosphorus values were consistent with those typically reported in Lake Thunderbird during recent years but are higher than optimum to effectively curb excess biological productivity. Late summer and early fall hypolimnetic phosphorus values were high, stemming from the effect of thermal stratification and internal release from anoxic sediment. In fall, hypolimnetically stored nutrients mixed into the water column resulting in higher epilimnetic values. Ortho-P, the biologically available form of phosphorus, was not detectable in the epilimnion, likely due to uptake by algae. Hypolimnetic ortho-P accumulated throughout the season before mixing into the water column in the fall. Lacustrine phosphorus concentrations were generally lower than riverine surface phosphorus, suggesting substantial loading of phosphorous is entering the system as runoff from the watershed. Riverine areas also allow constant cycling and resuspension of nutrients due to their shallow depths and susceptibility to wind mixing.

Nitrogen, another nutrient important for algal growth, was also readily available for algae in 2020. Ammonia, nitrate, and nitrite are forms of nitrogen available to algae; at the surface all remained below the detection limit for much of the season. This indicates a significant amount of algal production is occurring in the lake. Lacustrine nitrogen measures were generally lower than riverine nitrogen, again suggesting tributaries are an important source of both nitrogen and phosphorus inputs. Hypolimnetic accumulation of ammonia was evident in summer and into early fall, stemming from the effect of thermal stratification over anoxic sediment. The anoxic conditions in the hypolimnion promote the release of ammonia from the sediments and decomposition of organic matter also contributes to increased ammonia concentrations. Because oxygen is not present, nitrification reactions do not occur; thus, the increase of hypolimnetic ammonia concentrations was both typical and expected. Upon fall turnover of the lake, oxygen was introduced which triggers nitrification, creating nitrite, which is readily further oxidized to nitrate. This phenomenon was observed September to October by a dramatic decrease in ammonia and measurable increase in nitrate concentrations. Data collected in 2020 and documented relationships in scientific literature demonstrate the connection from excess nutrients to degraded raw water quality, therefore it remains imperative to meet nutrient reduction targets outlined in the TMDL.

Nutrient and sediment load reduction targets were developed in the 2013 TMDL that, if met, would improve water quality in the lake such that designated beneficial uses can be attained. It suggests a 35% load reduction rate for Total Nitrogen, Total Phosphorus, and Suspended Solids.

This waste load allocation is divided amongst the three primary municipalities in the watershed: Moore, Norman, and Oklahoma City (ODEQ, 2013).

Chlorophyll-a is used as a proxy to measure algal biomass and it is important to understand the factors driving growth, due to its potential to cause drinking water and recreation issues. Lake Thunderbird's SWS classification requires average chlorophyll to be less than 10 µg/L; however, lake wide chlorophyll concentrations in 2020 are over three times this number.

In 2020, average chlorophyll-a values increased from 2019 values, and remained excessive, representing a need to mitigate conditions driving increased algal biomass. Riverine sites experienced higher chlorophyll-a levels than lacustrine areas, but high turbidity likely limited algal growth and prevented even higher chlorophyll values. To control biological populations, it is important to understand what is driving their growth. In 2020, Walker's (1999) analysis on non-algal turbidity was employed to look at light's effect on algal growth. Results indicate non-native particles had a limiting effect on algal growth by minimizing the ability of light to penetrate the water column to drive productivity. Thunderbird's TSI was examined using the most stable index, Chl-a TSI, and determined the lake ranged from oligotrophic in April to hypereutrophic by July, where it remained until November. During this same time frame, TN:TP ratios indicate the lake as indeterminate or co-limiting, suggesting factors other than nitrogen or phosphorus are driving productivity and algal growth.

Another consequence of cultural eutrophication that can lead to environmental problems is the proliferation of Harmful Algal Blooms (HABs). Several species of Cyanobacteria, or blue-green algae - a known contributor to HABs, occur in and dominate phytoplankton communities in many Oklahoma waters, including Lake Thunderbird. Taste and odor causing compounds such as Geosmin and MIB are released from blue-green algal cells following lysis, or senescence, and decomposition. The removal of elevated T&O compounds significantly increases the cost of producing palatable drinking water. The City of Norman has historically received T&O complaints in finished drinking water in September following significant lake mixing events. These mixing events contributed to T&O complaints through the process of hypolimnetically stored compounds mixing up and releasing into the epilimnion. Taste and odor complaints increased from 16 in 2019, to 28 in 2020. Geosmin peaked November while MIB in late August. Additional monitoring between October 2020-January 2021 indicated chlorophyll declined to near SWS criteria (10 μg/L). Aside from their causal relationship to T&O events, blue-green algae have the capability to produce multiple toxins that can cause skin irritations or lethality to humans, livestock, and pets that drink from untreated contaminated water sources.

Lake Thunderbird is on Oklahoma's 2018 303(d) list of the Water Quality Integrated Report as impaired due to low dissolved oxygen, turbidity, and chlorophyll-a, with the driver of chlorophyll and dissolved oxygen impairments identified by the ODEQ TMDL as excess nitrogen and phosphorus.

Monitoring data collected in 2020 were added to the data set and analyzed for beneficial use impairments in accordance with the USAP (OAC 785:46-15) of the OWQS and Lake Thunderbird was found to be not supporting its Fish and Wildlife Propagation beneficial use due to turbidity. Additionally, Lake Thunderbird continues to exceed the 10 μg/L chlorophyll criterion for SWS and is thereby not supporting for its Public and Private Water Supply beneficial use. Nutrient and solids reductions are necessary for the lake to meet these water quality standards. Observed, continued eutrophication of Lake Thunderbird highlights the need for mitigation to meet impaired beneficial uses, as well as to improve and sustain suitability of a major drinking water source.

To improve water quality, dynamic in-lake and watershed level activities should be implemented in tandem and designed to facilitate effective, measurable mitigation in the future. Hypolimnetic oxidation is a worthwhile exercise to not only provide aerobic lake habitat, but also improve the quality of raw drinking water for municipalities and reduce recreational health risks due to the growth of harmful algae. Unfortunately, ongoing eutrophication indicates hypolimnetic oxygenation alone will not provide the relief Lake Thunderbird needs to recover its attainment of beneficial uses.

Recommendations

In past years, the monitoring strategy has been modified several times for a multitude of reasons, not the least of which is budgetary concerns. This has led to a somewhat disjointed monitoring plan that does not always address areas of concern. To that end, the water quality monitoring strategy was improved in 2020, at no cost to COMCD. The OWRB recommends those monitoring efforts be continued and expanded to include nutrients across all sites as they provided valuable information and minimize data gaps.

With the SDOX no longer operational, the COMCD should continue to explore and investigate other strategies or in-lake technologies to mitigate anoxic conditions in the hypolimnion. In 2021, the COMCD contracted an additional study to quantify the lake’s internal nutrient load. Such study can yield an important amount of information on existing/baseline conditions and additional sources of nutrients brought into the reservoir. Prior to this study, this information has only been estimated through sediment P concentrations. Results of internal loading should be included and considered to better understand a more accurate nutrient budget and could lead to improved management decisions and in selecting in-lake measures.

When watershed events continue to deliver non-point source pollutants above numeric targets and load allocations prescribed in a TMDL, the efficacy of in-lake measures may be diminished. Vigorous watershed BMP implementation is necessary to reduce nutrient and solids movement to waterways and into Lake Thunderbird where in-lake measures can further reduce pollutant concentrations. Watershed level BMPs and in-lake mitigation strategies are not mutually exclusive and should be implemented in tandem. Elevated nutrients and low water transparency of the riverine sites underscore this need to meet TMDL reduction targets. General ways to accomplish this include:

- Incorporating wetlands into the landscape to ameliorate NPS pollutant runoff and sediment erosion further contributing to nutrient loads.
- Planning new vegetated swales and infiltration basins and retrofitting existing vegetated swales and infiltration basins.
- Target the retention of precipitation and runoff to reduce the impact of impervious surfaces in the watershed.
- Adopt Low Impact Development (LID) into COMCD's practices for maintenance and construction.
- Encourage municipalities within the watershed to incorporate LID into any new construction within the watershed (Low Impact Development Center, 1999).
- Encouraging community involvement through outreach, education, Watershed Management Groups such as the Lake Thunderbird Watershed Alliance, grassroots neighborhood "Protect our Lake" groups, river cleanups etc.

Another avenue to improve Lake Thunderbird's water quality health is to continue to foster cooperation and collaboration between all stakeholders – including municipalities and the recently formed Lake Thunderbird Watershed Alliance – to assist in reducing runoff from construction activities and urban land uses within the watershed. The COMCD continues to be an active leader in the management of Lake Thunderbird and initiate improvements to water quality.

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Appendix A
Quality Assurance and Quality Control Data

Water quality sampling followed the agency-specific Standard Operating Procedures (SOPs) (OWRB, 2017 and 2018). Several types of Quality Assurance/Quality Control (QA/QC) measures were employed to ensure quality data as part for the 2020 monitoring year, in the categories of collection, post-processing, and laboratory checks. These include:

- Timely review process of SOPs
- Calibration of field equipment
- Acid-washing and blanking Van Dorns before sample collection
- Sampler training and audits for field collection and sample processing
- Geographic site and depth verification to locate all sites
- Multiple stage review process for profile, field and lab data flowing to database
- Reviewing analytical lab data for flags and abnormal data
- QA/QC sample collection

QA/QC samples were collected in 2020 and included replicates and analytical blanks. Replicate samples primarily control for the collection of a representative sample, but these results also include a measure of uncertainty from laboratory analysis. Analytical blanks control for cleaning the equipment, such as the dissolved integrated samplers and Van Dorns.

Replicate samples were collected at the surface of the Site 1 for each parameter and designated as Site 1(12) and Site 1(22) for environmental and replicate samples respectively (**Table 6**).

Table 6. Summary of 2020 Replicate Sample Results Designated as 1 (12) & 1 (22)

1(12)	TKN (mg/L)	Ammonia (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho-P (mg/L)	Chlorophyll (µg/L)
4/13/2020	0.62	<0.1	0.23	0.034	0.009	1.92
5/11/2020	0.52	<0.1	0.11	0.028	<0.005	5.57
6/8/2020	0.77	<0.1	<0.05	0.038	<0.005	13.0
7/13/2020	0.86	<0.1	<0.05	0.037	<0.005	43.6
7/28/2020	0.97	<0.1	<0.05	0.038	<0.005	38.9
8/12/2020	0.92	<0.1	<0.05	0.045	<0.005	32.2
8/26/2020	0.89	<0.1	<0.05	0.043	<0.005	26.0
9/16/2020	0.78	<0.1	0.1	0.062	<0.005	37.3
9/30/2020	0.97	<0.1	<0.05	0.069	<0.005	47.2
10/14/2020	0.86	<0.1	0.11	0.064	<0.005	32.4
11/10/2020	NS	NS	NS	NS	NS	24.6
12/8/2020	NS	NS	NS	NS	NS	4.78
1/21/2020	NS	NS	NS	NS	NS	10.3

1(22)	TKN (mg/L)	Ammonia (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho-P (mg/L)	Chlorophyll (µg/L)
4/13/2020	0.59	<0.1	0.23	0.033	0.009	3.1
5/11/2020	0.58	<0.1	0.11	0.026	<0.005	5.77
6/8/2020	0.67	<0.1	<0.05	0.033	<0.005	14.2
7/13/2020	0.87	<0.1	<0.05	0.038	<0.005	43.2
7/28/2020	0.95	<0.1	<0.05	0.037	<0.005	41.7
8/12/2020	0.91	<0.1	<0.05	0.046	<0.005	30.2
8/26/2020	0.86	<0.1	<0.05	0.039	<0.005	28.0
9/16/2020	0.81	<0.1	0.1	0.054	<0.005	38.6
9/30/2020	0.96	<0.1	<0.05	0.066	<0.005	45.4
10/14/2020	0.84	<0.1	0.12	0.056	<0.005	33.0
11/10/2020	NS	NS	NS	NS	NS	23.7
12/8/2020	NS	NS	NS	NS	NS	5.3
1/21/2020	NS	NS	NS	NS	NS	9.61

NS – not sampled

The relative percent difference (RPD) statistic is calculated to describe the precision of each laboratory parameter based on the comparison of replicate and duplicate sample pairs.

$$\textbf{Eq. 6} \quad \mathrm{RPD} = \left| x_{S1(12)} - x_{S1(22)} \right| / \ \bar{x}\,(x_{S1(12)}, x_{S1(22)})\ x\ 100$$

Equation 6 was applied to each replicate sample for each reported parameter. In **Table 7**, the acceptable precision limit for each parameter and the percent of sample events meeting that limit are listed.

Table 7. Acceptable Limits for Laboratory Precision of Contract Laboratory Measured Parameters and Percent of Samples meeting those based on Relative Percent Differences of Replicate Samples at Site 1.

Parameter	Acceptable precision for laboratory replicates	Number of Sample Events Meeting RPD Threshold	Percent of Sample Events Meeting RPD Threshold
Total Kjeldahl Nitrogen	± 20%	10	100%
Nitrate/Nitrite	± 10%	10	100%
Ammonia	± 20%	10	100%
Total Phosphorus	± 10%	7	70%
Ortho-Phosphorus	± 20%	10	100%
Chlorophyll-*a*, Sestonic Replicate	± 10%	11*	85%

*Chlorophyll-a sampled 13 times

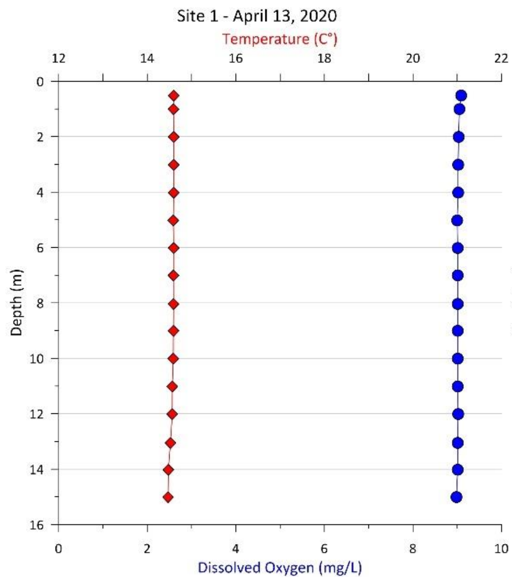
Chlorophyll replicates met precision limits for the majority of the time but were still higher than other parameters. Chlorophyll is a biological parameter that is extracted under extreme care, however, a high degree of variability in the chlorophyll pigment and other pigments between various algal species and individual algal cells is expected. Additionally, chlorophyll is analyzed using optical methods (i.e., spectrophotometric or fluorometric), which at times may over or underestimate chlorophyll concentrations due to the overlap of absorption and fluorescence bands of co-occurring pigments. Thus, it is not unexpected that a greater percentage of samples would not meet the RPD threshold for chlorophyll.

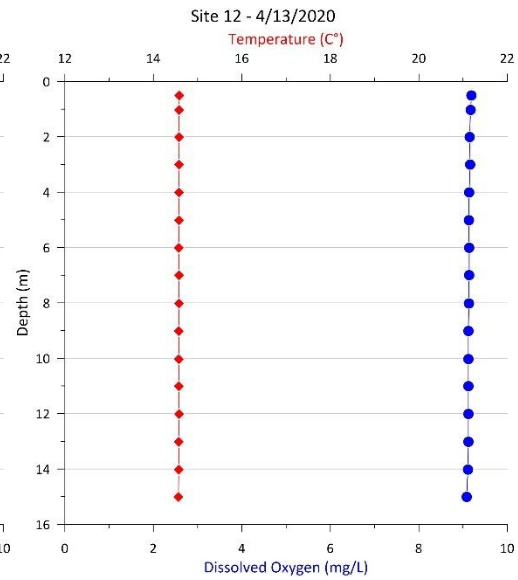
Appendix B

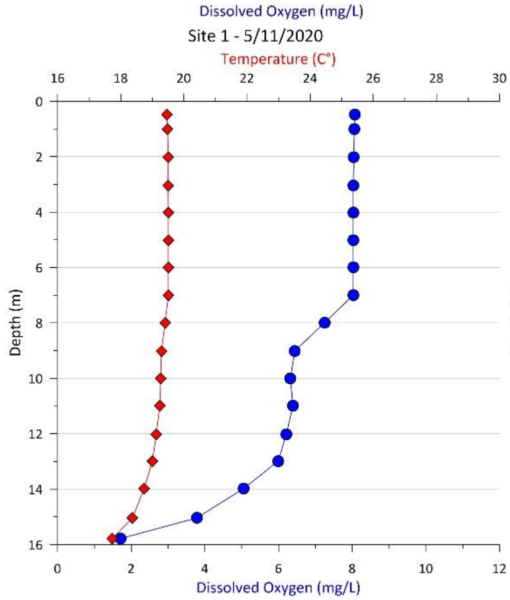
Temperature and Dissolved Oxygen with Depth

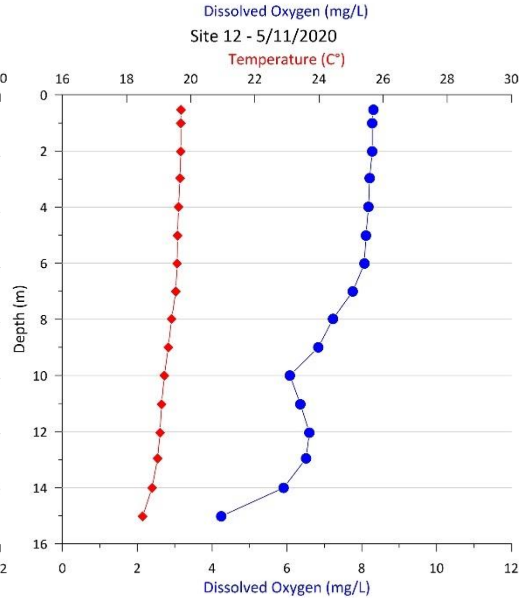
Temperature is denoted as Red Diamond Markers while Dissolved Oxygen is denoted as Blue Circle Markers.

Site 1 and 12 in April and May

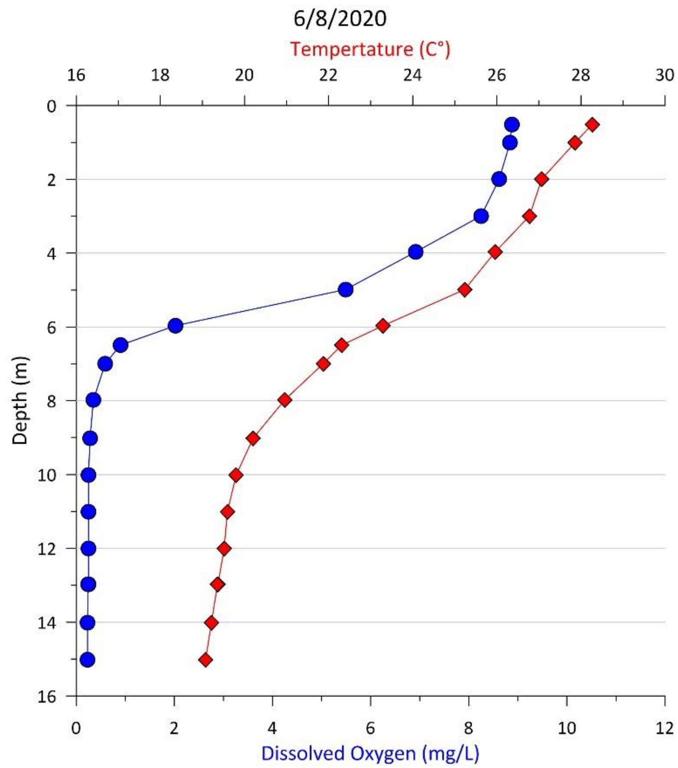


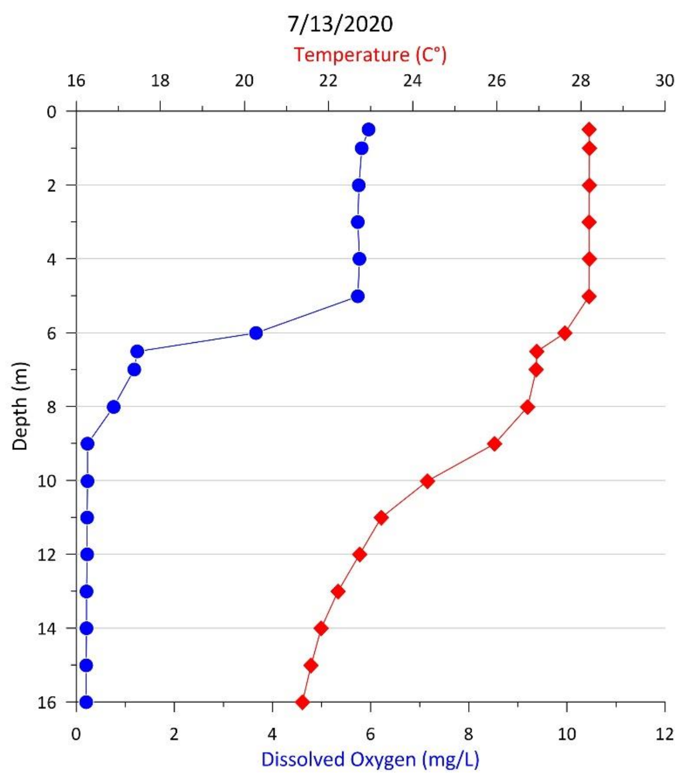






Site 1 Only


6/8/2020
Tempertature (C°)
16
18
20
22
24
26
28
30
Depth (m)
0
2
4
6
8
10
12
14
16
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)


7/13/2020
Temperature (C°)
16
18
20
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26
28
30
Depth (m)
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16
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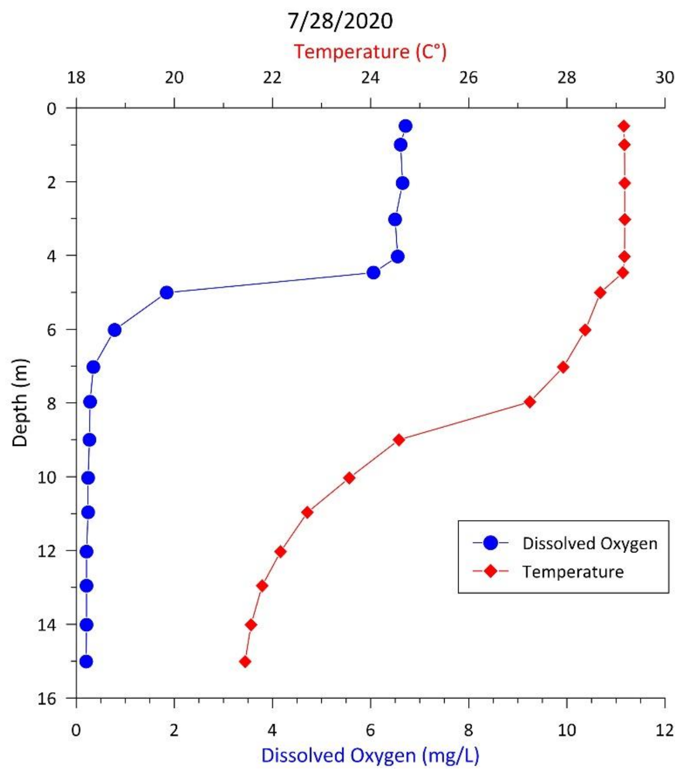
12
Dissolved Oxygen (mg/L)


7/28/2020
Temperature (C°)
18
20
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26
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30
Depth (m)
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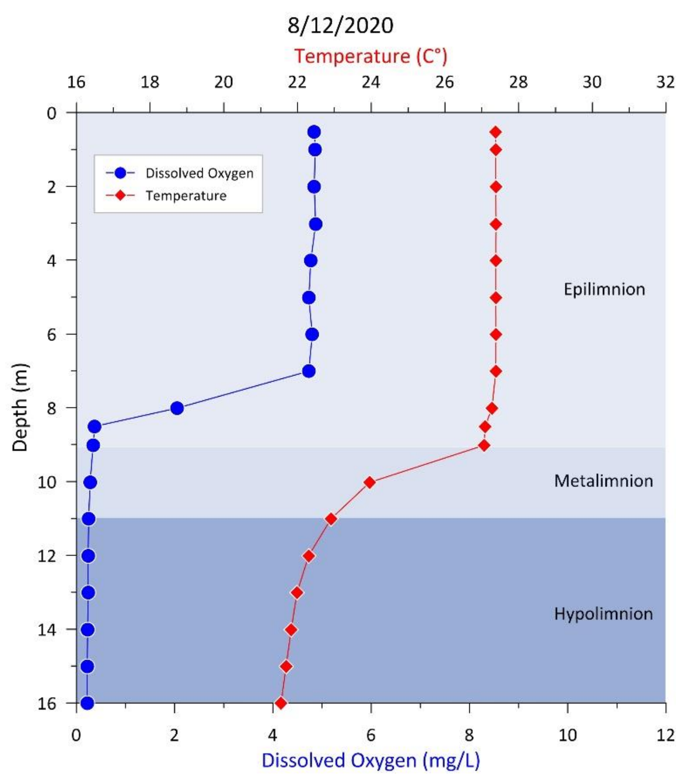
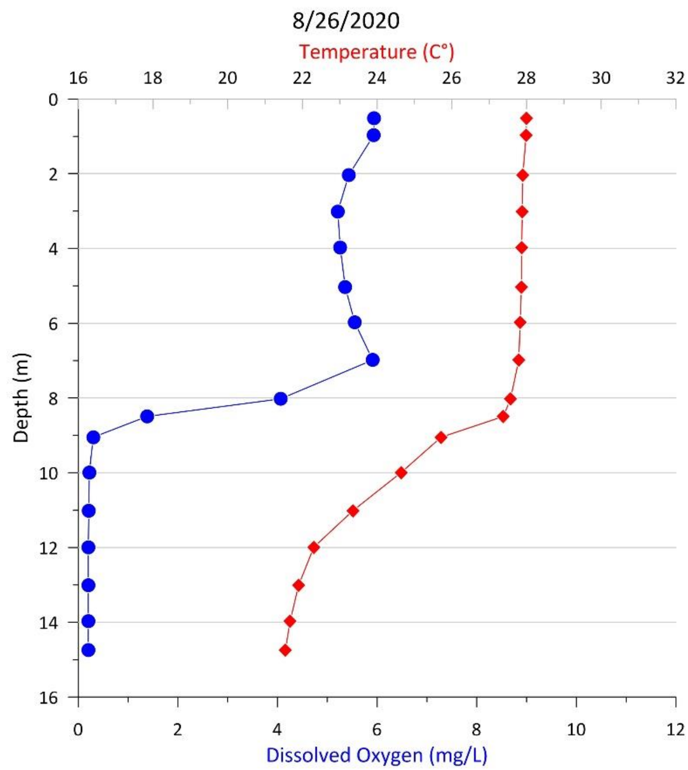
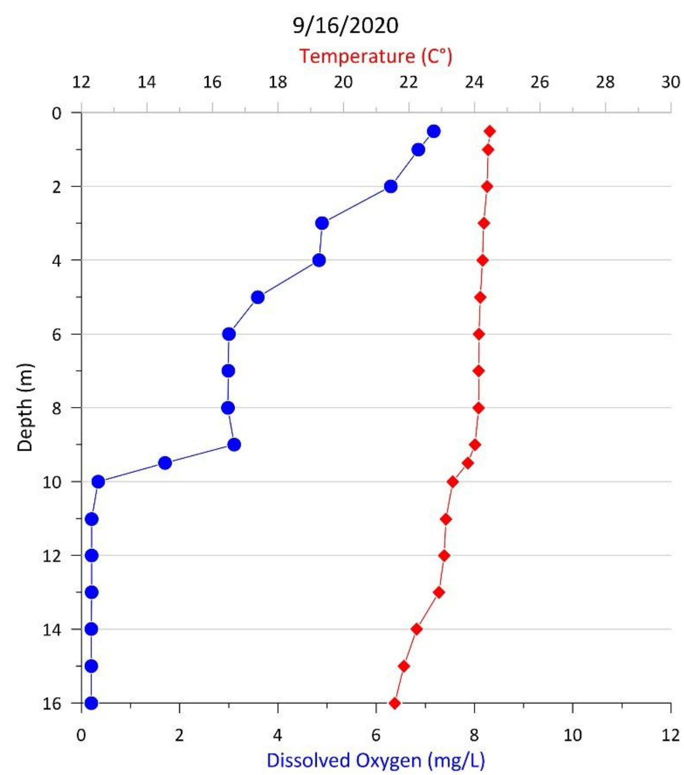
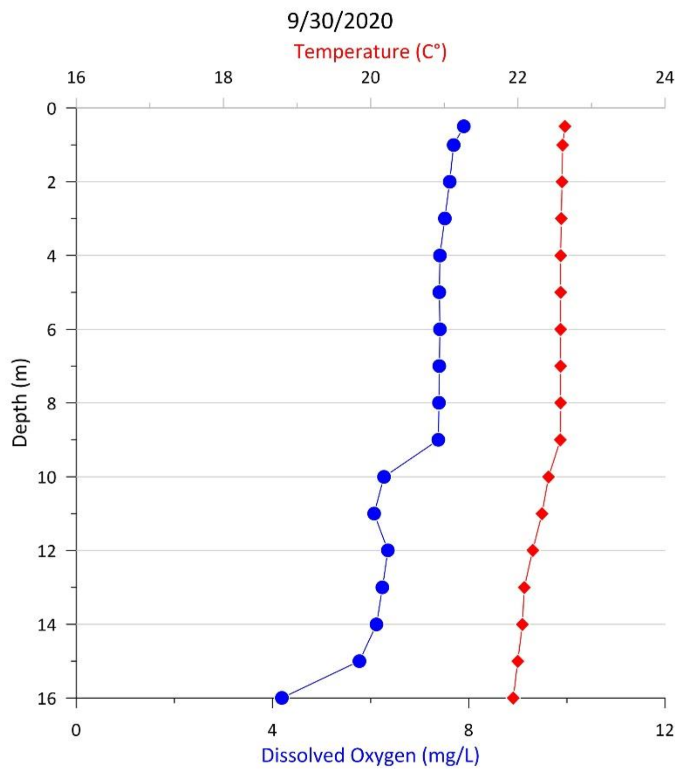
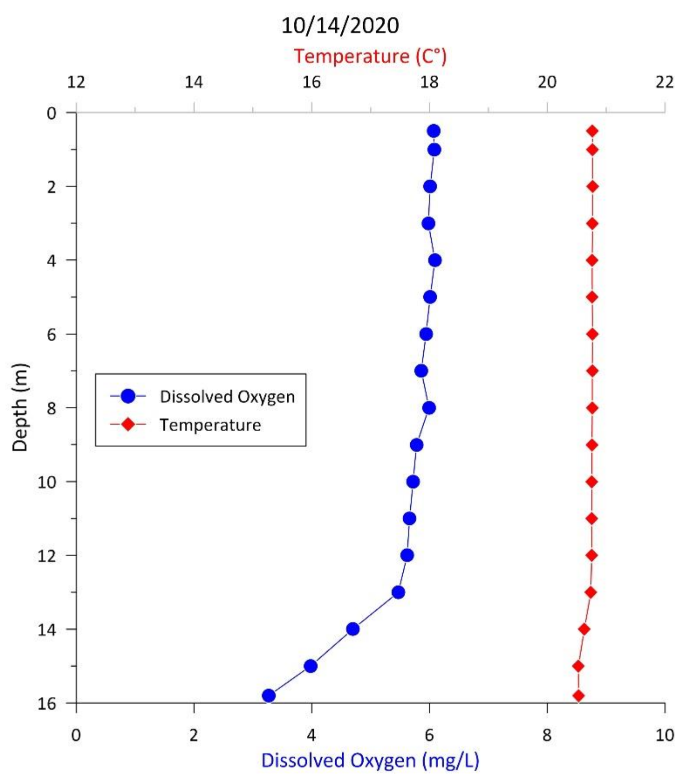
2
4
6
8
10
12
14
16
Dissolved Oxygen
Temperature
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

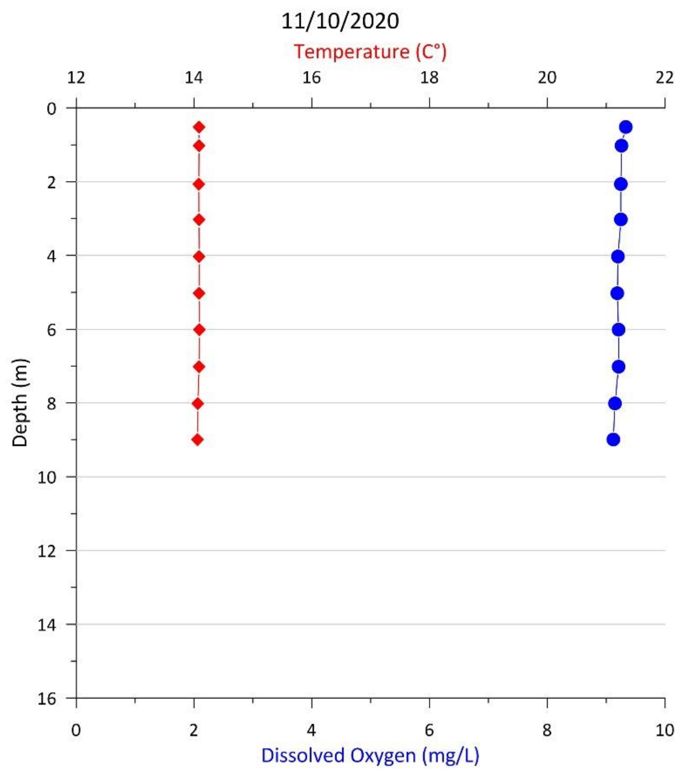

8/12/2020
Temperature (C°)
16
18
20
22
24
26
28
30
32
Depth (m)
0
2
4
6
8
10
12
14
16
Dissolved Oxygen
Temperature
Epilimnion
Metalimnion
Hypolimnion
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)

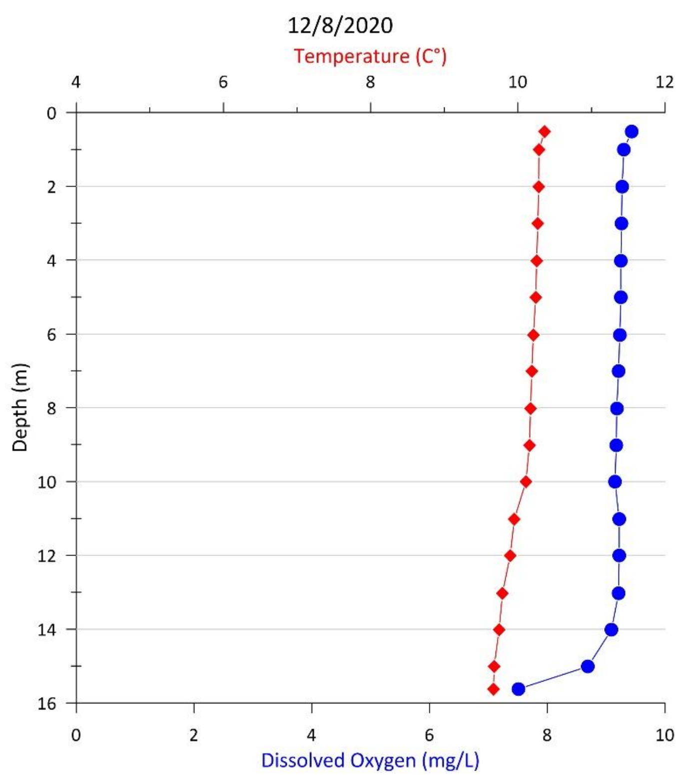

8/26/2020
Temperature (C°)
16 18 20 22 24 26 28 30 32
Depth (m)
0 2 4 6 8 10 12 14 16
0 2 4 6 8 10 12
Dissolved Oxygen (mg/L)

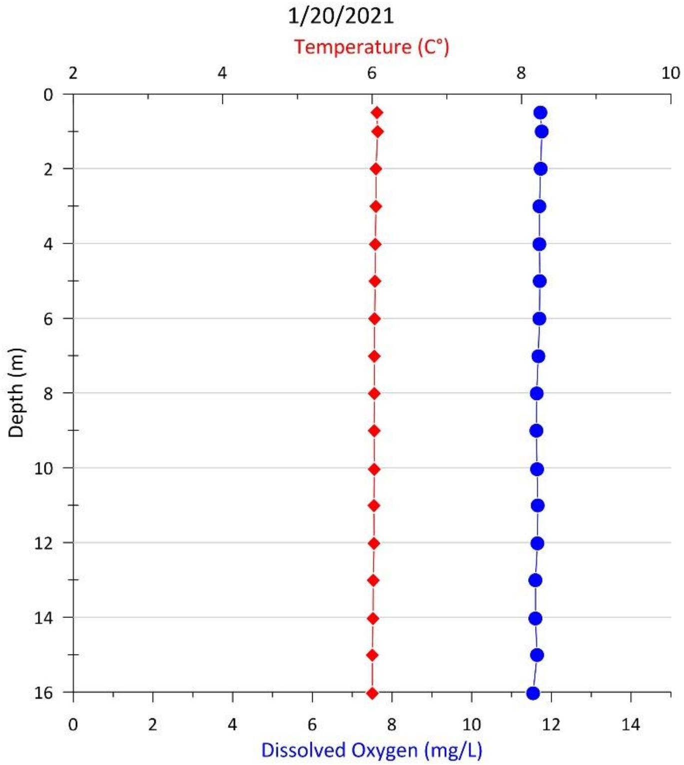

9/16/2020
Temperature (C°)
12 14 16 18 20 22 24 26 28 30
Depth (m)
0 2 4 6 8 10 12 14 16
0 2 4 6 8 10 12
Dissolved Oxygen (mg/L)


9/30/2020
Temperature (C°)
16
18
20
22
24
0
2
4
6
8
10
12
14
16
Depth (m)
0
4
8
12
Dissolved Oxygen (mg/L)


10/14/2020
Temperature (C°)
12
14
16
18
20
22
0
2
4
6
8
10
12
14
16
Depth (m)
Dissolved Oxygen
Temperature
0
2
4
6
8
10
Dissolved Oxygen (mg/L)

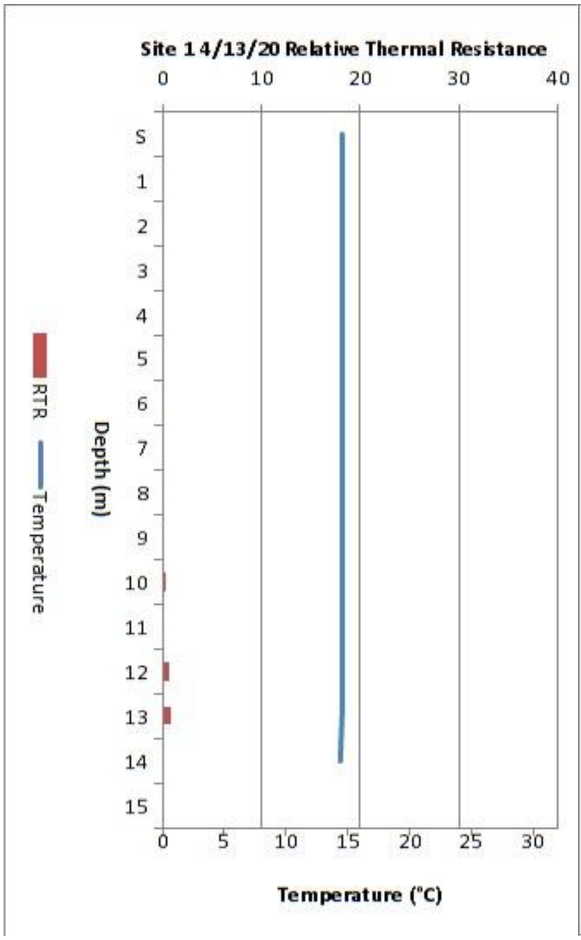

11/10/2020
Temperature (C°)
12
14
16
18
20
22
Depth (m)
0
2
4
6
8
10
12
14
16
0
2
4
6
8
10
Dissolved Oxygen (mg/L)

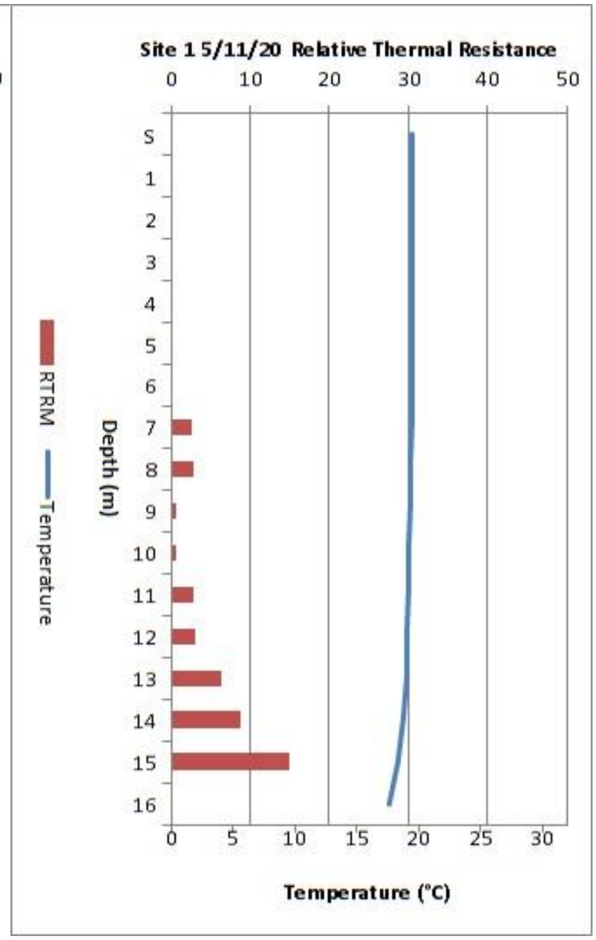

12/8/2020
Temperature (C°)
4
6
8
10
12
Depth (m)
0
2
4
6
8
10
12
14
16
0
2
4
6
8
10
Dissolved Oxygen (mg/L)

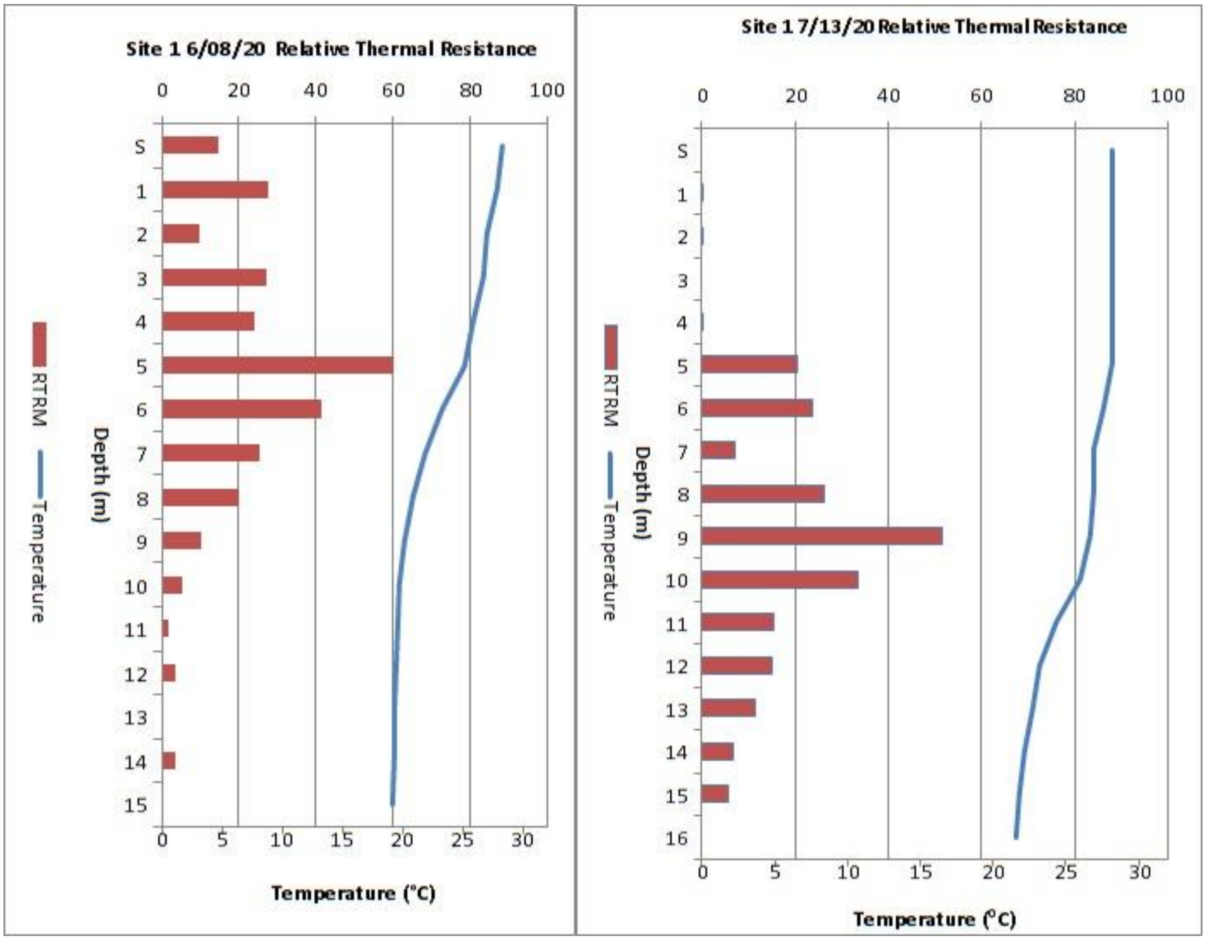


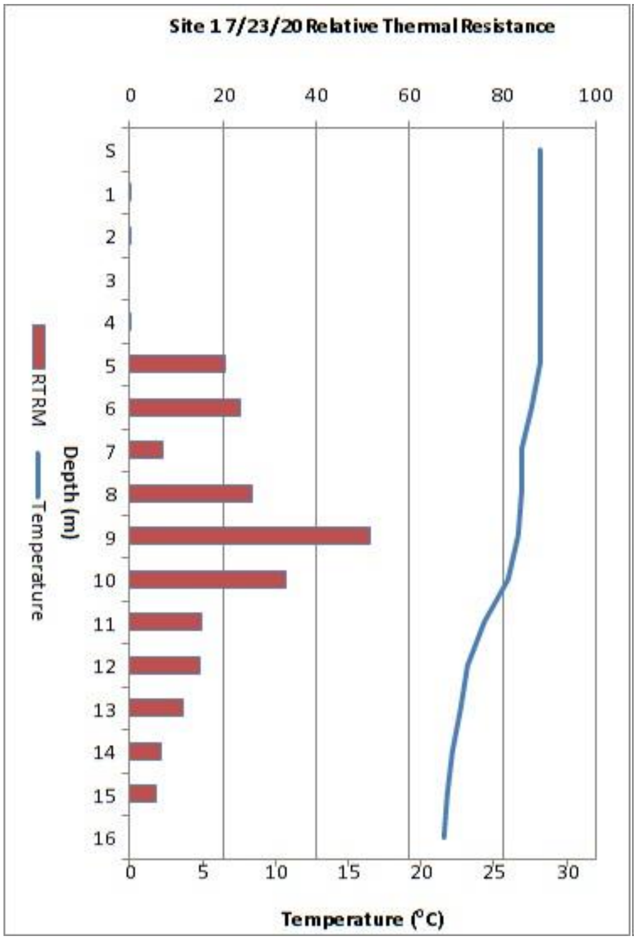
1/20/2021
Temperature (C°)
2
4
6
8
10
Depth (m)
0
2
4
6
8
10
12
14
16
0
2
4
6
8
10
12
14
Dissolved Oxygen (mg/L)

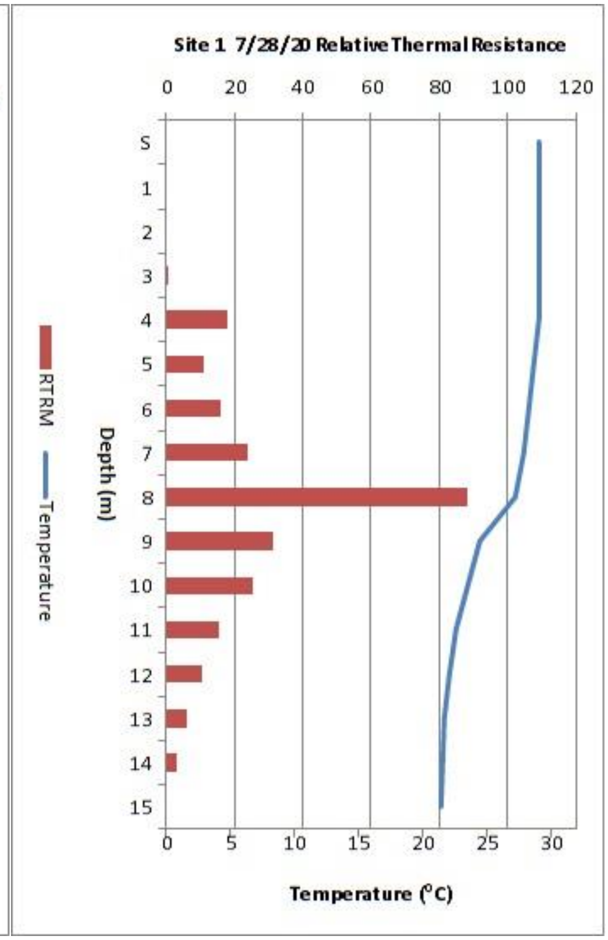
Appendix C
Relative Thermal Resistance Plots

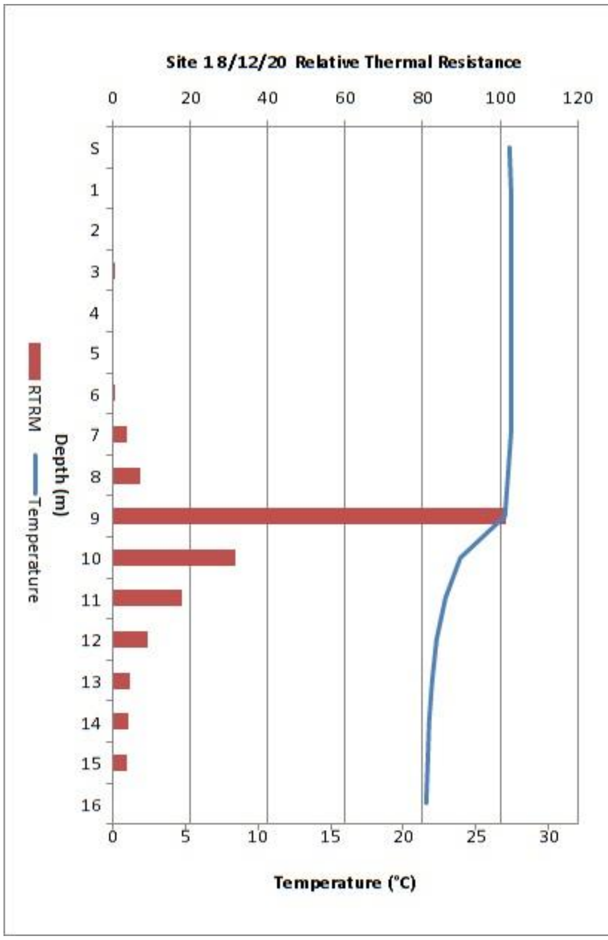


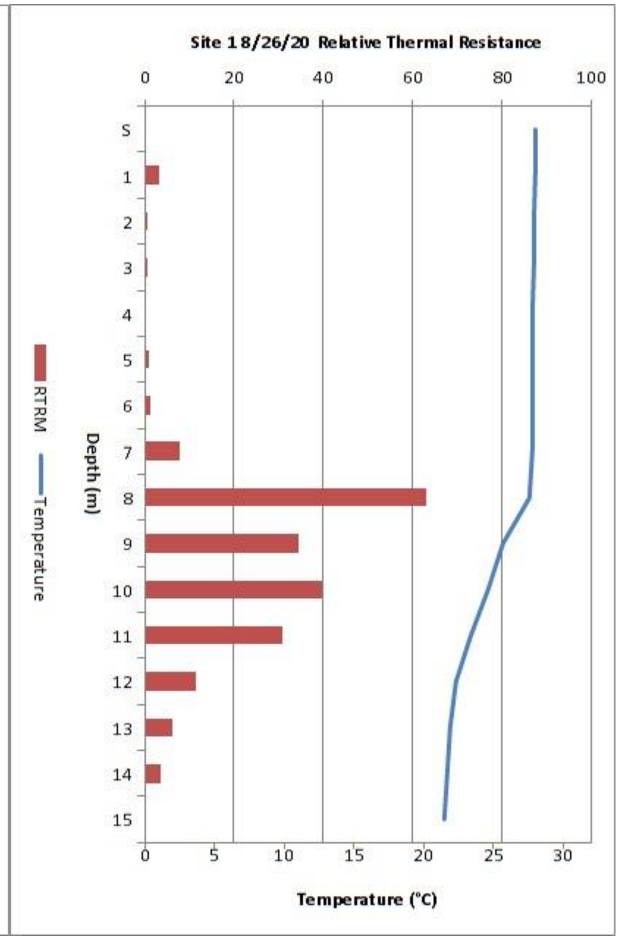


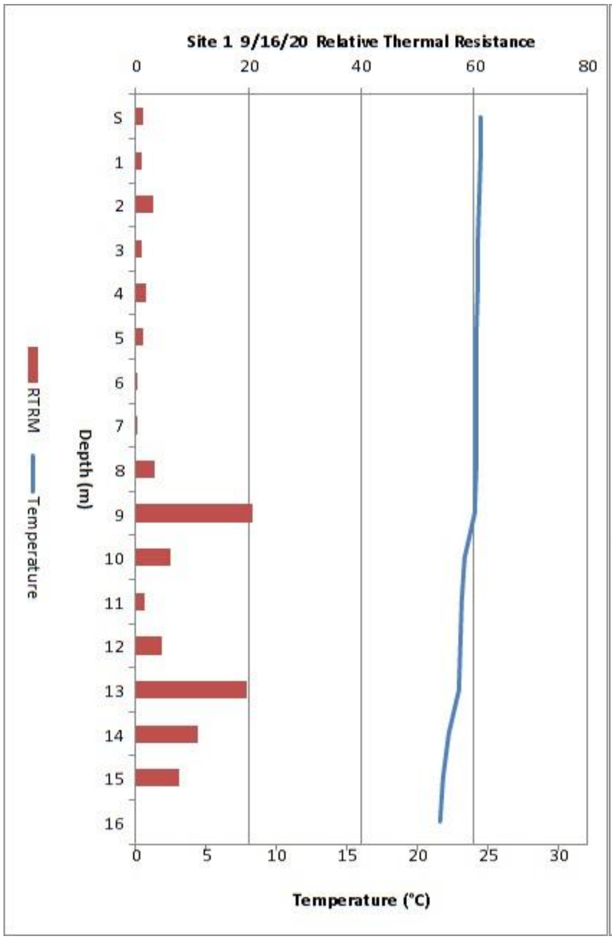

Site 1 6/08/20 Relative Thermal Resistance
0
20
40
60
80
100
S
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
5
10
15
20
25
30
Depth (m)
Temperature (°C)
RTRM
Temperature
Site 1 7/13/20 Relative Thermal Resistance
0
20
40
60
80
100
S
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
0
5
10
15
20
25
30
Depth (m)
Temperature (°C)
RTRM
Temperature

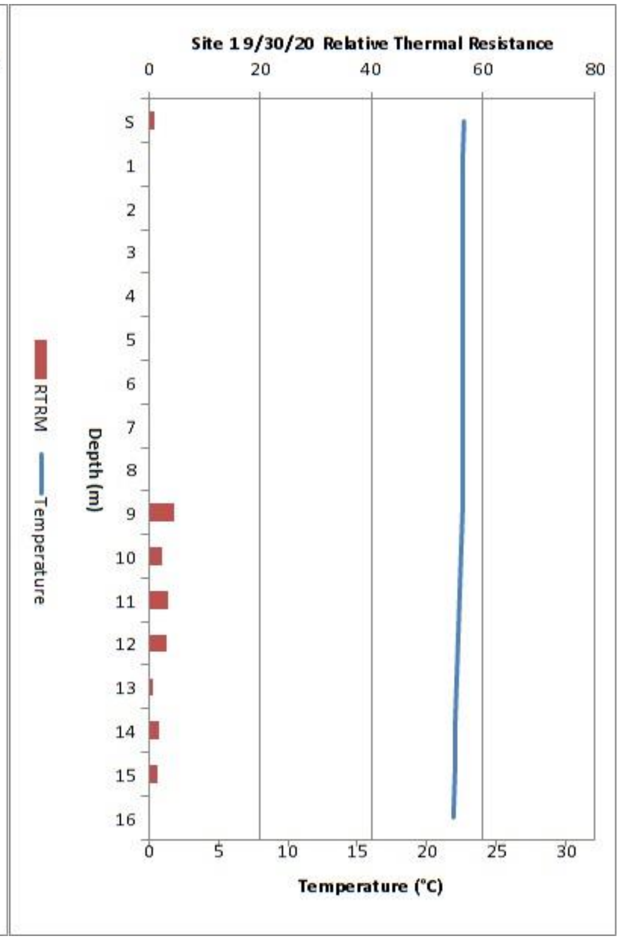

Site 1 7/23/20 Relative Thermal Resistance
RTRM
Temperature
Depth (m)
Temperature (°C)

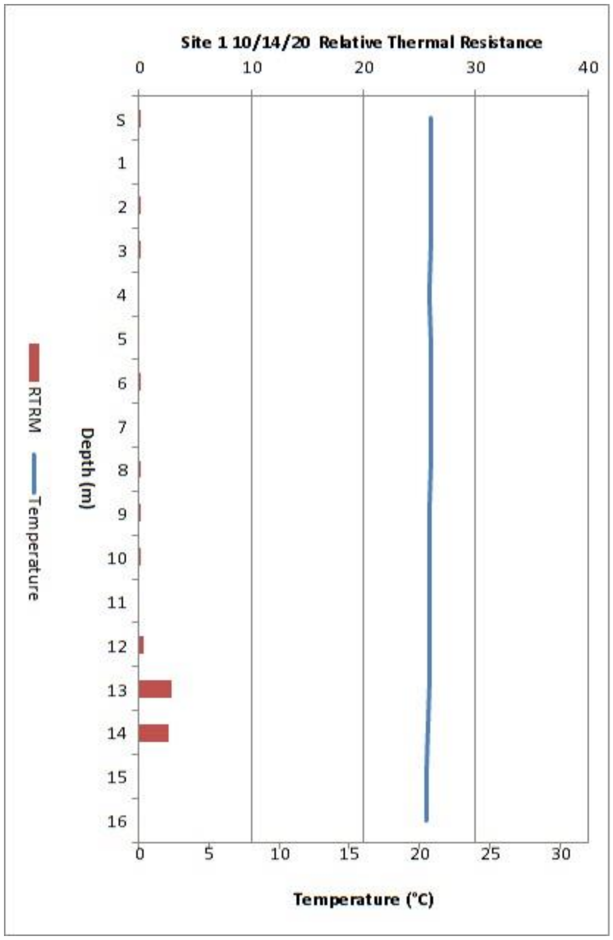

Site 1 7/28/20 Relative Thermal Resistance
RTRM
Temperature
Depth (m)
Temperature (°C)


Site 1 8/12/20 Relative Thermal Resistance
0 20 40 60 80 100 120
S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Depth (m)
RTRM
Temperature
0 5 10 15 20 25 30
Temperature (°C)


Site 1 8/26/20 Relative Thermal Resistance
0 20 40 60 80 100
S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Depth (m)
RTRM
Temperature
0 5 10 15 20 25 30
Temperature (°C)


Site 1 9/16/20 Relative Thermal Resistance
RTRM
Temperature
Depth (m)
Temperature (°C)
S
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
0
20
40
60
80
0
5
10
15
20
25
30


Site 1 9/30/20 Relative Thermal Resistance
RTRM
Temperature
Depth (m)
Temperature (°C)
S
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
0
20
40
60
80
0
5
10
15
20
25
30


Site 1 10/14/20 Relative Thermal Resistance
0
10
20
30
40
S
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Depth (m)
RTRM
Temperature
0
5
10
15
20
25
30
Temperature (°C)

Item D.3.

MINUTES OF REGULAR BOARD MEETING

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

Thursday, September 2, 2021

6:30 P.M.

Location: 12500 Alameda Dr, Norman, OK 73026

A. Call to Order

President Amanda Nairn called the meeting to Order at 6:30 pm.

Roll Call:
Board Members Present:
President Amanda Nairn
Vice President Casey Hurt
Treasurer Jann Knotts
Secretary Michael Dean
Board Member Kevin Anders
Board Members Absent:
William Janacek
Roger Frech

Staff Present:
Kyle Arthur, General Manager
Kelley Metcalf, Office Manager
Tim Carr, Operations & Maintenance Supervisor

Others Present:
Collins Balcome
Anna Hoag
Mark Roberts
Chris Mattingly
Alan Swartz

Virtually:
William Janacek
Don Maisch
James Allard
Matthew Warren
Geri Wellborn

B. Statement of compliance with Open Meeting Act

Kelley Metcalf, Office Manager, stated the notice of the monthly board meeting had been posted in compliance with the Open Meeting Act.

C. Administrative

C.1. Status report of the Del City Pipeline Project from Alan Plummer Associates, Inc. (Alan Swartz, Oklahoma Area Leader)

Alan Swartz reported:

- The record drawings are done
- Working thru the final pay application with the contractor
- Negotiating costs associated with weather delays
- Work is complete!

C.2. Presentation of initial Yield Model results and next steps for the Norman Project

Mr. Arthur introduced the Bureau of Reclamation guests. James Allard and Matthew Warren attended the meeting virtually. Collins Balcome and Anna Hoag attended in person. Mr. Balcombe thanked Mr. Arthur for inviting them and taking the reins on this project. Mr. Balcombe stated that the hope is to inform decision making and improve drought resiliency for the District. Mr. Arthur stated that the 3 cities have seen the presentation, although there have been some new additions made, particularly the next steps. Those include some of the things that are planned to help better inform our management of the water supply in Lake Thunderbird and it is a work in progress.

As a matter of background at the beginning of the presentation, Mr. Arthur stated he was approached by Chris Mattingly, City of Norman, not long after arriving in the General Manager's position with a long-standing question regarding the firm yield of Lake Thunderbird. Mr. Arthur consulted with the Bureau of Reclamation and requested that the Norman Project be put on the priority list for evaluation. Mr. Arthur thanked the Bureau of Reclamation for doing just that and for the quick delivery of the initial modeling results.

Please see the presentation included in the Board packet for more detailed information. Mr. Arthur stated that the actual firm yield of the reservoir itself was never originally calculated. What was calculated, however, was a "conjunctive" firm yield of approximately 21,500 ac-ft which included not only the reservoir, but also the available supply from the three cities' groundwater wells at the time. Since then, while the cities manage their supply sources conjunctively, COMCD's management of deliveries from the lake does not directly take into account the groundwater supplies. The District has a water right from the reservoir for 21,600 ac-ft (no one knows where that exact number came from) and currently manages deliveries using that volume. The expectation of the member cities has been that this volume will be routinely available unless drought conditions limit it.

Two model scenarios were run: (1) permit availability and (2) firm yield. The permit availability result showed that the 21,600 ac-ft could have been delivered in 89% of years and 96% of months over the historical period of record. There would have been 10 years where that volume was not deliverable. The second scenario showed a firm yield of 12,700 ac-ft driven by the drought of record in the 1950s.

Mr. Arthur then discussed the path forward given these results. He stated that his recommendation and intent is to continue to manage water deliveries around the permit number of 21,600 ac-ft because the results show that in most years, at least in the past, that would have been deliverable. Furthermore, in most years, if the District limited deliveries to the firm yield, there would be tremendous volumes of water not put to beneficial use each year. He believes we should maximize use when it is there. However, we should be prepared for how we will respond to years when there are shortages—and that will be the focus of the upcoming work.

The intent is to seek at least two grants from BOR to do four major tasks: (1) determine risk exposure, (2) evaluate risk tolerance, (3) perform drought preparedness planning and finally (4) develop a drought response plan. The vision is to create a tool that will inform the development of lake level triggers which, when combined with short term forecasts, will help to stretch and preserve to the greatest extent possible existing supplies during times of drought.

Mr. Arthur stated that the Partner Advisory Group, including the District, BOR and the cities, will continue to provide input and engagement to upcoming work.

C.3. <u>Report of FY 2021 Budget results and projection for FY 2022</u>

Please see document titled "FY 2021 Year-end budget vs. actual in the packet.

Mr. Arthur stated the FY 20-21 O&M budget was $1,258,565.00. Expenditures were $981,073.51. Costs associated with several categories were under budget, such as personnel, professional, maintenance, administrative, and purchasing of assets. Mr. Arthur gave a few examples of why there were certain categories under budget, for example the resignation of an employee during the year and a change in billing frequency for workers comp created a surplus in the Personnel category, not operating the SDOX unit created a surplus in the Water Quality category and being more prudent about necessary expenditures significantly saved in the Maintenance category.

Mr. Arthur then presented information on the forecast through FY 2022. He reminded the Board that in November 2020, a Budgeting Policy was passed to establish a process by which any carryover, or lack thereof, is considered when determining the O&M assessments to each member city annually. "Carryover funds" refer to those monies that are forecasted to be remaining in the operating accounts at the close of the current fiscal year. The policy states that operating accounts total balance carryover shall be maintained between $750,000 and $1,250,000. FY 20-21 the carryover was $1.6 million. In the future, if that is the case, the assessment to the 3 cities would be decreased. President Nairn mentioned that in the last 2 years the District had several expenses that were not assessed to the cities.

Mr. Arthur pointed out 4 items on the projected expenses for FY 22.

1. Additional Del City Pipeline costs of approximately $115,000 beyond the original Matthews contract and corresponding OWRB loan amount. This is due to weather related issues on the project. Mr. Arthur stated that the District could have borrowed more money than the $5.6 million contract, but the Board chose to only borrow the actual amount. Therefore, Board approval of additional expenditures will be sought. Negotiations are currently being held as to the final additional cost. This issue will be on a future board meeting agenda for the board to vote on.

2. Retirement contribution adjustment for $20,500. Mr. Arthur explained the Defined Benefit Plan is over funded, therefore for FY 22 the District will not be contributing. However, on the Customized Manager Option, the District still must match 15%. The $20,500 was missed during the development of this year's budget. However, it will not result in an increased assessment to the member cities; the District will pay for it out of surplus funds.

3. Worker's Comp adjustment. There was a billing change within the work comp company. The District was previously invoiced annually, in April, and somehow the District's billing frequency was changed to monthly. This occurrence made the "timing" off, therefore $11,000 will not be included in the FY 20-21 expenses, but rather in the FY 2022 budget.

4. Possible new hire. The District has had 2 employees out for several weeks. One employee with his own health issues and the other with a son that is very ill. Both are eligible for retirement. Mr. Arthur stated he is trying to be proactive and should the decision to hire a new employee be reached, he would seek Board approval. Mr. Carr, (District supervisor) is currently working on a job description.

In conclusion, Mr. Arthur stated that the current forecast is to have approximately $900,000 in carryover at the end of FY 2022 which is in line with the Budgeting Policy target guidelines of desired carryover.

Mr. Arthur informed the Board that the District is now invoicing the member cities monthly vs. quarterly. By doing this it provides more steady cash flow.

Mr. Arthur stated he and Treasurer Knotts spoke about taking some of the operating account balance and moving it into a money market to earn a better interest rate. The District's bank will be sending the paperwork to start this process.

Mr. Dean, at the August meeting, had inquired if the District uses a positive pay system with the bank. Mr. Arthur spoke to Treasurer Knotts, and she supports the District using this service. It is a check writing and ACH fraud protection service. The cost is nominal, $80 set up fee, and approximately $50.00 a month. The District's bank will be sending the paperwork to start the service soon.

D. Action**:** PURSUANT TO 82 OKLA. STATUTES, SECTION 541 (D) (10), THE BOARD OF DIRECTORS SHALL PERFORM OFFICIAL ACTIONS BY RESOLUTION AND ALL OFFICIAL ACTIONS INCLUDING FINAL PASSAGE AND ENACTMENT OF ALL RESOLUTIONS MUST BE APPROVED BY A MAJORITY OF THE BOARD OF DIRECTORS PRESENT, A QUORUM BEING PRESENT, AT A REGULAR OR SPECIAL MEETING. THE FOLLOWING ITEMS MAY BE DISCUSSED, CONSIDERED AND APPROVED, DISAPPROVED, AMENDED, TABLED OR OTHER ACTION TAKEN:

D.4. Minutes of the Regular Board Meeting held on Thursday, July 15, 2021, and corresponding Resolution
Treasure Knotts asked for permission to move this item to follow item # D.6. With no objection President Nairn postponed D.4. to follow D.6.

D.5. Financial statements for operating accounts for June 2021, and corresponding Resolution
Treasurer Knotts pointed out June 2021 is the end of the fiscal year. The Del City Pipeline project expense increased by $51,220.36. Mr. Swartz stated there will be one more payout for approximately $16,000.00.

Finding the financial statement in good order as presented, Jann Knotts made a motion seconded by Casey Hurt to approve the Resolution.

Roll call vote:

President Amanda Nairn	Yes
Vice President Casey Hurt	Yes
Treasurer Jann Knotts	Yes
Secretary Michael Dean	Yes
Member William Janacek	Absent
Member Roger Frech	Absent
Member Kevin Anders	Yes

Motion Passed

D.6. Financial statements for operating accounts for July 2021, and corresponding Resolution

Finding the financial statement in good order as presented, Jann Knotts made a motion seconded by Kevin Anders to approve the Resolution.

Roll call vote:

President Amanda Nairn	Yes
Vice President Casey Hurt	Yes
Treasurer Jann Knotts	Yes
Secretary Michael Dean	Yes
Member William Janacek	Absent
Member Roger Frech	Absent
Member Kevin Anders	Yes

Motion Passed

D.4. (postponed from earlier) Minutes of the Regular Board Meeting held on Thursday, July 15, 2021, and corresponding Resolution

The minutes were reviewed and finding those in good order as presented, Michael Dean made a motion seconded by Kevin Anders to approve the Resolution.

Roll call vote:

President Amanda Nairn	Yes
Vice President Casey Hurt	Abstain
Treasurer Jann Knotts	Yes
Secretary Michael Dean	Yes
Member William Janacek	Absent
Member Roger Frech	Absent
Member Kevin Anders	Yes

Motion Passed

E. Discussion

E.7. Legal Counsel's Report

July 15 Attended monthly meeting of COMCD board

July 19 Confirm with Kyle, General Manager, that termination date for temporary water use contracts with member cities coincides with termination date of USBOR contract with COMCD

July 27 Conference call with Alan Swart, Amanda Nairn and Kyle Arthur about the Del City Pipeline Project additional costs claims from Aegion and Matthews Trenching

July 27 Conference call with Krystina Phillips, attorney for Arbuckle Master Conservancy District (manager Steven Jolly) about position taken by Oklahoma Water Resources Board filed in a case involving stream water permits and interference

July 28 Review copy of Matthews Trenching contract

Aug 23 Confirm with Kyle Arthur that the COMCD can mandate masks for public meetings

Aug 26 Draft resolution about change order for Del City Pipeline Project additional cost claims

Aug 27 Draft Legal Counsel report

Mr. Dean inquired if the District owes for the additional costs associated with the weather delays, on the Del City Pipeline Project. Mr. Couch stated discussions and negotiations are being held about the contract and the contract language and acts of God, and how that ties in and to what extent.

President Nairn requested that a written detailed explanation be given to the Board at the next meeting. Mr. Arthur stated it was originally planned to be on the agenda at this meeting, but he caught a technicality that needs to be addressed.

E.8. General Manager's Report
Please see document titled "Manager's Report" in the packet.

E.9. President's report

- President Nairn invited all to sign a card for the James Neyman family. Mr. Neyman is an employee at the District and his son is very ill.

- President Nairn, recently, introduced Scott Martin to Mr. Arthur. Mr. Martin is the City of Norman Chamber of Commerce President. The Chamber has spoke about enhancements at Lake Thunderbird. President Nairn requested that the Chamber keep the other two cities in the loop on all future plans. Mr. Arthur provided Mr. Martin with Midwest City's and Del City's City Manager contact information.

- President Nairn stated the final Wetlands Project presentation is scheduled to be presented at the next board meeting. As soon as the presentation is available it will be emailed prior to the board meeting.

- The fish fry, that was supposed to take place on October 14th, will be postponed, due to the Delta variant. The hope is to reschedule the event soon.

E.10. New business (any matter not known prior to the meeting, and which could not have been reasonably foreseen prior to the posting of the agenda) None

F. Adjourn

There being no further business, President Nairn adjourned the meeting at 9:07 P.M.

Resolution

OF

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

REGARDING OFFICIAL ACTION

WHEREAS, a quorum of the Board of Directors of the Central Oklahoma Master Conservancy District met in a regular meeting and considered approval of minutes of a previous meeting.

IT IS HEREBY RESOLVED that minutes of the regular board meeting held on September 2, 2021 are approved.

APPROVED by a majority of Board members present on this 7th day of October, 2021.

Item D.4.

09/17/21

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

Balance Sheet

As of August 31, 2021

	Aug 31, 21	Jul 31, 21	$ Change
ASSETS			
Current Assets			
Checking/Savings			
1023-BANCFIRST #3940 & #0014	1,974,608.69	1,690,312.70	284,295.99
1050-LPL FINANCIAL			
1051-LPL ACCT# -2885 AT MARKET	4,346,340.67	4,352,458.64	-6,117.97
1052-LPL ACCRUED INTEREST	26,559.22	28,631.01	-2,071.79
Total 1050-LPL FINANCIAL	4,372,899.89	4,381,089.65	-8,189.76
Total Checking/Savings	6,347,508.58	6,071,402.35	276,106.23
Accounts Receivable			
1800-GRANTS RECEIVABLE	32,500.12	32,500.12	0.00
1900-ASSESSMENTS RECEIVABLE			
1901-DEL CITY			
1902-OPERATIONS AND MAINTENANCE	146,007.01	146,007.01	0.00
1903-POWER	65,625.00	65,625.00	0.00
Total 1901-DEL CITY	211,632.01	211,632.01	0.00
1905-MIDWEST CITY			
1906-OPERATIONS AND MAINTENANCE	311,111.96	373,334.36	-62,222.40
1907-POWER	220,500.00	264,600.00	-44,100.00
Total 1905-MIDWEST CITY	531,611.96	637,934.36	-106,322.40
1909-NORMAN			
1910-OPERATIONS AND MAINTENANCE	337,294.67	542,566.47	-205,271.80
1911-POWER	162,312.50	254,904.71	-92,592.21
Total 1909-NORMAN	499,607.17	797,471.18	-297,864.01
Total 1900-ASSESSMENTS RECEIVABLE	1,242,851.14	1,647,037.55	-404,186.41
Total Accounts Receivable	1,275,351.26	1,679,537.67	-404,186.41
Other Current Assets			
1920-(BANCFIRST)-DWSRF ESCROW	40,724.41	32,627.69	8,096.72
1951-DWSRF REPYMT DUE-CURRENT	48,926.37	56,792.58	-7,866.21
Total Other Current Assets	89,650.78	89,420.27	230.51
Total Current Assets	7,712,510.62	7,840,360.29	-127,849.67
Fixed Assets			
2000-WATER SUPPLY ASSETS			
BUILDING AND STRUCTURES	54,811.23	54,811.23	0.00
DAM AND RESERVOIR	4,605,177.00	4,605,177.00	0.00
EQUIPMENT AND FENCE	31,209.74	31,209.74	0.00
NEW DEL CITY PIPELINE	6,515,293.90	6,508,313.90	6,980.00
PIPELINE	3,402,225.92	3,402,225.92	0.00
PUMPING PLANT	1,593,951.30	1,593,951.30	0.00
Total 2000-WATER SUPPLY ASSETS	16,202,669.09	16,195,689.09	6,980.00
2010-TRANSFERRED FROM BUREC			
OFFICE FURNITURE & FIXTURES	1,326.00	1,326.00	0.00
SHOP TOOLS	853.00	853.00	0.00
Total 2010-TRANSFERRED FROM BUREC	2,179.00	2,179.00	0.00
2020-OTHER PURCHASED ASSETS			
BUILDINGS,STRUCTURES & ROADS	2,065,006.87	2,065,006.87	0.00
OFFICE EQUIPMENT	92,029.88	92,029.88	0.00
PLANT AND DAM EQUIPMENT	5,485,457.89	5,469,764.01	15,693.88
VEHICLES AND BOATS	648,942.23	648,942.23	0.00
Total 2020-OTHER PURCHASED ASSETS	8,291,436.87	8,275,742.99	15,693.88
2030-ALLOWANCE FOR DEPRECIATION	-9,671,350.08	-9,636,245.20	-35,104.88
Total Fixed Assets	14,824,934.88	14,837,365.88	-12,431.00
Other Assets			
DEBT ISSUANCE COSTS	44,777.00	44,777.00	0.00
DWSRF REPAYMENTS-NONCURRENT	426,318.36	426,318.36	0.00
NET PENSION ASSET	266,750.00	266,750.00	0.00
Total Other Assets	737,845.36	737,845.36	0.00
TOTAL ASSETS	**23,275,290.86**	**23,415,571.53**	**-140,280.67**

ACCOUNTANT'S NOTES

- Boat dock rent received for the month was $1,200.00

Del City pipeline costs for the month were $6,980.00
Year to date Del City pipeline costs are $7,480.00

Other fixed asset acquisitions during the month:

Additional generator costs $15,693.68

Year to date other fixed asset acquistions total $16,779.51

The preparer of these statements is not a "public accountant", and they are not intended for third party reliance.

09/17/21

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

Balance Sheet

As of August 31, 2021

	Aug 31, 21	Jul 31, 21	$ Change
LIABILITIES & EQUITY			
Liabilities			
Current Liabilities			
Other Current Liabilities			
4000.1-DEFERRED PENSION COSTS	25,963.85	25,963.85	0.00
4000.2-MISC PENSION PAYABLES	3,717.38	3,717 38	0.00
4002-DWSRF INTEREST PAYABLE	26,001.40	26,001.40	0.00
4005-ACCRUED PAYROLL	10,631.51	0.00	10,631.51
4009-FYE ACCRUALS	15,774.24	15,774.24	0.00
4010-PAYROLL DEDUCTIONS			
4011.1-SOCIAL SECURITY PAYABLE	1,504.39	333.78	1,170.61
4011.2-MEDICARE PAYABLE	351.84	78.06	273.78
4012-FWIT PAYABLE	2,956.00	0.00	2,956.00
4013-OWIT PAYABLE	941.00	0.00	941.00
4014-RETIREMENT PLAN PAYABLE	3,910.29	3,194.33	715.96
4016-GROUP INSURANCE PAYABLE	506.60	506.60	0.00
Total 4010-PAYROLL DEDUCTIONS	10,170.12	4,112.77	6,057 35
4017-COMPENSATED ABSENCES	31,975.65	31,975.65	0.00
4019-CONTRACTS-DUE W/I 1 YEAR			
4019.3-DWSRF CURRENT PYMTS	94,484.00	94,484.00	0.00
Total 4019-CONTRACTS-DUE W/I 1 YEAR	94,484.00	94,484.00	0.00
Total Other Current Liabilities	218,718.15	202,029.29	16,688.86
Total Current Liabilities	218,718.15	202,029.29	16,688.86
Long Term Liabilities			
4020-CONTRACTS PAYABLE			
4055-DWSRF PAYMENTS			
4075-SUBSEQUENT PAYMENTS	426,318.36	426,318.36	0.00
Total 4055-DWSRF PAYMENTS	426,318.36	426,318.36	0.00
4080-NEW DEL CITY PIPELINE LOAN	5,276,633.88	5,239,920.08	36,713.80
Total 4020-CONTRACTS PAYABLE	5,702,952.24	5,666,238.44	36,713.80
Total Long Term Liabilities	5,702,952.24	5,666,238.44	36,713.80
Total Liabilities	5,921,670.39	5,868,267.73	53,402.66
Equity			
4802-BOR MANDATED MAINTRESERVE	50,000.00	50,000.00	0.00
4803-RESTRICTED-CAP IMPRVEMENTS	400,000.00	400,000.00	0.00
4806.5 UNRESTRICTED SURPLUS			
4807-UNRESTRICTED SURPLUS	15,768,412.35	15,768,412.35	0.00
Total 4806.5 UNRESTRICTED SURPLUS	15,768,412 35	15,768,412.35	0.00
Retained Earnings	-9,209.25	-9,209.25	0.00
Net Income	1,144,417.37	1,338,100.70	-193,683.33
Total Equity	17,353,620.47	17,547,303.80	-193,683.33
TOTAL LIABILITIES & EQUITY	**23,275,290.86**	**23,415,571.53**	**-140,280.67**

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09/17/21

Accrual Basis

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

BANCFIRST #3940 & # 0014 ACTIVITY

August 2021

Type	Date	Num	Name	Memo	Split	Amount	Balance
1023-BANCFIRST #3940 & #0014							
Bill Pmt -Check	8/3/2021		CompSource Mutual	inv # 1023342297	4000-CURRENT CLAIMS PA..	-7,946.45	-7,946.45
Bill Pmt -Check	8/9/2021		City of Norman Utility Division	acct 416325-057566	4000-CURRENT CLAIMS PA...	-97.77	-8,044.22
Bill Pmt -Check	8/9/2021		Dobson Fiber	27354	4000-CURRENT CLAIMS PA..	-273.64	-8,317.86
Bill Pmt -Check	8/9/2021		Cardmember Service **	XXXX XXXX XXXX 2834 (Tim)	4000-CURRENT CLAIMS PA..	-377 77	-8,695.63
Bill Pmt -Check	8/10/2021		American Fidelity (FSA)	MCP 98957 inv# 6009553	4000-CURRENT CLAIMS PA..	-380.00	-9,075.63
Bill Pmt -Check	8/10/2021		American Fidelity Assurance	customer # 98957 Inv D346573	4000-CURRENT CLAIMS PA...	-687.20	-9,762.83
Bill Pmt -Check	8/11/2021		LOCKE SUPPLY	25783	4000-CURRENT CLAIMS PA..	-59.82	-9,822.65
Bill Pmt -Check	8/10/2021		O.G. & E.	129423800-9	4000-CURRENT CLAIMS PA..	-32 14	-9,854.79
Bill Pmt -Check	8/10/2021		LOWE'S HOME CENTERS. INC.	99000263634	4000-CURRENT CLAIMS PA...	-18 55	-9,873.34
Bill Pmt -Check	8/10/2021		OEC Fiber	7005868200	4000-CURRENT CLAIMS PA...	-125.00	-9,998.34
Bill Pmt -Check	8/9/2021		Cardmember Service **	XXXX XXXX XXXX 6008 (Kyle)	4000-CURRENT CLAIMS PA .	-6,794.60	-16,792.94
Bill Pmt -Check	8/11/2021		Velocigo Inc	3356	4000-CURRENT CLAIMS PA.	-969.52	-17,762.46
Bill Pmt -Check	8/18/2021		OEC	930305800	4000-CURRENT CLAIMS PA...	-86.00	-17,848.46
Bill Pmt -Check	8/18/2021		Texas Life Insurance Company	Inv # SM0E0N20210714001	4000-CURRENT CLAIMS PA..	-57.28	-17,905.74
Bill Pmt -Check	8/18/2021		John Deere Financial	11112-28103	4000-CURRENT CLAIMS PA...	-536 33	-18,442.07
Bill Pmt -Check	8/18/2021		AT & T MOBILITY		4000-CURRENT CLAIMS PA.	-325.79	-18,767.86
Check	8/24/2021		DCM Internet		5201-TELEPHONE,PAGING...	-75.00	-18,842.86
Check	8/23/2021		Bank charge		5401-OFFICE SUPPLIES, M..	-127.12	-18,969.98
Deposit	8/31/2021			Deposit	4923-INVEST INT DIVS & G...	1.27	-18,968.71
Deposit	8/26/2021			boat dock rent	4921-MISCELLANEOUS RE...	600.00	-18,368.71
Transfer	8/10/2021			Funds Transfer	1920-(BANCFIRST)-DWSRF..	-8,096.72	-26,465.43
Check	8/13/2021		OKLAHOMA TAX COMMISSION		4013-OWIT PAYABLE	-616.00	-27,081.43
Check	8/13/2021		BANCFIIRST		-SPLIT-	-5,049.11	-32,130.54
Check	8/13/2021		NET PAYROLL		-SPLIT-	-10,631.51	-42,762.05
Payment	8/17/2021		NORMAN		1910-OPERATIONS AND M...	137,812.86	95,050.81
Payment	8/17/2021		NORMAN		1911-POWER	60.129.71	155,180.52
Transfer	8/9/2021			MWC	4080-NEW DEL CITY PIPEL. .	14,832.38	170,012.90
Deposit	8/13/2021			BOAT DOCK RENT	4921-MISCELLANEOUS RE...	600.00	170,612.90
Deposit	8/18/2021			Deposit	-SPLIT-	7,967.24	178,580.14
Deposit	8/10/2021			Deposit	-SPLIT-	22,052.56	200,632.70
Payment	8/20/2021		MIDWEST CITY		1906-OPERATIONS AND M...	62,222.40	262,855.10
Payment	8/20/2021		MIDWEST CITY		1907-POWER	22,991.92	285,847.02
Payment	8/24/2021		NORMAN		1910-OPERATIONS AND M...	67,458.94	353,305.96
Payment	8/24/2021		NORMAN		1911-POWER	26,155.99	379,461.95
Deposit	8/31/2021			Deposit-ok to here	4923-INVEST INT DIVS & G...	27.44	379,489.39
Check	8/2/2021		SWEEP CHARGE		5401-OFFICE SUPPLIES, M...	-326.80	379,162.59
Deposit	8/2/2021			SWEEP FEE REBATE	5401-OFFICE SUPPLIES, M...	326.80	379,489.39
Deposit	8/23/2021			SVC CHARGE REFUND	5401-OFFICE SUPPLIES, M .	60.30	379,549.69
Check	8/31/2021	39			1051-LPL ACCT# -2885 AT ...	12,746.07	392,295.76
Bill Pmt -Check	8/11/2021	20351	Alan Plummer Associates, Inc	1703-004-03 inv # 49186	4000-CURRENT CLAIMS PA...	-6,980.00	385,315.76
Bill Pmt -Check	8/11/2021	20352	OKLA STATE &EDUCATION EMPL. GROU...	GR# 100914 Div # 0759	4000-CURRENT CLAIMS PA..	-3,511.26	381,804.50
Bill Pmt -Check	8/11/2021	20353	Ace of Norman	700031	4000-CURRENT CLAIMS PA .	-50.63	381,753.87
Bill Pmt -Check	8/11/2021	20354	Catalyst Mechanical & Electrical, LLC	Inv # 2830	4000-CURRENT CLAIMS PA.	-2,170.00	379,583.87
Check	8/11/2021	20355	OKLAHOMA WATER RESOURCES BOARD		5603-WATER QUALITY MO..	-7,888 89	371,694.98
Bill Pmt -Check	8/12/2021	20356	OKLAHOMA MUNI RETIREMENT FUND	7-30-21 & 8-13-21 payroll	4000-CURRENT CLAIMS PA...	-4,996.72	366,698.26
Bill Pmt -Check	8/12/2021	20357	GWN Marketing, Inc.	Aug 2021 payroll	4000-CURRENT CLAIMS PA...	-3,283.49	363,414.77
Bill Pmt -Check	8/18/2021	20358	GableGotwals	inv 745342	4000-CURRENT CLAIMS PA...	-1,260.00	362,154.77
Bill Pmt -Check	8/18/2021	20359	Gordon Cooper Technology Center	Inv 707	4000-CURRENT CLAIMS PA..	-50.00	362,104.77
Bill Pmt -Check	8/18/2021	20360	Worth Hydrochem of Okla., Inc	Inv 10037IN	4000-CURRENT CLAIMS PA...	-1,254.00	360,850.77
Bill Pmt -Check	8/20/2021	20361	Electrical Solutions of Oklahoma Inc	Invoice 101297	4000-CURRENT CLAIMS PA.	-15,693.88	345,156.89
Bill Pmt -Check	8/24/2021	20363	O.G. & E.	35957503-2	4000-CURRENT CLAIMS PA..	-54,760.27	290,396.62
Bill Pmt -Check	8/27/2021	20364	Kyle Arthur	100 hours annual leave sell b...	4000-CURRENT CLAIMS PA	-4,218.50	286,178.12
Bill Pmt -Check	8/30/2021	20365	PENLEY OIL COMPANY	CEN	4000-CURRENT CLAIMS PA. .	-1,882.13	284,295.99
Total 1023-BANCFIRST #3940 & #0014						284,295.99	284,295.99
TOTAL						**284,295.99**	**284,295.99**

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

09/17/21

Profit & Loss YTD Comparison

August 2021

	Aug 21	Jul 21	Jul - Aug 21
Income			
4900-ASSESSMENTS			
4901-MUNI SHARE, OPERATING COST			
4902-DEL CITY	0.00	146,007.01	146,007.01
4903-MIDWEST CITY	0.00	373,334.38	373,334.38
4904-NORMAN	0.00	404,753.61	404,753.61
Total 4901-MUNI SHARE, OPERATING COST	0.00	924,095.00	924,095.00
4905-MUNI SHARE, POWER			
4906-DEL CITY	0.00	65,625.00	65,625.00
4907-MIDWEST CITY	0.00	264,600.00	264,600.00
4908-NORMAN	0.00	194,775.00	194,775.00
Total 4905-MUNI SHARE, POWER	0.00	525,000.00	525,000.00
Total 4900-ASSESSMENTS	0.00	1,449,095.00	1,449,095.00
4920-OTHER REVENUES			
4921-MISCELLANEOUS RECEIPTS	1,200.00	600.00	1,800.00
4922- ASSESSMENT ADJUSTMENTS	-27,414.59	0.00	-27,414.59
4923-INVEST INT DIVS & GAINS	11,014.53	9,076.99	20,091.52
4925-DWSRF INTEREST INCOME	272.17	273.12	545.29
4930-SECURITIES VALUE ADJUSTS	-6,429.51	19,290.12	12,860.61
Total 4920-OTHER REVENUES	-21,357.40	29,240.23	7,882.83
Total Income	-21,357.40	1,478,335.23	1,456,977.83
Expense			
5000-PERSONNEL			
5000.1-EMPLOYEES' WAGES	42,038.34	35,548.34	77,586.68
5009-EMPLOYEES' RETIREMENT	2,607.51	1,712.57	4,320.08
5011-PAYROLL TAXES	1,771.54	2,719.44	4,490.98
5012-TRAINING, EDUCATION&TRAVEL	380.95	267.00	647.95
5013-UNIFORM & BOOTS ALLOWANCE	223.84	0.00	223.84
5014-EMPLOYEE HEALTH, ETC, INS.	3,622.54	3,622.54	7,245.08
5015-WORKMEN'S COMPENSATION	7,946.45	2,273.00	10,219.45
Total 5000-PERSONNEL	58,591.17	46,142.89	104,734.06
5100-MAINTENANCE			
5101-PLANT& DAM R&M, SUPPLIES	1,893.84	40,684.81	42,578.65
5103-VEHICLE OPS, R&M	1,956.84	2,326.40	4,283.24
5104-BUILDINGS ROADS & GROUNDS	2,444.84	44.95	2,489.79
5106-EQUIPMENT R&M, RENTAL	375.19	0.00	375.19
Total 5100-MAINTENANCE	6,670.71	43,056.16	49,726.87
5200-UTILITIES			
5201-TELEPHONE,PAGING,IT SERVIC	1,854.40	1,888.70	3,743.10
5204-ELECTRICITY	884.89	80.00	964.89
5206-WASTE REMOVAL	97.77	0.00	97.77
Total 5200-UTILITIES	2,837.06	1,968.70	4,805.76
5300-INSURANCE AND BONDS			
5301-INSURANCE	1,818.33	0.00	1,818.33
Total 5300-INSURANCE AND BONDS	1,818.33	0.00	1,818.33
5400-ADMINISTRATIVE EXPENSE			
5401-OFFICE SUPPLIES, MATERIALS	2,573.38	641.90	3,215.28
Total 5400-ADMINISTRATIVE EXPENSE	2,573.38	641.90	3,215.28
5500-PROFESSIONAL SERVICES			
5501-LEGAL	1,404.00	920.00	2,324.00
5503-CONSULTANTS AND ENGINEERS	1,254.00	0.00	1,254.00
5511-WETLAND-SHORELINE STABILIZ	189.99	0.00	189.99
Total 5500-PROFESSIONAL SERVICES	2,847.99	920.00	3,767.99
5600-WATER QUALITY SERVICES			
5601-STREAM GAUGING (OWRB)	0.00	12,400.00	12,400.00
5603-WATER QUALITY MONITORING	7,888.89	0.00	7,888.89
Total 5600-WATER QUALITY SERVICES	7,888.89	12,400.00	20,288.89
5800-PUMPING POWER	53,993.52	0.00	53,993.52
6000-DEPRECIATION	35,104.88	35,104.88	70,209.76
Total Expense	172,325.93	140,234.53	312,560.46
Net Income	**-193,683.33**	**1,338,100.70**	**1,144,417.37**

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT
Profit & Loss Budget vs. Actual
July through August 2021

	Jul - Aug 21	Budget	$ Over Budget
Income			
4900-ASSESSMENTS			
4901-MUNI SHARE, OPERATING COST			
4902-DEL CITY	146,007.01	146,007.01	0.00
4903-MIDWEST CITY	373,334.38	373,334.38	0.00
4904-NORMAN	404,753.61	404,753.61	0.00
Total 4901-MUNI SHARE, OPERATING CO...	924,095.00	924,095.00	0.00
4905-MUNI SHARE, POWER			
4906-DEL CITY	65,625.00	65,625.00	0.00
4907-MIDWEST CITY	264,600.00	264,600.00	0.00
4908-NORMAN	194,775.00	194,775.00	0.00
Total 4905-MUNI SHARE, POWER	525,000.00	525,000.00	0.00
Total 4900-ASSESSMENTS	1,449,095.00	1,449,095.00	0.00
4920-OTHER REVENUES			
4921-MISCELLANEOUS RECEIPTS	1,800.00		
4922- ASSESSMENT ADJUSTMENTS	-27,414.59		
4923-INVEST INT DIVS & GAINS	20,091.52	21,000.00	-908.48
4925-DWSRF INTEREST INCOME	545.29		
4930-SECURITIES VALUE ADJUSTS	12,860.61		
Total 4920-OTHER REVENUES	7,882.83	21,000.00	-13,117.17
Total Income	1,456,977.83	1,470,095.00	-13,117.17
Expense			
5000-PERSONNEL			
5000.1-EMPLOYEES' WAGES	77,586.68	72,500.00	5,086.68
5009-EMPLOYEES' RETIREMENT	4,320.08	1,750.00	2,570.08
5010-DIRECTORS' EXPENSES	0.00	833.30	-833.30
5011-PAYROLL TAXES	4,490.98	5,616.70	-1,125.72
5012-TRAINING, EDUCATION&TRAVEL	647.95	1,250.00	-602.05
5013-UNIFORM & BOOTS ALLOWANCE	223.84	400.00	-176.16
5014-EMPLOYEE HEALTH, ETC, INS.	7,245.08	7,500.00	-254.92
5015-WORKMEN'S COMPENSATION	10,219.45	2,500.00	7,719.45
5017-SERVICE & SAFETY AWARDS	0.00	903.50	-903.50
Total 5000-PERSONNEL	104,734.06	93,253.50	11,480.56
5100-MAINTENANCE			
5101-PLANT& DAM R&M, SUPPLIES	42,578.65	21,250.00	21,328.65
5103-VEHICLE OPS, R&M	4,283.24	3,666.70	616.54
5104-BUILDINGS ROADS & GROUNDS	2,489.79	2,916.70	-426.91
5106-EQUIPMENT R&M, RENTAL	375.19	3,666.70	-3,291.51
Total 5100-MAINTENANCE	49,726.87	31,500.10	18,226.77
5200-UTILITIES			
5201-TELEPHONE,PAGING,IT SERVIC	3,743 10	4,166.70	-423.60
5204-ELECTRICITY	964.89	1,666.70	-701.81
5205-PROPANE	0.00	500.00	-500.00
5206-WASTE REMOVAL	97.77	200.00	-102.23
Total 5200-UTILITIES	4,805.76	6,533.40	-1,727.64
5300-INSURANCE AND BONDS			
5301-INSURANCE	1,818.33	10,833.30	-9,014.97
Total 5300-INSURANCE AND BONDS	1,818.33	10,833.30	-9,014.97
5400-ADMINISTRATIVE EXPENSE			
5401-OFFICE SUPPLIES, MATERIALS	3,215.28	2,833.30	381.98
Total 5400-ADMINISTRATIVE EXPENSE	3,215.28	2,833.30	381.98
5500-PROFESSIONAL SERVICES			
5501-LEGAL	2,324.00	5,833.30	-3,509.30
5502-ACCOUNTING AND AUDIT	0.00	4,166.70	-4,166.70
5503-CONSULTANTS AND ENGINEERS	1,254.00	7,500.00	-6,246.00
5511-WETLAND-SHORELINE STABILIZ	189.99		
Total 5500-PROFESSIONAL SERVICES	3,767.99	17,500.00	-13,732.01
5600-WATER QUALITY SERVICES			
5601-STREAM GAUGING (OWRB)	12,400.00	2,066.70	10,333.30
5603-WATER QUALITY MONITORING	7,888.89	10,454.00	-2,565.11
Total 5600-WATER QUALITY SERVICES	20,288.89	12,520.70	7,768.19
5800-PUMPING POWER	53,993.52	21,000.00	32,993.52
6000-DEPRECIATION	70,209.76		
Total Expense	312,560.46	195,974.30	116,586.16
Net Income	**1,144,417.37**	**1,274,120.70**	**-129,703.33**

COMCD

Account Number:

Activity Statement

Values as of August 31, 2021

CENTRAL OKLAHOMA
MASTER CONSERVANCY DISTRICT
A NON-PROFIT ORGANIZATION
12500 ALAMEDA DRIVE
NORMAN OK 73026

Investment Objective

Income with Capital Preservation

Your Financial Advisor: Robert Lockard Sr
580-221-5250 I rob.lockard@LPL.com
310 W Main St
Ardmore, OK 73401

Value on January 1, 2021	Value as of last statement 07/31/2021	Value on August 31, 2021
$4,317,124.97	$4,352,458.64	$4,346,340.67

Account Summary

	Quarter to Date 07/01 - 08/31/2021	Year to Date 01/01 - 08/31/2021
Starting Value	**$4,332,866.95**	**$4,317,124.97**
Total Change in Value of Assets	$13,473.72	$29,215.70
Inflows	—	—
Outflows	*($13,148.57)*	*($58,773.07)*
Dividends	*$607.71*	*$4,625.10*
Interest	*$13,153.97*	*$71,426.46*
Capital Gains	—	*$2,043.00*
Other Distributions	—	—
Market Fluctuations [1]	*$12,860.61*	*$9,894.21*
Total Ending Value (August 31, 2021)	**$4,346,340.67**	**$4,346,340.67**

Account Holdings As of August 31, 2021

Cash and Cash Equivalents

Description	Interest / Dividend Paid in August	Interest / Dividend Rate[3]	Current Balance
Insured Cash Account [4]			
Tristate Capital Bank			$246,502.09

Cash and Cash Equivalents continued on next page...

1 *Market Fluctuations reflects the impact of changes in the value of securities held in your LPL Financial account, as well as the impact of any transfers of securities into or out of your account during the statement period.*
3 *Bank Deposit Sweep interest is the current rate. Money Market Sweep dividend is a 30-day yield.*
4 *Bank Deposit Sweep Accounts are FDIC insured, are not obligations of LPL Financial or SIPC, and are not available for margin purposes. See message section for further information.*

Account Holdings As of August 31, 2021 *Continued*

Cash and Cash Equivalents *Continued*

Description	Interest / Dividend Paid in August	Interest / Dividend Rate[3]	Current Balance
JPMorgan Chase Bank NA			$41,928.92
HSBC Bank USA NA			$33,599.97
Wells Fargo Bank NA			$0.04
Total Insured Cash Account	$2.74	0.010%	$322,031.02
Total Cash and Cash Equivalents			**$322,031.02**

ETPs, Mutual Funds, Exchange-Traded Closed-End Funds and Interval Funds

Security ID / Description	Quantity / Price ($)	Market Value ($)	Cost Basis ($) / Purchase Cost ($)[5]	Unrealized Gain / Loss ($)	Estimated Annual Income ($)[a] / Est 30-Day Yield[a]
ABALX AMERICAN BALANCED CL A [R]	11,575.086 / $33.51	387,881.13	363,979.29 / 350,005.00	23,901.84	*4,628* / *1.19%*
MIAQX AMERICAN MULTISECTOR INCOME CL A [R]	4,549.591 / $10.82	49,226.57	50,005.00 / 50,005.00	(778.43)	*1,848* / *3.75%*
ABNDX BOND FUND OF AMERICA CL A [R]	1,807.664 / $13.58	24,548.07	25,005.00 / 25,005.00	(456.93)	*357* / *1.46%*
CAIBX CAPITAL INCOME BUILDER CL A [R]	709.421 / $69.36	49,205.44	50,005.00 / 50,005.00	(799.56)	*1,418* / *2.88%*
CWGIX CAPITAL WORLD GROWTH & INCOME CL A [R]	446.894 / $66.34	29,646.94	30,005.00 / 30,005.00	(358.06)	*331* / *1.12%*
EALDX EATON VANCE SHORT DURATION GOVT INCOME CL A [R]	31,114.289 / $8.02	249,536.59	252,338.27 / 250,005.00	(2,801.68)	*4,019* / *1.61%*
AIBAX INTERMEDIATE BOND FUND OF AMERICA CL A [R]	1,806.358 / $13.86	25,036.12	25,005.00 / 25,005.00	31.12	*196* / *0.78%*
AWSHX WASHINGTON MUTUAL INVESTORS CL A [R]	1,191.895 / $57.70	68,772.34	70,005.00 / 70,005.00	(1,232.66)	*1,029* / *1.50%*
Total of ETPs, Mutual Funds, Exchange-Traded Closed-End Funds and Interval Funds		**883,853.20**	**866,347.56** / **850,040.00**	**17,505.64**	***13,826***

R Dividends and/or capital gains distributed by this security will be reinvested.

5 *Purchase Cost equals Cost Basis of Equities and Mutual Funds less any reinvested dividends and interest.*

a *Refer to the statement message titled ESTIMATED ANNUAL INCOME (EAI) AND ESTIMATED YIELD (EY) for information on how this figure is calculated.*

Account Holdings As of August 31, 2021 *Continued*

Corporate Bonds

Security ID / Description	Quantity / Price ($)	Market Value ($)	Cost Basis ($)	Unrealized Gain / Loss ($) / Accrued Int ($)	Estimated Annual Income ($)[a] / Est 30-Day Yield[a]
002824BB5 ABBOTT LABS SR NOTE CPN 2.950% DUE 03/15/25 DTD 03/10/15 FC 09/15/15 CALL 12/15/24 @ 100.000 MOODYS RATING: A2 S&P RATING: A+	312,000 $107.0926	334,128.91	314,561.37	19,567.54 *4,244.07*	*9,204* *2.75%*
097023BK0 BOEING CO SR NOTE CPN 3.300% DUE 03/01/35 DTD 02/20/15 FC 09/01/15 CALL 09/01/34 @ 100.000 MOODYS RATING: BAA2 S&P RATING: BBB-	44,000 $101.5794	44,694.93	44,865.81	(170.88) *726.00*	*1,452* *3.25%*
097023BR5 BOEING CO SR NOTE CPN 2.250% DUE 06/15/26 DTD 05/18/16 FC 12/15/16 CALL 03/15/26 @ 100.000 MOODYS RATING: BAA2 S&P RATING: BBB-	150,000 $102.2475	153,371.25	150,854.99	2,516.26 *712.50*	*3,375* *2.20%*
05565QDM7 BP CAP MKTS PLC GTD NOTE CPN 3.588% DUE 04/14/27 DTD 02/14/17 FC 10/14/17 CALL 01/14/27 @ 100.000 MOODYS RATING: A2 S&P RATING: A-	150,000 $110.9939	166,490.85	162,061.81	4,429.04 *2,048.15*	*5,382* *3.23%*
10922NAC7 BRIGHTHOUSE FINL INC SR NOTE CPN 3.700% DUE 06/22/27 DTD 12/22/17 FC 06/22/18 CALL 03/22/27 @ 100.000 MOODYS RATING: BAA3 S&P RATING: BBB+	250,000 $109.709	274,272.50	246,119.20	28,153.30 *1,772.92*	*9,250* *3.37%*
20826FAA4 CONOCOPHILLIPS CO GTD NOTE CPN 2.400% DUE 12/15/22 DTD 12/07/12 FC 06/15/13 CALL 09/15/22 @ 100.000 MOODYS RATING: A3 S&P RATING: A-	175,000 $102.1291	178,725.92	172,680.20	6,045.72 *886.67*	*4,200* *2.35%*
36966TDN9 GENL ELECTRIC CAP CORP INTERNOTES SURVIVOR OPTION CPN 4.300% DUE 11/15/25 DTD 11/03/11 FC 05/15/12 MOODYS RATING: BAA1 S&P RATING: BBB+	300,000 $110.1322	330,396.60	300,000.00	30,396.60 *3,798.33*	*12,900* *3.90%*
38143C6D8 GOLDMAN SACHS GROUP INC MEDIUM TERM NOTE NO SURVIVOR OPTION CPN 3.000% DUE 08/15/29 DTD 08/04/16 FC 09/15/16 CALL 08/15/28 @ 100.000 MOODYS RATING: A2 S&P RATING: BBB+	161,000 $100.7662	162,233.58	161,049.84	1,183.74 *214.67*	*4,830* *2.98%*
500255AS3 KOHLS CORP NOTE CPN 3.250% DUE 02/01/23 DTD 09/25/12 FC 02/01/13 CALL 11/01/22 @ 100.000 MOODYS RATING: BAA2 S&P RATING: BBB-	200,000 $102.6927	205,385.40	200,365.48	5,019.92 *541.67*	*6,500* *3.16%*

Corporate Bonds continued on next page...

a *Refer to the statement message titled ESTIMATED ANNUAL INCOME (EAI) AND ESTIMATED YIELD (EY) for information on how this figure is calculated.*

Account Holdings As of August 31, 2021 *Continued*

Corporate Bonds *Continued*

Security ID / Description	Quantity / Price ($)	Market Value ($)	Cost Basis ($)	Unrealized Gain / Loss ($) / Accrued Int ($)	Estimated Annual Income ($)[a] / Est 30-Day Yield[a]
594918BB9 MICROSOFT CORP NOTE CPN 2.700% DUE 02/12/25 DTD 02/12/15 FC 08/12/15 CALL 11/12/24 @ 100.000 MOODYS RATING: AAA S&P RATING: AAA	76,000 $106.5525	80,979.90	75,332.36	5,647.54 *108.30*	*2,052* *2.53%*
594918BC7 MICROSOFT CORP NOTE CPN 3.500% DUE 02/12/35 DTD 02/12/15 FC 08/12/15 CALL 08/12/34 @ 100.000 MOODYS RATING: AAA S&P RATING: AAA	165,000 $117.4184	193,740.36	171,140.71	22,599.65 *304.79*	*5,775* *2.98%*
655664AS9 NORDSTROM INC SR NOTE CPN 4.000% DUE 03/15/27 DTD 03/09/17 FC 09/15/17 CALL 12/15/26 @ 100.000 MOODYS RATING: BAA3 S&P RATING: BB+	250,000 $104.75	261,875.00	255,985.40	5,889.60 *4,611.11*	*10,000* *3.82%*
682680AQ6 ONEOK INC NEW NOTE CPN 4.250% DUE 02/01/22 DTD 01/26/12 FC 08/01/12 CALL 11/01/21 @ 100.000 MOODYS RATING: BAA3 S&P RATING: BBB	95,000 $100.5945	95,564.77	91,265.00	4,299.77 *336.46*	*4,037* *4.22%*
717081DM2 PFIZER INC SR NOTE CPN 3.400% DUE 05/15/24 DTD 05/15/14 FC 11/15/14 MOODYS RATING: A2 S&P RATING: A+	132,000 $107.6779	142,134.82	133,002.48	9,132.34 *1,321.47*	*4,488* *3.16%*
718549AB4 PHILLIPS 66 PRTNRS LP SR NOTE CPN 3.605% DUE 02/15/25 DTD 02/23/15 FC 08/15/15 CALL 11/15/24 @ 100.000 MOODYS RATING: BAA3 S&P RATING: BBB	107,000 $107.4988	115,023.71	106,937.86	8,085.85 *171.44*	*3,857* *3.35%*
844741BC1 SOUTHWEST ARLNS CO NOTE CPN 3.000% DUE 11/15/26 DTD 11/04/16 FC 05/15/17 CALL 08/15/26 @ 100.000 MOODYS RATING: BAA1 S&P RATING: BBB	150,000 $106.8253	160,237.95	150,618.20	9,619.75 *1,325.00*	*4,500* *2.81%*
88165FAG7 TEVA PHARM FIN CO BV SR NOTE CPN 2.950% DUE 12/18/22 DTD 12/18/12 FC 06/18/13 MOODYS RATING: BA2 S&P RATING: BB-	240,000 $100.50	241,200.00	240,093.28	1,106.72 *1,435.67*	*7,080* *2.94%*
Total of Corporate Bonds		**3,140,456.45**	**2,976,933.99**	**163,522.46** ***24,559.22***	*98,882*

a *Refer to the statement message titled ESTIMATED ANNUAL INCOME (EAI) AND ESTIMATED YIELD (EY) for information on how this figure is calculated.*

Account Holdings As of August 31, 2021 *Continued*

Total Account Holdings	Market Value ($)	Cost Basis ($) / Purchase Cost ($)[6]	Unrealized Gain / Loss ($)	Estimated Annual Income ($)[a]
	4,346,340.67	4,165,312.57 / 1,172,071.02	181,028.10	*112,708*

Cash Activity Summary

	Since last statement *08/01 - 08/31/2021*	Year to Date *01/01 - 08/31/2021*
Securities Purchased	($250,030.00)	($250,030.00)
Securities Sold	$257,245.85	$542,245.85
Cash Inflows	—	—
Cash Outflows	($12,746.07)	($58,773.07)
Dividends	$308.80	$4,625.10
Interest	$12,748.81	$71,426.46
Capital Gains	—	$2,043.00
Other Distributions	—	—
Reinvestments	($308.80)	($6,668.10)

Account Activity August 1 - August 31, 2021 *(Since last statement)*

Date	Transaction Type	Description/Security ID	Price($) / Quantity	Amount
08/02/2021	Cash Dividend	EATON VANCE SHORT DURATION GOVT INCOME CL A 073021 31,075.83300 EALDX AS OF 07/30/21	— / —	$308.80
08/02/2021	Dividend Reinvest	EATON VANCE SHORT DURATION GOVT INCOME CL A REINVEST AT 8.030 EALDX	— / 38.456	($308.80)
08/02/2021	Interest	KOHLS CORP NOTE CPN 3.250% DUE 02/01/23 DTD 09/25/12 FC 02/01/13 CALL 11/01/22 @ 100.000 080121 200,000 500255AS3 AS OF 08/01/21	— / —	$3,250.00
08/02/2021	Interest	ONEOK INC NEW NOTE CPN 4.250% DUE 02/01/22 DTD 01/26/12 FC 08/01/12 CALL 11/01/21 @ 100.000 080121 95,000 682680AQ6 AS OF 08/01/21	— / —	$2,018.75

Account Activity continued on next page...

6 *Purchase Cost equals Cost Basis less any reinvested dividends, interest, Fixed Income and Alternative Investments.*
a *Refer to the statement message titled ESTIMATED ANNUAL INCOME (EAI) AND ESTIMATED YIELD (EY) for information on how this figure is calculated.*

Account Activity August 1 - August 31, 2021 *(Since last statement)* *Continued*

Date	Transaction Type	Description/Security ID	Price($) / Quantity	Amount
08/03/2021	Sweep (Deposit)[7]	INSURED CASH ACCOUNT	— / —	$5,268.75
08/12/2021	Interest	MICROSOFT CORP NOTE CPN 3.500% DUE 02/12/35 DTD 02/12/15 FC 08/12/15 CALL 08/12/34 @ 100.000 081221 165,000 594918BC7	— / —	$2,887.50
08/12/2021	Interest	MICROSOFT CORP NOTE CPN 2.700% DUE 02/12/25 DTD 02/12/15 FC 08/12/15 CALL 11/12/24 @ 100.000 081221 76,000 594918BB9	— / —	$1,026.00
08/13/2021	Sweep (Deposit)[7]	INSURED CASH ACCOUNT	— / —	$3,913.50
08/16/2021	Interest	GOLDMAN SACHS GROUP INC MEDIUM TERM NOTE NO SURVIVOR OPTION CPN 3.000% DUE 08/15/29 DTD 08/04/16 FC 09/15/16 081521 161,000 38143C6D8 AS OF 08/15/21	— / —	$402.50
08/16/2021	Interest	PHILLIPS 66 PRTNRS LP SR NOTE CPN 3.605% DUE 02/15/25 DTD 02/23/15 FC 08/15/15 CALL 11/15/24 @ 100.000 081521 107,000 718549AB4 AS OF 08/15/21	— / —	$1,928.68
08/17/2021	Sweep (Deposit)[7]	INSURED CASH ACCOUNT	— / —	$2,331.18
08/25/2021	Purchase	AMERICAN MULTISECTOR INCOME CL A MIAQX	$10.99 / 4,549.591	($50,005.00)
08/25/2021	Purchase	BOND FUND OF AMERICA CL A ABNDX	$13.83 / 1,807.664	($25,005.00)
08/25/2021	Purchase	CAPITAL INCOME BUILDER CL A CAIBX	$70.48 / 709.421	($50,005.00)
08/25/2021	Purchase	CAPITAL WORLD GROWTH & INCOME CL A CWGIX	$67.13 / 446.894	($30,005.00)
08/25/2021	Purchase	INTERMEDIATE BOND FUND OF AMERICA CL A AIBAX	$13.84 / 1,806.358	($25,005.00)
08/25/2021	Purchase	WASHINGTON MUTUAL INVESTORS CL A AWSHX	$58.73 / 1,191.895	($70,005.00)
08/26/2021	Interest	RAYTHEON CO NOTE CPN 2.500% DUE 12/15/22 DTD 12/04/12 FC 06/15/13 CALL 09/15/22 @ 100.000 RAYTHEON CO 755111BX8	— / —	$1,232.64

Account Activity continued on next page...

7 *Bank Deposit and Money Market Sweep transactions reflect the net of all transfers of free cash balance to and from your sweep on the date referenced.*

Account Activity August 1 - August 31, 2021 *(Since last statement)* *Continued*

Date	Transaction Type	Description/Security ID	Price($) / Quantity	Amount
08/26/2021	Redemption	RAYTHEON CO NOTE CPN 2.500% DUE 12/15/22 DTD 12/04/12 FC 06/15/13 CALL 09/15/22 @ 100.000 755111BX8	— / (250,000)	$257,245.85
08/27/2021	Sweep (Deposit)[7]	INSURED CASH ACCOUNT	— / —	$8,448.49
08/31/2021	Interest	INSURED CASH ACCOUNT 083121 322,031	— / —	$2.74
08/31/2021	Sweep (Interest Deposit)[7]	INSURED CASH ACCOUNT	— / —	$2.74
08/31/2021	Sweep (Withdrawal)[7]	INSURED CASH ACCOUNT	— / —	($12,746.07)
08/31/2021	ACH Funds	INCOME DISTRIBUTION TRACE # 021000010001249	— / —	($12,746.07)

7 *Bank Deposit and Money Market Sweep transactions reflect the net of all transfers of free cash balance to and from your sweep on the date referenced.*

Messages From LPL Financial

PAPERLESS STATEMENTS

Go paperless and view your monthly statements and trade confirmations online. Monthly statements are available online within three business days, and trade confirmations are available the next business day after the trade is executed. To go paperless, click on the LPL Account View link accessible through your financial professional or institution website. Paperless statements are convenient, secure, fast and environmentally friendly. Enjoy the many benefits of free paperless statements and sign up today.

ESTIMATED ANNUAL INCOME (EAI) AND ESTIMATED YIELD (EY)

EAI is calculated by taking the indicated annualized dividend and multiplying by the number of shares owned. EY is calculated by taking the EAI and dividing by the aggregate value of the shares owned. If no dividend information is available, no EAI or EY numbers will be generated. EAI and EY for certain types of securities could include a return of principal or capital gains in which case the EAI and EY would be overstated. EAI and EY are estimates and the actual income and yield might be lower or higher than the estimated amounts. Additionally the actual dividend or yield may vary depending on the security issuer's approval of paying the dividends. EY reflects only the income generated by an investment. It does not reflect changes in its price, which may fluctuate.

NON-TRANSFERABLE SECURITIES THAT ARE WORTHLESS

As part of our continuing effort to provide exceptional service, please be advised that LPL Financial will remove any non-transferable securities that are worthless from customer accounts. Your account may or may not be affected. Should you have any questions or concerns, please contact your financial professional.

SETTLEMENT FEE

LPL passes through certain regulatory fees incurred by LPL as a result of executing the transaction on your behalf. This includes fees charged under Section 31 of the Securities Exchange Act for sell transactions in equities and options.

POLICY FOR BENEFICIARY ACCOUNTS

Beneficiaries are required to open an account to receive any securities or cash from a deceased client's account. LPL generally will divide all securities and cash proportionately among the designated beneficiaries based on the allocations indicated by the account holder. However, this policy and procedure address specific situations, such as the treatment of securities remaining after the proportionate division of assets. You may visit lpl.com to learn more.

ICA INFORMATION

Your balances in the Insured Cash Account (ICA) Program are allocated to each depository institution on the Priority Bank List in increments of $246,500 for individual and trust accounts and $493,000 for joint accounts. As always, you should review your cash positions with various depository institutions to determine whether your cash is within the FDIC insurance coverage limits. For more information about FDIC insurance limits, please contact your financial professional or go to www.fdic.gov

Please be advised that the Priority Bank List for the ICA Program may change from time to time. These changes include the order of priority in which banks are listed as well as the addition and removal of banks. Please be sure to consult your financial professional or LPL.com periodically throughout the month for recent updates and information regarding how these changes may impact your account.

Disclosures and Other Information

ACCOUNT PROTECTION LPL Financial is a member of the Securities Investor Protection Corporation (SIPC). SIPC provides protection for your account up to $500,000, of which $250,000 may be claims for cash, in the unlikely event that LPL fails financially. SIPC protection limits apply to all accounts that you hold in a particular capacity. For example, if you hold two accounts at LPL as a sole account holder and third as a joint account holder, the two individual accounts are protected under SIPC up to a combined limit of $500,000, and the joint account is protected under SIPC separately up to $500,000. LPL Insured Cash Account (ICA) and LPL Deposit Cash Account (DCA) are not protected by SIPC. More information on SIPC, including obtaining an explanatory SIPC Brochure, may be obtained by calling SIPC directly at (202) 371-8300 or by visiting www.sipc.org. The account protection applies when an SIPC member firm fails financially and is unable to meet its obligations to securities clients, but it does not protect against losses from the rise and fall in the market value of investments.
ADJUSTED COST The cost basis of securities sold, matured, redeemed or exercised is adjusted for return of principal, original issue discount, accrual and partnership distributions for CMO, CDO, REMIC and MLP transactions. Eligible securities on the Realized Gains and Losses Statement have not been adjusted for bond amortization, return of capital, liquidating distributions, wash sales or similar items. N/A displays when the information is incomplete or missing and is treated as zero when calculating totals.
ADJUSTMENTS TO OPTION CONTRACTS As a general rule, corporate actions can result in an adjustment in the number of shares underlying an options contract or the exercise price, or both. Please review any adjustment to an option position. Contact your financial professional for further information with respect to option contract adjustment or visit the OCC website at http://www.optionsclearing.com/webapps/infomemos.
AGENCY If LPL Financial acts as your agent, or as agent for both you and another person in a transaction, the transaction details, including the identity of the seller or buyer and the source and amount of any fees or payments will be supplied upon written request.
ASSET-BACKED SECURITIES The actual yield from transactions in asset-backed securities (e.g., CMO, FNMA, FHLMC OR GMNA transactions) may vary according to the rate at which the underlying assets or receivables are repaid. Information about yield factors is available from your financial professional on request.
CALLED SECURITIES In the event of a partial call of corporate or municipal bonds, or preferred stock held in bulk segregation, the securities to be called will automatically be selected on a random basis, as is customary in the securities industry. The probability that your securities will be selected is proportional to the amount of your holdings relative to the bulk holdings. A detailed description of the random selection procedure is available upon request.
CHANGE OF ADDRESS Please notify your financial professional or LPL Financial promptly in writing of any change of address.
COST BASIS Transactions are automatically paired against holdings on a "First-In/First-Out" basis (unless manually adjusted). Designating liquidations as "versus purchase" on a trade will cause the trade confirmation or other closed tax lot notification to reflect the selected closed tax lots. For assets not purchased in the LPL account, you or the previous broker / dealer upon transfer may have provided the Date Acquired and Purchase Cost of the position. If no such data was submitted, N/A is listed as the Purchase Cost, and is treated as zero when calculating Gain or Loss totals. Since the cost basis on certain securities may have been provided by another source, the cost basis information on your statement may not reflect accurate data or correspond to data on your trade confirmations. This information should not be relied upon for tax reporting purposes. Please refer to your tax reporting statement, if applicable. For accounts electing average cost, the total cost may be computed using a combination of averaged and non-averaged unit prices for eligible securities.
DISCREPANCIES Please notify your financial professional and LPL Financial immediately of any discrepancies on your statement. If your financial professional is affiliated with another broker/dealer, you must notify them as well. Please contact your financial professional for the broker/dealer's contact information. Your financial professional's address and telephone number can be found on the bottom of each page of this statement. LPL Financial's telephone number is (800) 558-7567 and address can be found on the first page of this statement. Additionally, any verbal communications should be re-confirmed in writing to each of the above parties to further protect your rights, including rights under Securities Investor Protection Act (SIPA).
FRACTIONAL SHARE LIQUIDATION For information on fractional share transactions, please refer to LPL.com>Disclosures>Market & Trading Disclosures>Fractional Share Transactions.
FREE CREDIT BALANCES LPL Financial may use your free credit balances subject to the limitations of 17 CFR Section 240.15c3-3 under the Securities Exchange Act of 1934. You have the right to receive from us, upon demand in the course of normal business, the delivery of any free credit balances to which you are entitled, any fully paid securities to which you are entitled, and any securities purchased on margin upon full payment of any indebtedness to LPL Financial.
INVESTMENT RISK LPL Financial is not a bank, savings and loan, or credit union. Securities and insurance offered through LPL and its affiliates are not FDIC, NCUA or government insured, not endorsed or guaranteed by LPL, its affiliates or any other financial institution, are not a deposit, and involve investment risk including possible loss of principal.
INVESTMENTS HELD OUTSIDE LPL FINANCIAL Information on investments Held Outside LPL is provided for informational purposes only. Values for investments not held in your LPL account are based on the market value of priced securities at the end of the statement period. Values for annuities reflect a pricing date approximately three business days prior to the statement date. Values for alternative investments such as Managed Futures and REITs (Real Estate Investment Trusts) reflect a pricing date three to five business days prior to the statement date, depending on the availability of the data. The account registration for investments held outside LPL may not be the same as the registration for the LPL account with which it is affiliated. For example, an outside investment with a joint registration may be reflected on an LPL account with an individual registration.
LPL INSURED BANK DEPOSIT SWEEP PROGRAMS Cash in the Insured Cash Account (ICA) and LPL Deposit Cash Account (DCA) programs is protected by the Federal Deposit Insurance Corporation (FDIC). LPL Financial allocates your money to the ICA program to banks in the order of the Priority Bank List and to the DCA program to any bank on the Available Bank list in increments up to the programs disclosed amounts until your balance in each of the ICA and DCA programs is allocated to the program max. All banks are FDIC members. FDIC coverage is $250,000 per depositor per bank ($500,000 for joint account holders). More information on FDIC insurance is available on request, or by visiting the FDIC website at www.fdic.gov. LPL Financial is not a bank. Unless otherwise disclosed, securities and other investments obtained through LPL Financial ARE NOT FDIC INSURED, ARE NOT BANK GUARANTEED AND MAY LOSE VALUE.
MARGIN ACCOUNT If you use margin, this statement combines information about your investment account(s) and a special miscellaneous account maintained for you under Section 220.6 of Regulation T issued by the Board of Governors of the Federal Reserve System. The permanent record of the separate account required by Regulation T is available for your inspection upon request.
MONEY MARKET FUNDS Money market fund transactions, if any, are displayed chronologically. The 30-day yield for the fund is also reflected as of the statement date.
MUNICIPAL MATERIAL DISCLOSURE Copies of any material disclosures for municipal bonds are available at www.emma.msrb.org. To obtain specific municipal bond information, enter the nine-digit CUSIP number in the search field within the EMMA web site. If you do not have access to the Internet or would prefer a physical copy of the material disclosure, please contact your financial professional. Additional municipal bond information that may be available on www.emma.msrb.org includes, but is not limited to advance refunding documents, continuing disclosures, including annual financial statements and notices of material events, real-time and historical trade data, daily market statistics and education material.
N/A OR "–" DATA Information that displays as N/A or "–" is unavailable, missing, or incomplete and is treated as zero when calculating account totals, market values and performance.
OPTION CLIENTS Information on commissions and other charges incurred in connection with the execution of options transactions has been included in the confirmations of these transactions furnished to you. A summary of this information will be made available upon request. In accordance with the Option Agreement and Approval form you signed, you must promptly advise the firm of any material change in your investment objectives or financial situation.
ORDER ROUTING Quarterly Order Routing information for equities and options can be found on LPL.com>Disclosure>Market & Trading Disclosure>SEC Rule 606 Report Disclosure. This information is also available upon request.
PAYMENT FOR ORDER FLOW LPL Financial acts as your agent and does not receive any compensation in the form of payment for order flow.
PRICING Securities prices shown on this statement may vary from actual liquidation value. Prices shown should only be used as a general guide to portfolio value. We receive prices from various services, which are sometimes unable to provide timely information. Where pricing sources are not readily available, particularly on certain debt instruments including, but not limited to, bills, notes, bonds, banker's acceptances, certificates of deposit, or commercial paper, estimated prices may be generated by a matrix system or market driven pricing model, taking various factors into consideration. These prices may not be the actual price you would receive if you sold before the maturity of a certificate of deposit. The pricing of listed options takes into account the last closing price, as well as the current bid and offer prices. Where securities have not been priced, their values have not been included in the Portfolio Summary information at the beginning of this statement.
PRINCIPAL If your broker-dealer is acting as principal in a transaction, your broker-dealer has sold to or bought from you the security, and may have received a profit from the transaction.
PURCHASE COST Original cost including fees, commissions and less accrued interest of the quantity sold or redeemed. For transferred securities, this could be the purchase amount you or the former institution provided to us. Purchase Cost may be adjusted to reflect corporate actions, such as stock splits, mergers, spinoffs, or other events. N/A is displayed when the information is incomplete or missing and is treated as zero when calculating totals.
*Transferred securities may not be included in Purchase Cost.
REGULATION All transactions are subject to the constitution, rules, regulations, customs, usages, rulings and interpretations of the exchange or market-and its clearing house, if any- where the transactions are executed, and of the Financial Industrial Regulation Authority (FINRA).
REINVESTMENT The dollar amount of mutual fund distributions, money market fund income, or dividends on other securities on your statement may have been reinvested in additional shares. You will not receive confirmations for these reinvestment transactions. However, you may request information on these transactions by writing to LPL Financial. LPL will also, if requested, furnish you with the time of execution and the name of the person from who your security was purchased.
REVENUE SHARING LPL may have a fee arrangement with the investment advisor or distributor ("sponsor") of the mutual fund you have purchased, called revenue-sharing. In such case, the sponsor pays LPL a fee based on the amount of your purchase, and LPL provides marketing support to the sponsor and allows the sponsor to access your financial professional so that the sponsor can promote such mutual funds. This arrangement gives LPL a financial incentive to have LPL clients invest in participating mutual funds instead of funds whose sponsors do not make such payments to LPL. Although your financial professional does not share in this compensation, this conflict of interest affects the ability of LPL to provide you with unbiased, objective investment advice concerning the selection of mutual funds for your account. This could mean that other mutual funds, whose sponsors do not make revenue sharing payments, may be more appropriate for your account than the mutual funds whose sponsors make revenue sharing payments to LPL. For a complete list of the participating sponsors, and the range of fee payments, please visit LPL.com>Disclosures>Account Disclosures,Agreements, Fee Schedules & Conflicts of Interest>Third Party Compensation and Related Conflicts of Interest.
STATEMENT OF FINANCIAL CONDITION You may call the LPL Client Service line at (800) 877-7210 to request a copy of LPL's audited and unaudited financial statements at no cost. These statements are available for inspection at LPL's office or online at https://www.lpl.com/disclosures.html in the LPL LLC Financial Reports section.
SWEEP OPTION Your account may provide for a daily sweep in an insured bank deposit sweep program (either LPL Insured Cash Account—ICA—or LPL Deposit Cash Account—DCA) or a money market mutual fund. The balance in the ICA, DCA or money market mutual fund sweep may be liquidated on the customer's order and the proceeds returned to the securities account, or remitted to the customer. If you have any questions about your sweep option, including rates of the depository institutions currently participating in the sweep option, or you would like to change your sweep option, please contact your financial professional.
TRADING AWAY POLICY Additional information regarding trading practices of equity portfolio managers on Manager Select and Manager Access Select is available on Third-Party Portfolio Manager Trading Practices page online at https://www.lpl.com/disclosures.html in the Market & Trading Disclosures section.
LPL FINANCIAL LLC is an affiliate of LPL Financial Holdings Inc

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Resolution

OF

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

REGARDING OFFICIAL ACTION

WHEREAS, a quorum of the Board of Directors of the Central Oklahoma Master Conservancy District met in a regular meeting and considered approval of financial statements for the operating account for a previous month.

IT IS HEREBY RESOLVED that financial statements for operating account for August 2021 are approved.

APPROVED by a majority of Board members present on this 7th day of October, 2021.

Item D.5.

2022 CALENDAR YEAR
SCHEDULE OF REGULAR MEETINGS

Central Oklahoma Master Conservancy District
Name of Board/Commission/Committee

DATE	TIME	PHYSICAL LOCATION
January 6, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
February 3, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
March 3, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
April 7, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
May 5, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
June 2, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
July 7, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
August 4, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
September 1, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
October 6, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
November 3, 2022	6:30 PM	12500 Alameda Drive, Norman, OK
December 1, 2022	6:30 PM	12500 Alameda Drive, Norman, OK

Resolution

OF

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

REGARDING OFFICIAL ACTION

WHEREAS, a quorum of the Board of Directors of the Central Oklahoma Master Conservancy District met in a regular meeting and considered approval of the Districts' Schedule of Regular Meetings for calendar year 2022.

IT IS HEREBY RESOLVED that Central Oklahoma Master Conservancy Districts' Schedule of Regular Meetings for calendar year 2022 are approved.

APPROVED by a majority of Board members present on this 7th day of October, 2021.

Item D.6

IN THE DISTRICT COURT OF CLEVELAND COUNTY

STATE OF OKLAHOMA

IN Re CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT.))) **No. 18422**

ANNUAL REPORT OF THE BOARD OF DIRECTORS

To the Honorable ______________________________, Judge of the District Court:

As required by Title 82, Section 649, Oklahoma Statutes, the Board of Directors of the above-named Master Conservancy District, submits the following report for the fiscal year beginning July 1, 2020, and ending June 30, 2021:

3:01 PM

09/02/21

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT
Statement of Cash Flows
July 2020 through June 2021

	Jul '20 - Jun 21
OPERATING ACTIVITIES	
Net Income	318,450.05
Adjustments to reconcile Net Income to net cash provided by operations:	
1800-GRANTS RECEIVABLE	-32,500.12
1900-ASSESSMENTS RECEIVABLE:1901-DEL CITY:1...	-10,491.78
1900-ASSESSMENTS RECEIVABLE:1901-DEL CITY:1...	1,437.90
1900-ASSESSMENTS RECEIVABLE:1905-MIDWEST C...	-26,827.09
1900-ASSESSMENTS RECEIVABLE:1905-MIDWEST C...	3,670.15
1900-ASSESSMENTS RECEIVABLE:1909-NORMAN:19...	-29,084.84
1900-ASSESSMENTS RECEIVABLE:1909-NORMAN:19...	245.80
1920-(BANCFIRST)-DWSRF ESCROW	108.90
1951-DWSRF REPYMT DUE-CURRENT	-92.23
4000-CURRENT CLAIMS PAYABLE	-32,684.03
4000.1-DEFERRED PENSION COSTS	25,963.85
4000.2-MISC PENSION PAYABLES	3,717.38
4002-DWSRF INTEREST PAYABLE	25,104.19
4009-FYE ACCRUALS	-580,320.37
4010-PAYROLL DEDUCTIONS:4011.1-SOCIAL SECUR...	333.78
4010-PAYROLL DEDUCTIONS:4011.2-MEDICARE PAY...	78.06
4010-PAYROLL DEDUCTIONS:4014-RETIREMENT PL...	-6,437.40
4010-PAYROLL DEDUCTIONS:4016-GROUP INSURAN...	-787.00
4017-COMPENSATED ABSENCES	14,825.27
4019-CONTRACTS-DUE W/I 1 YEAR:4019.3-DWSRF C...	55.95
Net cash provided by Operating Activities	-325,233.58
INVESTING ACTIVITIES	
2000-WATER SUPPLY ASSETS:DAM AND RESERVOIR	75,000.00
2000-WATER SUPPLY ASSETS:NEW DEL CITY PIPELINE	-3,610,309.43
2020-OTHER PURCHASED ASSETS:BUILDINGS,STRUCT...	-4,645.00
2020-OTHER PURCHASED ASSETS:OFFICE EQUIPMENT	7,251.01
2020-OTHER PURCHASED ASSETS:PLANT AND DAM E...	-463,699.25
2020-OTHER PURCHASED ASSETS:VEHICLES AND BO...	85,980.44
2030-ALLOWANCE FOR DEPRECIATION	270,245.12
DEBT ISSUANCE COSTS	-44,777.00
DWSRF REPAYMENTS-NONCURRENT	94,484.00
NET PENSION ASSET	-266,750.00
Net cash provided by Investing Activities	-3,857,220.11
FINANCING ACTIVITIES	
4020-CONTRACTS PAYABLE:4055-DWSRF PAYMENTS:4...	-94,484.00
4020-CONTRACTS PAYABLE:4080-NEW DEL CITY PIPEL...	3,663,729.80
4806.5 UNRESTRICTED SURPLUS:4807-UNRESTRICTED...	432,185.60
4806.5 UNRESTRICTED SURPLUS:4808-FYE '21 ADJUST...	239,226.00
Retained Earnings	-441,608.61
Net cash provided by Financing Activities	3,799,048.79
Net cash increase for period	-383,404.90
Cash at beginning of period	6,345,161.01
Cash at end of period	**5,961,756.11**

Matters or proceedings of significance occurring during the fiscal year ending June 30, 2021, or in progress at June 30, 2021, are as follows, to-wit:

-The Central Oklahoma Master Conservancy District Balance Sheet (Prev. Year Comparison) as of June 30, 2021, and Profit & Loss-(Prev. Year Comparison) for the Fiscal Year Ending June 30, 2021, are attached hereto and made a part of the Annual Report of the Board of Directors.

-Refer to the copy of the (most recent) annual audit for FYE 6/30/20 by Finley & Cook., Certified Public Accountants, which is attached hereto.

-Refer to the summary of legal matters of significance affecting the Conservancy District during FYE 6/30/21, labeled "Addendum re Legal Matters to Annual Report of Central Oklahoma Master Conservancy District to the Cleveland County District Court", which is attached hereto.

The above is a true and complete report as required by statute.

Witness our hands this ___ day of _______________, 2021.

President

Treasurer

Attest:

Secretary

Bank Reconciliation:

Balance per BancFirst Bank Statement Acct # xxxx3940 dated June 30, 2021	$150,001.23
Balance per BancFirst Bank Statement Acct # xxxx0014 dated June 30, 2021	$1,907,938.89
Subtotal	$2,057,940.12
Add: Deposits in transit at June 30,2021	15,480.00
Less: checks outstanding at June 30, 2021	
Check #20261 to Rose State College	($260.00)
Check #20274 to Amanda Nairn	($798.40)
Check #20276 to Kevin Anders	($530.36)
Check #20286 to Watkins Insurance	($8,199.10)
Check #20291 to Cardmember Services	($1,987.35)
Check #20292 to Charles Wadsack	($480.00)
Check #20294 to Ace Hardware	($930.68)
Check #20297 to Midwest Hose	($95.55)
Check #20298 to Worth Hydrochem	($3,415.00)
Check #20299 to Worth Hydrochem	($24,673.00)
Check #20301 to EMC Insurance	($231.67)
Check #20302 to Charles Wadsack	($480.00)
Check #20303 to Electrical Solutions	($417,520.00)
Check #20304 to OG&E	($31.51)
Check #20305 to Dept of Environmental Quality	($184.00)
Check #20306 to Shouse & Associates	($4,500.00)
Check #20309 to Locke Supply	($83.75)
Check #20310 to Custom Sheet Metal	($300.00)
Check #20311 to Lowe's Home Centers	($41.53)
Check #20312 to Ace of Norman	($61.49)
Reconciled balance Acct#xxx3940 & Acct #xxxx0014 at June 30,2021	$1,608,616.73

Attachments:

-Central Oklahoma Master Conservancy District Balance Sheet (Prev. Year Comparison) as of June 30, 2021

-Central Oklahoma Master Conservancy District Profit & Loss (Prev. Year Comparison) July 2020 through June 2021.

-

-BancFirst, Moore, OK Bank Statement of Account Number xxxx3940 dated 06/29/21

-BancFirst, Moore OK Bank Statement of Account Number xxxx0014 dated 06/29/21

-Addendum re Legal Matters to Central Oklahoma Master Conservancy District Annual Report to the Cleveland County District Court for the Year Ending June 30, 2021.

-Annual Audit for FYE 6/30/20.

3:02 PM
09/02/21
Accrual Basis

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT
Balance Sheet
As of June 30, 2021

	Jun 30, 21		Jun 30, 20	
ASSETS				
Current Assets				
Checking/Savings				
1023-BANCFIRST #3940 & #0014		1,608,616.73		2,218,013.09
1050-LPL FINANCIAL				
1051-LPL ACCT# -2885 AT MARKET	4,332,866.95		4,127,147.92	
1052-LPL ACCRUED INTEREST	20,272.43		0.00	
Total 1050-LPL FINANCIAL		4,353,139.38		4,127,147.92
Total Checking/Savings		5,961,756.11		6,345,161.01
Accounts Receivable				
1800-GRANTS RECEIVABLE		32,500.12		0.00
1900-ASSESSMENTS RECEIVABLE				
1901-DEL CITY				
1902-OPERATIONS AND MAINTENANCE	49,713.31		39,221.53	
1903-POWER	9,639.58		11,077.48	
Total 1901-DEL CITY	59,352.89		50,299.01	
1905-MIDWEST CITY				
1906-OPERATIONS AND MAINTENANCE	127,115.05		100,287.96	
1907-POWER	48,687.36		52,357.51	
Total 1905-MIDWEST CITY	175,802.41		152,645.47	
1909-NORMAN				
1910-OPERATIONS AND MAINTENANCE	137,812.86		108,728.02	
1911-POWER	60,129.71		60,375.51	
Total 1909-NORMAN	197,942.57		169,103.53	
Total 1900-ASSESSMENTS RECEIVABLE		433,097.87		372,048.01
Total Accounts Receivable		465,597.99		372,048.01
Other Current Assets				
1920-(BANCFIRST)-DWSRF ESCROW		24,530.97		24,639.87
1951-DWSRF REPYMT DUE-CURRENT		64,658.79		64,566.56
Total Other Current Assets		89,189.76		89,206.43
Total Current Assets		6,516,543.86		6,806,415.45
Fixed Assets				
2000-WATER SUPPLY ASSETS				
BUILDING AND STRUCTURES	54,811.23		54,811.23	
DAM AND RESERVOIR	4,605,177.00		4,680,177.00	
EQUIPMENT AND FENCE	31,209.74		31,209.74	
NEW DEL CITY PIPELINE	6,507,813.90		2,897,504.47	
PIPELINE	3,402,225.92		3,402,225.92	
PUMPING PLANT	1,593,951.30		1,593,951.30	
Total 2000-WATER SUPPLY ASSETS		16,195,189.09		12,659,879.66
2010-TRANSFERRED FROM BUREC				
OFFICE FURNITURE & FIXTURES	1,326.00		1,326.00	
SHOP TOOLS	853.00		853.00	
Total 2010-TRANSFERRED FROM BUREC		2,179.00		2,179.00
2020-OTHER PURCHASED ASSETS				
BUILDINGS,STRUCTURES & ROADS	2,065,006.87		2,060,361.87	
OFFICE EQUIPMENT	92,029.88		99,280.89	
PLANT AND DAM EQUIPMENT	5,468,678.18		5,004,978.93	
VEHICLES AND BOATS	648,942.23		734,922.67	
Total 2020-OTHER PURCHASED ASSETS		8,274,657.16		7,899,544.36
2030-ALLOWANCE FOR DEPRECIATION		-9,601,140.32		-9,330,895.20
Total Fixed Assets		14,870,884.93		11,230,707.82
Other Assets				
DEBT ISSUANCE COSTS		44,777.00		0.00
DWSRF REPAYMENTS-NONCURRENT		426,318.36		520,802.36
NET PENSION ASSET		266,750.00		0.00
Total Other Assets		737,845.36		520,802.36
TOTAL ASSETS		**22,125,274.15**		**18,557,925.63**

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT
Balance Sheet
As of June 30, 2021

	Jun 30, 21		Jun 30, 20	
LIABILITIES & EQUITY				
Liabilities				
Current Liabilities				
Accounts Payable				
4000-CURRENT CLAIMS PAYABLE		0.00		32,684.03
Total Accounts Payable		0.00		32,684.03
Other Current Liabilities				
4000.1-DEFERRED PENSION COSTS		25,963.85		0.00
4000.2-MISC PENSION PAYABLES		3,717.38		0.00
4002-DWSRF INTEREST PAYABLE		26,001.40		897.21
4009-FYE ACCRUALS		105,563.89		685,884.26
4010-PAYROLL DEDUCTIONS				
4011.1-SOCIAL SECURITY PAYABLE	333.78		0.00	
4011.2-MEDICARE PAYABLE	78.06		0.00	
4014-RETIREMENT PLAN PAYABLE	-1,572.55		4,864.85	
4016-GROUP INSURANCE PAYABLE	0.00		787.00	
Total 4010-PAYROLL DEDUCTIONS		-1,160.71		5,651.85
4017-COMPENSATED ABSENCES		31,975.65		17,150.38
4019-CONTRACTS-DUE W/I 1 YEAR				
4019.3-DWSRF CURRENT PYMTS	94,484.00		94,428.05	
Total 4019-CONTRACTS-DUE W/I 1 YEAR		94,484.00		94,428.05
Total Other Current Liabilities		286,545.46		804,011.75
Total Current Liabilities		286,545.46		836,695.78
Long Term Liabilities				
4020-CONTRACTS PAYABLE				
4055-DWSRF PAYMENTS				
4075-SUBSEQUENT PAYMENTS	426,318.36		520,802.36	
Total 4055-DWSRF PAYMENTS	426,318.36		520,802.36	
4080-NEW DEL CITY PIPELINE LOAN	5,203,207.23		1,539,477.43	
Total 4020-CONTRACTS PAYABLE		5,629,525.59		2,060,279.79
Total Long Term Liabilities		5,629,525.59		2,060,279.79
Total Liabilities		5,916,071.05		2,896,975.57
Equity				
4802-BOR MANDATED MAINTRESERVE		50,000.00		50,000.00
4803-RESTRICTED-CAP IMPRVEMENTS		400,000.00		400,000.00
4806.5 UNRESTRICTED SURPLUS				
4807-UNRESTRICTED SURPLUS	15,210,950.06		14,778,764.46	
4808-FYE '21 ADJUSTS-PRIOR YRS	229,802.99		-9,423.01	
Total 4806.5 UNRESTRICTED SURPLUS		15,440,753.05		14,769,341.45
Net Income		318,450.05		441,608.61
Total Equity		16,209,203.10		15,660,950.06
TOTAL LIABILITIES & EQUITY		**22,125,274.15**		**18,557,925.63**

3:00 PM
09/02/21
Accrual Basis

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT
Profit & Loss Prev Year Comparison
July 2020 through June 2021

	Jul '20 - Jun 21	Jul '19 - Jun 20	$ Change
Income			
4900-ASSESSMENTS			
4901-MUNI SHARE, OPERATING COST			
4902-DEL CITY	198,853.27	313,772.20	-114,918.93
4903-MIDWEST CITY	508,460.26	802,303.60	-293,843.34
4904-NORMAN	551,251.47	869,824.20	-318,572.73
Total 4901-MUNI SHARE, OPERATING C...	1,258,565.00	1,985,900.00	-727,335.00
4905-MUNI SHARE, POWER			
4906-DEL CITY	65,625.00	65,625.00	0.00
4907-MIDWEST CITY	264,600.00	264,600.00	0.00
4908-NORMAN	194,775.00	194,775.00	0.00
Total 4905-MUNI SHARE, POWER	525,000.00	525,000.00	0.00
4900-ASSESSMENTS - Other	0.00	11,681.76	-11,681.76
Total 4900-ASSESSMENTS	1,783,565.00	2,522,581.76	-739,016.76
4920-OTHER REVENUES			
4921-MISCELLANEOUS RECEIPTS	174,828.49	26,882.62	147,945.87
4922- ASSESSMENT ADJUSTMENTS	-49,187.10	-300,490.60	251,303.50
4923-INVEST INT DIVS & GAINS	151,326.94	141,689.58	9,637.36
4925-DWSRF INTEREST INCOME	3,384.91	3,812.07	-427.16
4930-SECURITIES VALUE ADJUSTS	96,122.18	55,788.59	40,333.59
Total 4920-OTHER REVENUES	376,475.42	-72,317.74	448,793.16
Total Income	2,160,040.42	2,450,264.02	-290,223.60
Expense			
5000-PERSONNEL			
5000.1-EMPLOYEES' WAGES	438,041.21	371,110.02	66,931.19
5009-EMPLOYEES' RETIREMENT	49,275.33	23,771.34	25,503.99
5010-DIRECTORS' EXPENSES	4,343.62	4,813.87	-470.25
5011-PAYROLL TAXES	34,876.38	29,693.63	5,182.75
5012-TRAINING, EDUCATION&TRAVEL	3,365.81	2,677.85	687.96
5013-UNIFORM & BOOTS ALLOWANCE	2,150.20	2,163.99	-13.79
5014-EMPLOYEE HEALTH, ETC, INS.	47,953.10	48,756.04	-802.94
5015-WORKMEN'S COMPENSATION	3,963.55	10,933.64	-6,970.09
5016-ANNUAL LEAVE ADJUSTMENTS	14,825.27	9,858.13	4,967.14
5017-SERVICE & SAFETY AWARDS	4,950.59	2,725.00	2,225.59
5018-TEMPORARY HELP	1,764.00	16,630.00	-14,866.00
5019-SEVERANCE	0.00	89,133.66	-89,133.66
Total 5000-PERSONNEL	605,509.06	612,267.17	-6,758.11
5100-MAINTENANCE			
5101-PLANT& DAM R&M, SUPPLIES	37,708 92	62,075.66	-24,366.74
5103-VEHICLE OPS, R&M	17,391.99	30,251.94	-12,859.95
5104-BUILDINGS ROADS & GROUNDS	9,716.97	8,386.56	1,330.41
5106-EQUIPMENT R&M, RENTAL	11,374.04	23,355.30	-11,981.26
Total 5100-MAINTENANCE	76,191.92	124,069.46	-47,877.54
5200-UTILITIES			
5201-TELEPHONE,PAGING,IT SERVIC	24,596.95	23,690.32	906.63
5204-ELECTRICITY	9,642.82	10,482.86	-840.04
5205-PROPANE	1,831.50	2,655.00	-823.50
5206-WASTE REMOVAL	1,167.84	834.69	333.15
Total 5200-UTILITIES	37,239.11	37,662.87	-423.76
5300-INSURANCE AND BONDS			
5301-INSURANCE	72,748.77	54,962.20	17,786.57
5305-TREASURER &EMPLOYEE BONDS	250.00	250.00	0.00
Total 5300-INSURANCE AND BONDS	72,998.77	55,212.20	17,786.57
5400-ADMINISTRATIVE EXPENSE			
5401-OFFICE SUPPLIES, MATERIALS	10,511.60	16,347.14	-5,835.54
Total 5400-ADMINISTRATIVE EXPENSE	10,511.60	16,347.14	-5,835.54
5500-PROFESSIONAL SERVICES			
5501-LEGAL	23,379.92	19,070.33	4,309.59
5502-ACCOUNTING AND AUDIT	25,510.00	24,310.00	1,200.00
5503-CONSULTANTS AND ENGINEERS	29,173.00	0.00	29,173.00
5511-WETLAND-SHORELINE STABILIZ	-2,598.91	83,221.45	-85,820.36
Total 5500-PROFESSIONAL SERVICES	75,464.01	126,601.78	-51,137.77
5600-WATER QUALITY SERVICES			
5601-STREAM GAUGING (OWRB)	12,400.00	12,400.00	0.00
5603-WATER QUALITY MONITORING	63,813.76	80,038.80	-16,225.04
5607-O2 TANK RENTAL-SDOX SYSTEM	0.00	52,468.94	-52,468.94
Total 5600-WATER QUALITY SERVICES	76,213.76	144,907.74	-68,693.98
5700-CONTINGENCY	0.00	0.00	0.00
5800-PUMPING POWER	476,598.36	484,428.64	-7,830.28
5976-INTEREST EXPENSE-DWSRF	2,820.31	3,292.45	-472.14
6000-DEPRECIATION	408,043.47	403,865.96	4,177.51
Total Expense	1,841,590.37	2,008,655.41	-167,065.04
Net Income	**318,450.05**	**441,608.61**	**-123,158.56**

Dir 1 251 52 63X0C.001 BNCF:0004975

PO BOX 6309
MOORE, OK 73153-0309
(405) 794-5511

BancFirst Loyal
To Oklahoma & You

(405) 495-2489

4 *0004975
CENTRAL OKLAHOMA MASTER
CONSERVANCY DISTRICT
12500 ALAMEDA DR
NORMAN OK 73026-8604

PAGE 1

ACCOUNT NUMBER
[redacted]3940
STATEMENT DATE
6/30/21

ACCOUNT ANALYSIS

Beginning Balance	6/01/21	150,001.27	
Deposits / Misc Credits	22	249,784.60	
Withdrawals / Misc Debits	55	249,784.64	
** Ending Balance	6/30/21	150,001.23	**

Service Charge	65.11
Interest Paid Thru 6/30/21	1.23
Interest Paid Year To Date	5.53
Annual Percentage Yield Earned	.01%
Number of Days for A.P.Y.E.	30
Average Balance for A.P.Y.E.	150,000.00
Enclosures	52

8002-00000

DEPOSITS

Date	Deposits	Withdrawals	Activity Description
6/01	17,046.50		LPL/CREDIT
6/03	75.00		Trnsfr from Checking Acct Ending in 0014
6/08	480.00		Trnsfr from Checking Acct Ending in 0014
6/10	41,055.09		Trnsfr from Checking Acct Ending in 0014
6/11	1,370.00		Trnsfr from Checking Acct Ending in 0014
6/14	4,625.78		Trnsfr from Checking Acct Ending in 0014
6/15	5.66		DEPOSIT
6/15	2,166.00		DEPOSIT
6/15	41,634.19		Trnsfr from Checking Acct Ending in 0014
6/16	11,648.89		Trnsfr from Checking Acct Ending in 0014
6/17	543.40		Trnsfr from Checking Acct Ending in 0014

Continued on Reverse

BANCFIRST Dir 1 192X0W.003 BNCF:0008671

PO BOX 6309
MOORE, OK 73153-0309
(405) 794-5511

(405) 495-2489

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CENTRAL OKLAHOMA MASTER
CONSERVANCY DISTRICT
12500 ALAMEDA DR
NORMAN OK 73026-8604

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6/30/21

Sweep Fee Rebate Notice

- *What is a Sweep Fee Rebate?* Low interest rates initiated by the Federal Reserve have reduced sweep account rates to a point that BancFirst is voluntarily rebating a portion of your sweep fee.
- *How will I identify a Sweep Fee Rebate?* The credit to your account will be identified with a statement description of "Sweep Fee Rebate".
- *How is the Sweep Fee Rebate calculated?* As Sweep Dividend yields decrease BancFirst will rebate 1 basis point of our sweep fee for every 4 basis points below a dividend yield of 150 basis points. Using this calculation the entire Sweep Fee would be rebated on Sweep Dividend yields of 50 basis points or lower. BancFirst will utilize the same calculation in reverse as Sweep Dividend yields increase.
- *I have questions. Who can I call?* Contact your BancFirst Account Officer today for more details or additional options.

GOVERNMENT OBLIGATIONS TAX-MANAGED FUND
7 DAY YIELD 0.01%

Mutual funds are not deposits or obligations of any bank, are not guaranteed by any bank, and are not insured or guaranteed by the FDIC, the Federal Reserve Board, or any other government agency.

8022-00000

SWEEP ACCOUNT

Beginning Market Value	6/01/21	2,116,410.46
Purchases / Misc Credits	4	16,501.21
Redemptions / Misc Debits	17	224,972.78
** Ending Market Value	6/30/21	1,907,938.89 **

Periodic Fee	.00
Dividend Paid Thru 6/30/21	16.87
Dividend Paid Year To Date	103.37

DEPOSITS

Date	Deposits	Redemptions	Activity Description
6/01	444.60		SWEEP FEE REBATE
6/01	15,974.63		PURCHASE
6/22	65.11		PURCHASE
6/30	16.87		DIVIDEND PAID

OTHER DEBITS

Date	Deposits	Redemptions	Activity Description
6/01		444.60	SWEEP FEE
6/03		75.00	REDEMPTION
6/08		480.00	REDEMPTION
6/10		41,055.09	REDEMPTION

Continued on Reverse

Addendum re Legal Matters to Annual Report of Central Oklahoma Master Conservancy District to the Cleveland County District Court

Other than appointments of Board members by the District Court, the transfer of surplus property to the Oklahoma Department of Tourism and Recreation was approved by the District Court during the past year.

Central Oklahoma Master Conservancy District
Board Officers and Members for FY 20-21

City	Director	Term expires
Norman	Amanda Nairn, President	June 2022
Midwest City	Casey Hurt, Vice-President	June 2024
Midwest City	Kevin Anders	June 2022
Norman	Jann Knotts, Treasurer	June 2024
Midwest City	William Janacek	June 2022
Norman	Roger Frech	June 2022
Del City	Michael Dean, Secretary	June 2024

As of June 30th, 2021, the District's officers were: Amanda Nairn, president, and chairman of the Board, Casey Hurt, vice-president, Michael Dean, secretary; and Jann Knotts, treasurer.

The District Manager is Kyle Arthur.

General Counsel is Dean Couch, OBA#1939

2020-2021 Annual Report to the District Court of Cleveland County Year Summary of Major Actions

Letter sent to Bureau of Reclamation requesting Temporary Water Delivery Contract 169E640075 for the Norman Project be revised:

1. to clarify annual period for maintaining records about the actual quantity of Temporary Water delivered is the 12-month period beginning October 1 through September 30.
2. Temporary Water Delivery Contract be revised to require that actual Temporary Water deliveries be reported by the District to the Bureau annually instead of monthly
3. contract delivery amount be revised from 10,000 acre-feet to 25,000 acre-feet
4. for an extension to the term of the Contract, until June 30, 2040

Execution of Memorandum of Agreement with OWRB and USGS for stream gaging fiscal year ending June 2021, cost $12,400.00

Recognition of reappointments of Jann Knotts and Casey Hurt to the Board, each for a four-year term expiring June 2024, by the Cleveland County District Court, and signing of their respective oaths of office

Election of officers, Amanda Nairn was elected President and Chairman of the Board. Casey Hurt was elected Vice-President. Jann Knotts was elected Treasurer. Michael Dean was elected Secretary.

Approval of Declaration of Surplus Equipment, September 3, 2020

Approval increasing the General Manager's check writing authority for payment of claims to Matthews Trenching for Del City Pipeline Project

Approval of the annual Cleveland County Court report for FY 19-20

Approval of Districts' Schedule of Regular Meetings for calendar year 2021

Approval of Budgeting Policy, November 5, 2020

Approval of renewing COMCD's support to the Oklahoma Association of Reclamation Projects for the services of Jerrod Shouse of Shouse and Associates Consulting

Approval of Investment Policy, November 5, 2020

Approval of Agreement with the OWRB to conduct a long-term trend analysis of Lake Thunderbird water quality data, cost $42,215.00

Approval of Pandemic Attendance Policy for Board members

Approval of modifications to District benefits and budget category adjustment for FY 2021 salaries

The District Board voted to not seek single-purpose title transfer at this time on the Norman Project, December 3, 2020

Approval of modifications to District benefits and budget category adjustment for FY 2021 benefit expenditures

Agreement signed, December 15, 2020, with Doerner, Saunders, Daniel & Anderson, L.L.P for legal counsel

Approval of Declaration of Surplus Equipment, February 4, 2021

The District Board approved the FY 19-20 audit from Finley & Cook

The District entered into an agreement with Worth Hydrochem of Oklahoma, Inc. for SCADA programming and Dell Server, cost $27,973.00

The District approved and awarded contract with Electrical Solutions of Oklahoma, Inc. for plant backup generator replacement, cost $510,213.88

Approval of execution of Intergovernmental Agreement with OWRB for Water Quality Monitoring, cost $62,724.00

Approval of the FY 2022-2024 budget

Approval of Amendment to Engineering Agreement between the District and Alan Plummer Associates, Inc., May 6, 2021, cost additional $11,927.10

Approval of transferring items deemed surplus to Oklahoma Tourism and Recreation Department. Judge Thad Balkman approved motion to confirm transfer surplus property of Central Oklahoma Master Conservancy District to Oklahoma Department of Tourism and Recreation on June 3, 2021

Contract between the Bureau of Reclamation and the District for delivery of Temporary Water. Contract # 219E640007 now supersedes and replaces Contract # 169E640075. Contract date June 23, 2021

Approval of revised and updated Personnel Policy Manual

Approval of Letter of Engagement of Finley & Cook, PLLC to perform FY 20-21 financial audit

Approval of Memorandum Agreement with OWRB & USGS for stream gaging FY ending June 2022, cost $12,400

Approval of a one-time bonus for the General Manager and allowing the General Manager to participate in the OkMRF defined benefit plan, and provide a stipend for cell phone the General Manager uses to conduct District business

Manager's Report – July 2020

- Title Transfer
    - Rough draft of PowerPoint presentation has been mostly completed
    - Will send to James Allard and Dean Couch for input and review
    - Trying to better assess insurance impacts for assets that would be transferred
        - Meeting with Watkins Insurance the week of 6/29 to discuss
- Dean and I drafted, and I have signed and sent, the letter to James Allard at BOR requesting to amend the temporary water contract
    - Change monthly accounting to annual
    - Clarify reporting year to match federal water year (Oct-Sept)
    - Increase usage amount from 10,000 ac-ft to 25,000
- Attended a meeting at the City of Norman regarding an effort by a consultant to assess their building codes relative to "green" building/infrastructure and low impact development
    - City Council goal to have codes that encourage/incentivize green building
    - Met with city staff: holistic overhaul needed, out-of-date, does not incentivize
    - This meeting sought input from developers and builders
    - Positive ultimate impact for Thunderbird with the hopeful implementation of develop projects that would better control run-off
- Work continues on the floating wetlands
    - Students have been out each week
    - All units have been power-washed and are mostly reassembled and structurally reinforced
    - As of the writing of this report, 12 of the 20 units have been planted and are in the water; hope to have the remainder done in the next week to two weeks
- Technology upgrades
    - New laptop for use in the Board room has been delivered
    - A camera for virtual meetings has been installed
    - A new wireless router has been installed to address speed requirements for streaming video
- Met individually with both Del City and Midwest City (Tim Carr also attended)
    - Del City: met with interim City Manager Mike Cantrell and new Board member Michael Dean. Also met with Beverly Palmer, City Attorney
    - MWC: met with treatment plant supervisor Mark Roberts
- Preparing to perform an equipment inventory
    - Evaluating equipment that we use infrequently and could otherwise be rented
    - Identifying items for auction
    - Will come to the Board with any recommendations for approval
- Fencing project on the south and east side of the dam, as requested by BOR, is ongoing. The two areas considered most critical have been completed.
- Plan to post position for permanent maintenance Supervisor
- Held interview with Travis Boone, pipeline inspector, to ultimately replace our current inspector (Dennis Yarbro) for the remainder of the Del City pipeline project

- New air conditioning interface panels have been fabricated for each of the VFD (Variable Frequency Drives) in the pumping plant
    - Will allow back-mounted air conditioners to better and more efficiently circulate air around the VFD
- Participated in Zoom meeting with OU (Nairn and Knox) and the OWRB on the OU CEES Capstone project
    - Trend analysis with potential engineering solutions for identified water quality issues is the chosen project
- Discussed the trend analysis proposal the OWRB is working on with Julie Chambers
    - Discussed integrating an analysis of water quality improvement/technologies based upon findings

Manager's Report – August 2020

- Floating Wetlands Project
  - All units have all been planted and deployed to their location in the lake
  - Data collection is set to begin this first week of August
  - Steve Patterson visited July 30 to inspect progress of work and function and was thoroughly pleased with the status
  - A field day is being scheduled in the near future for all interested parties or people
- Del City Pipeline
  - The new pipeline inspector began July 27th to relieve the temporary inspector Dennis Yarbro. His name is Travis Boone.
- Annual employee evaluations were completed
- On July 10th, the Norman Fire Dept completed another confined spaced training class as well as the familiarization of facilities for emergency response purposes
- Meeting with BOR Supervisors and Deputy Area Manager held with Tim and I. Discussed a broad spectrum of "orientation" topics:
  - Facility Operations Programs: Facility Reviews/Inspections, Emergency Management, Security and Dam Operator Training, SOPs
  - Resource Management Programs: Real Property, NEPA compliance, Cultural resources, Trespass and Unauthorized Use, Incident Reporting, Pesticide Use, etc
  - Planning and Project Development Programs: Water Conservation, Technical and Financial Assistance
- Dam inspections were performed by BOR on July 22nd. Scheduled full gate operation inspection/ and gate inspection for late August
- Met with Developer of Turtlewood Addition located on the MWC pipeline to discuss drainage issues on behalf of BOR. Awaiting plans/proposals from Home Creations to submit to BOR for approval
- Evaluated a property on behalf of BOR regarding possible erosion problems along Del City Pipeline, that issue is being review by BOR and looks to be a City issue and not a District responsibility
- Met with Midwest City officials over lunch to discuss a variety of current issues
- Visited the office of Watkins Insurance Agency to better understand our policies
  - As a follow-up, also hosted Travis Watkins at the District to take a tour of our facilities and audit against our current policies (equipment and coverages)
  - Also wanted to understand our liability coverage relative to potential partial title transfer
- Sent partial title transfer analysis presentation to James Allard and Dean Couch for their review. Will be incorporating their comments, incorporating some things learned from the meeting with BOR this past month and what we determine from our insurance audit.
- Drafted budgeting policy and vetted with Roger and Jann. Plan to present to Board at the next meeting.

Manager's Report
September 2nd, 2020

- Held interviews for Maintenance Supervisor position. Tim Carr chosen as permanent Supervisor.
- Shoreline Erosion/Wetlands Project
  - Data collection is continuing on the wetlands.
  - ODWC performed a fish survey around the wetlands in comparison to the control point for data collection and results were positive. On average there are 5x more species and quantities of fish life around the floating wetlands.
  - Completed paperwork for access to ASAP and SAM for BOR reimbursement of Wetland Costs as per the agreement between the District and the Bureau of Reclamation.
- Intercom for gate was ordered to work in sync with the new phone systems.
- August 13th & 14th, Kyle and Tim toured two other Master Conservancy Districts (Arbuckle and Mountain Park) to better understand similarities and functions. Discussed budget, employee pay and benefits, title transfer, equipment inventory, etc.
- Held staff meetings with entire District team to discuss equipment needs, possible surplus equipment that is no longer needed, and spare components to ensure full functionality of COMCD's mission.
- Replaced worn drive shaft on Pump 5 (going to Relift). Motor is back in full operational status.
- BOR Visits
  - BOR completed gate inspections following the re-coating of the repaired gate from last year. Additionally, the BOR inspected the other gate to ensure no damage was occurring.
  - BOR also completed full gate exercise for all gates (Emergency and Regulating)
  - In accordance with BOR's O&M recommendations, a dehumidifier was ordered for gate house cellar to reduce corrosion
- Began ordering of approved New Capital Assets for FY20-21.
- Global Production Systems (GPS) toured the facility as a possible local vendor for equipment at the Pumping Plant, as well as at the Relift station.
- Two employees completed License Renewal Training to retain their Class C Operator license.
- Held monthly Construction Progress Meeting for the Del City Pipeline Project.
- Alliance Maintenance performed Sanitation Cleaning of Office Headquarters.
- August 11th, Aflac visited the office for insurance information and inquiries
- August 24th, American Fidelity did the same. (Current Provider)
- New phone system installed
- Continued work on Budgeting Policy. Currently evaluating equipment need and schedule of replacement for 10-year horizon.
- Received recommendations from Watkins Insurance Agency audit. Will have Tanner Watkins present at an upcoming Board meeting.

- Continued work on Title Transfer presentation. Plan to have as discussion item at the October Board meeting.
- Working on an analysis of pay and benefits for District employees. Plan to make a presentation and recommendations to the Board in the near future.

Manager's Report – October 2020

- Shoreline Erosion/Floating Wetlands
  - Data collection continues
  - OU Students/staff visiting multiple time a week
  - The redesigned wetland units are proving more efficient and durable compared to previous runs
- Equipment building was cleaned out and organized to allow for equipment storage for upcoming winter months.
- Leak was located on MWC line
  - After uncovering leak, found the problem was a leaking bell connection
  - Ordered Bell clamp to fix and it should be by Oct 2nd
  - Midwest City was informed and have been updated on status of repair and schedule
- OG&E sub contractors cleared and trimmed trees on property that were in utility easement
- Performed CCTV on Del City pipeline to prepare for line segment 1 compressed liner work
  - Access windows were cut in two spots on the line on either side of Sooner Road/Crutcho Creek
  - After completing inspection, a leak was noticed and repaired
  - Del City is back to normal operational status
- Held Staff safety meeting Sept 14th
- Repaired leaking air relief valve located near the intake structure on the lake.
- Re-connected barrier buoys surrounding intake structure
- Met with Southwest Electric on September 22 to inquire about motor, pump, and controls support they may be able to provide
- Set up meeting with representative from Prime Controls regarding telemetry and programming needs
  - Meeting is tentatively scheduled for Oct. 7th, 2020
- Kelley and I met with the cities of Norman, Midwest City and Del City to discuss job titles, pay schedules and benefits
  - Working on a presentation of findings and recommendations for upcoming Board meeting
- Met with Rob Lockard, Jann, Dean and Amanda to discuss investment policy revisions
  - Comments due by October 7th
  - Target is to present at November Board meeting if ready
- Casey, Amanda, and I will meet with Susie Snider, manager of Lake Thunderbird State Park, on Wednesday, September 30
- Lunch meeting scheduled with Chris Mattingly, new Director of Utilities at the City of Norman, for Monday, September 28
- Attended a meeting of the Oklahoma Association of Reclamation Projects (OARP) at Quartz Mountain Lodge on September 10-11
- Met with Jerrod Shouse, lobbyist for the OARP, on September 21
  - Previously on contract with COMCD; would recommend future contract through OARP
- Received recommendations back from Tanner Watkins of Watkins Insurance for policy additions
  - Will be preparing discussion for upcoming Board meeting

Manager's Report – November 2020

- Data collection continued with OU on the shoreline erosion/wetlands project
  - Extension received from BOR
- Leak on the MWC line has been repaired
  - Involved a special-order bell clamp and gasket: tremendous work by the team!
- Met with property owners neighboring easement on Del City pipeline project
- Discussed work schedule along with property access for the first pull of HDPE liner pipe west of Sooner Rd
- Met with Prime Controls to discuss telemetry programming and settings and schedule a full assessment of current operation systems
  - assessment is tentatively scheduled for the week of NOV 9th
- Met with Total Construction Inc. to discuss the possibility of upgrade on back-up generator for the pumping plant
  - Will be obtaining additional quotes and commence bid solicitation
- Met with Jacob Harrington from Big Iron Auctions to place approved surplus equipment on auction site
  - Auction opened for bids on Nov. 4t and will end on Nov. 25th
- Sent 3 spare VFDs to GPS for load testing and repairs if needed
  - Will serve as back-ups for 350hp, 250 hp and 100 hp motors at Plant and Relift facilities
- Finely and Cook began audit process Oct 19th
- New communications antenna was installed on the "Checkerboard" surge tower along with a cable fall arrest system
  - Cable fall arrest systems installed now on Checkerboard and MWC Surge towers
  - Will be installed on Norman surge tower next
- Held Monthly Del City Construction Meeting Oct. 27th and decided to have weekly meetings moving forward given the complexity of the compressed fit liner installation
- Presented to Norman Business Association on Friday, October 9th
  - Background and history of the District; current events
- Participated in conference calls in support of the development of the Investment and Budget policies
- Presented partial title transfer presentation to the City of Norman
  - Del City presentation to be Nov. 9th; Midwest City on Nov. 17th
- Participated in call hosted by the USACE to discuss replacement and relocation of Del City pipeline segment under Tinker property
  - Current in very preliminary stages of design; construction planned to start 1Q/2Q 2022
- Held preliminary discussion with BOR on old office demolition and requirements for possible additional equipment storage facility
- Added equipment to our insurance policy based upon the results of our "audit"

Manager's Report – December 2020

- Work continues on the Shoreline Stabilization/Floating Wetlands project
  - Along with data collection, the recent weather brought about additional maintenance. (high winds, ice storm, fluctuation of elevation… etc.)
  - Collection will continue through second week of December and Final Report to follow upon translation of data (by March 31st, 2021)
- Identified need for portable diesel tank, particularly for the relift during weather events for the emergency generator.
  - Researching various models and prices. Also, the requirements for road hauling
    - It has been determined that the driver needs the "H" endorsement on license. (CDL)
- Mowing season is coming to an end. End of season maintenance being performed on tractors and mowers. (Oil changes, filter cleanings, blades… etc.)
- Held staff meeting on November 19th for safety and to discuss upcoming tasks to be completed during the winter season. (Re-lift paint, fencing, facility maintenance and clean up… etc.)
  - Re-lift floor and pumps getting a "make-over"
  - Power washed Office building
- The back up generator for the office (included in the budget for FY 20-21 under new capital assets) was ordered and should arrive by end of November
- Prime Controls, Inc. did an overall analysis of our current software and telemetry equipment
  - Awaiting the results of their findings and quote to complete should we choose to move forward on any/all their recommendations
- Auction ended Nov. 25th for our surplus equipment liquidation
  - There is one more item that is scheduled to be auctioned by Dec 16th. It was delayed due to the fact it was posted as "inoperable" but is operational and we were advised to push to the next auction to bring in more money.
- Researched requirements of the competitive bidding process and any existing State contracts for Generator Replacement.
  - No State contracts are available to utilize, therefore bidding process will begin
  - Plan to advertise starting the week of December 7.
- Presented partial title transfer analysis and findings to officials with Del City and Midwest City
- Tim met with a representative from OEC regarding the solar garden being built south of Robinson between 60th and 48th and the crossing of the pipeline easement. He has been working with Ashley Dixson from the BOR in the matter
- Finished up recommendations on salary schedule, promotional plan, and benefits package modifications
- Spent time researching the Open Meeting Act, along with Dean, Amanda, and Kelley, to prepare for December meeting to ensure compliance
- I have been asked to serve on the Technical Advisory Group for the Lake Thunderbird Watershed Alliance

    - Participated in initial virtual meeting on November 16th
- Witnessed one of the first "pulls" of the compressed fit liner on the Del City pipeline project
    - Staff attended for learning opportunity
- Received draft contract from BOR for amendments to our temporary water contract
    - Dean and I are reviewing

Manager's Report – February 4th, 2021

- Shoreline Erosion Project
  - Dec 31st concluded the data collection from the floating wetland project
  - Approximately $19,000 left of BOR funds
    - One more invoice from OU
    - Opportunity to bill time to the project as we remove units from the water
- Clean-up, Beautification and Maintenance
  - Relift facility and gatehouse meticulously cleaned and repainted floor, motors, piping, etc.
  - Gatehouse cleaned and painted inside as well
  - Cleaned-up all the "bone yard" area east of the road between the office and the plant
    - 3 roll-offs filled with debris collected over the last several decades
    - Metal that could be salvaged was taken to recycler. Over $3,000 collected
  - Similar clean-up around shop area
  - Identified additional surplus equipment to auction
  - Gate chamber was cleaned out from gate repairs and de-humidifier installed according to BOR Recommendation report
- Replaced heater in gatehouse to avoid damage during freezing weather
- Contacted, met with and received proposals for needed software, hardware and programming of new Human Machine Interface (HMI) from two companies
  - Prime Controls of Lewisville, TX
  - Worth Hydrochem of Norman, OK
- Staff meetings with outside benefits vendors
  - Met with American Fidelity to re-enroll on December 15th
  - Met with Horizon Financial Services (457b) to discuss investments and market conditions
- Reorganized file/work room
  - Re-located several file cabinets
  - Preparing for possible old office demo
- Back-up Generator at Main Plant
  - Assembled bid packet
  - Published notice in Norman Transcript and Journal Record (3 times each)
  - Pre-bid conference held on January 25th (four companies attended)
  - Bids due Feb 5th; to be opened on Feb 8th
- Reserved Boom lift for surge tower exterior coating spot repair in May
  - Identified on recent Associated Facility Review by BOR
- Held Staff meeting to discuss benefits changes as well as upcoming tasks for winter season
- Christmas lunch was prepared by Kyle and Kelley and held on December 11th
- Gutters were installed on office building

- Motor #5 (Del City) at re-lift was serviced by Southwest Electric
    - New vendor, pleased with service
- Technician from Hydradyne assessed and serviced gatehouse pump
    - Has been extremely noisy for several years
    - Recommended a new pump which has been ordered
- Had "spare" VFDs load tested to ensure we had back-ups available
    - Will need a spare 100-hp for Relift facility (MWC side)
- Continued investigation of building quotes for new storage facility
- Continued work on needs for demo old office building. (electric relocation, data/coms relocation, inspections, etc...)
    - Office back-up generator order; should arrive any day
- Successfully renegotiated an amended and extended contract with BOR for temporary water use
    - Will be coming to the Board for action in March
    - This is the federal contract that allows the District to use temporary water (Norman, in turn, purchases through a contract from the District)
- General Manager participated in two workgroups for which he has been asked to serve
    - Lake Thunderbird Watershed Alliance Technical Advisory Group
    - Oklahoma Opinion Leaders Network (OLAN) for S^3OK: Finding Socially Sustainable Solutions for Water, Carbon, and Infrastructure Resilience in Oklahoma
- Commenced comprehensive review of the Personnel Policy Manual
    - Updated with new benefits changes
    - Working with Kristen Brightmire whom the District has utilized previously

Manager's Report – March 2021

- Storm Related Issues
  - Several days where pumps were being operated by hand due to communications issues from the storm
    - Looking into other options for tank level measurements to help with freezing issues in the future
    - New HMI software will allow for remote control of pumps
  - Two significant leaks on the relift line
    - One on a blow-off valve
    - The other was on an air relief valve
- Worked commenced with Worth Hydrochem of Norman to develop new software programming for our Human Machine Interface (HMI)
  - Ignition is the new software, which will replace Lookout
  - Anticipate work will be completed by mid-April
  - Two new workstations to support the software; two servers purchased (one as back-up)
- Met with two construction companies to get quotes on gravel work around emergency spillway
  - O&M Recommendation from BOR
- Reviewed bids for back-up generator at the plant
- Del City Shut down began on Feb 8th.
  - Shut down was cut short due to the winter storm and desire to have service available to Del City
  - Crews worked extremely hard to get complete installation of compressed fit liner and valves at the Sooner Road pull
  - Leak was discovered and repaired at the relift facility
- Additional data collection was performed for the floating wetlands to supplement data previously collected
  - Final report from OU forthcoming
- Met with steel building contractor to discuss needs, site plan and cost for new equipment storage building
- Luncheon meeting scheduled at District office with Lake Thunderbird State Park leadership for March 9th
- Lectured to OU Civil Engineering and Environmental Science Capstone class on February 9th
  - Talked about the project, the district, water quality and water quantity issues
- Continued participation in two workgroups
  - Technical Advisory Group for the development of the Lake Thunderbird Watershed Alliance
  - Scoping discussions on potential project ideas for passive treatment systems/wetlands within the watershed of Lake Thunderbird and Norman
- Oklahoma Association of Reclamation Projects meeting reschedule for March 12th
- Worked with Kristen Brightmire and Dean Couch on changes to the personnel manual

Manager's Report – May 2021

- Reclamation Inspections
    - Reclamation staff, including some from the Technical Services Center in Denver, completed various routine/scheduled inspections recently
        - April 14th performed mechanical inspection
        - April 15th performed dive examination of inlet works at gates
        - April 29th performed civil exam of the dam and associated facilities
- Shoreline Erosion Project
    - Shoreline Erosion project data collection was concluded, and removal of wetland frames was completed April 27th, 2021.
    - Barge is scheduled for May 7th to remove concrete anchors
    - Final Report from OU and presentation tentatively scheduled for June Board meeting
- Generator Replacement
    - Kick-off meeting held on April 8th
    - Generator replacement project work officially broke ground on April 26th with relocation of current back-up generator
    - Foundation and conduit prep work currently underway
    - ETA of new generators is May 27th
- Big Iron Auction items were open to bid on April 14th. Bids close on May 5th.
- Hosted meeting with Lake Thunderbird State Park staff to discuss various items.
    - Parks had an interest in two items the Board had deemed surplus
    - Resolution to approve their transfer is on current agenda
- Completed remodel of Control Room/HMI building.
    - Dave and Jim did excellent work!
    - Created a completed connected building (3 rooms + bathroom)
    - Rehabilitated existing bathroom
    - Organized and cleaned out old chlorine room for use as a workshop
- Met with three contractors to obtain estimates on placing gravel along sidewalls of emergency spillway as per the recommendation of Reclamation
- Security cameras were ordered and will be installed inside buildings to be able to remotely and safely inspect any alarms we receive
- HMI Programming
    - Paul Cunningham with Worth Hydrochem is continuing work on updating the platform to replace our current HMI software ("Lookout") with "Ignition".
    - Met with staff on two occasions to receive input on desired functionality
    - Has completed the major of the programming; currently working on reporting features
- May 3rd, walk-through punch list meeting with Plummer, Travis Boone (inspector).
    - Estimated final completion date is May 21st, 2021.
- Placed new rock on boat jetty to replace damage from past winter storms

- Recorded video for the Lake Thunderbird Watershed Alliance (LTWA)
    - Came on-site and toured facility
    - Talked about the District, water quality, support for the Alliance, etc.
    - Will be posted on LTWA website
- Reclamation has been working on an updated yield model for the lake
    - Plan to meet with the three cities within the next 2-3 weeks
    - Presentation to Board will follow
- Spoke to Norman Rotary on April 8th
- Spoke to OU Civil Engineering and Environmental Science seminar class on April 30th
- Governor Stitt signed into law the bill raising the threshold for requiring the solicitation of bids through the competitive bidding process from $50,000 - $100,000
    - Will be working on updating and enhancing our internal purchasing policy to reflect this change, as well as create a hierarchy for Manager and Board approval thresholds below $100,000

Manager's Report
June 2021

- BOR presented results from most recent update of lake water supply yield model
    - Presented to cities, will present to Board next
    - Next steps are to further refine and enhance the model to develop a conservation plan
        - evaluate and establish lake level triggers for drought contingency planning
        - refine drought scenarios
        - conservation scenarios
        - augmentation and supplemental supplies
- Majority of items from auction have been picked-up
    - Received check from Big Iron for $86,900
    - Total for both auctions of $146,327
- A lot of general maintenance was performed due to recent weather events and otherwise
    - Boathouse repair, boathouse jetty repair, limb removal, septic system problem diagnosis and eventual repair at the shop
- Due to excessive rainfall amounts and days, we are behind on our mowing relative to our typical schedule. Will commence once it dries out satisfactorily.
- Relift O&M
    - Replaced two malfunctional check valves at re-Lift station
    - Removed pump #5 to evaluate and possibly rebuild (Del City)
        - Currently waiting on pump returning from repair
- Held lunch meeting on May 18th with Norman Chamber of Commerce, District 2 County Commissioner, NormanNext and VisitNorman to provide an introduction to the District and a tour
- All technicians and Supervisor completed the annual renewal education for Class D water operator's license
- Spot repair on Norman surge tower completed in fulfillment of BOR recommendation
- General Manager and Supervisor attended BOR training for emergency response and security on June 1st
- Supervisor discussed security protocols with BOR and emergency response agencies in the event of security breach of any kind on district properties
    - Included Norman Police Department, Cleveland County Sheriff, State Park Rangers, and OHP
- Participated in lunch meeting with Midwest City officials on June 1st to discuss budget for 2022
- Participated in EPSCOR Sustainable Solutions for Oklahoma (S3OK) Academy/Town Hall
- General Manager has asked to participate in an Oklahoma Comprehensive Water Plan (OCWP) discussion group by the OWRB
    - Will help develop the programmatic work plan for the OCWP
- Staff met with Paul Cunningham from Worth Hydrochem to discuss reporting functions of new Ignition software

- Participated in May 13th meeting to review and provide comment on the draft RFP for the DC pipeline replacement project across Tinker AFB property
- Met with Mike Smith of BancFirst to discuss some process improvement opportunities with billing and deposits

Central Oklahoma
Master Conservancy District

The Auditors' Communication with
Those Charged with Governance

June 30, 2020

FINLEY & COOK
CERTIFIED PUBLIC ACCOUNTANTS

FINLEY & COOK
CERTIFIED PUBLIC ACCOUNTANTS

December 21, 2020

Board of Directors
Central Oklahoma Master Conservancy District

We have audited the financial statements of the Central Oklahoma Master Conservancy District (the "District") as of and for the year ended June 30, 2020. Professional standards require that we provide you with information about our responsibilities under auditing standards generally accepted in the United States and *Government Auditing Standards*, as well as certain information related to the planned scope and timing of our audit. We have communicated such information in our engagement letter to you dated January 24, 2020. Professional standards also require that we communicate to you the following information related to our audit.

Significant Audit Matters

Qualitative Aspects of Accounting Practices

Management is responsible for the selection and use of appropriate accounting policies. The significant accounting policies used by the District are described in Note 1 to the financial statements. No new accounting policies were adopted and the application of existing policies was not changed during the year. We noted no transactions entered into by the District during the year for which there is a lack of authoritative guidance or consensus. All significant transactions have been recognized in the financial statements in the proper period.

In January 2017, the Governmental Accounting Standards Board issued Statement No. 84, *Fiduciary Activities* (GASB 84). GASB 84 improves guidance regarding the recognition and reporting of fiduciary activities. GASB 84 identifies four types of reportable fiduciary fund types, including 1) pension (and other employee benefit) trust funds, 2) investment trust funds, 3) private-purpose trust funds, and 4) custodial funds. GASB 84 outlines the accounting and disclosure requirements for operating structures that qualify as a fiduciary activity. The District will adopt GASB 84 effective July 1, 2020, for the June 30, 2021, reporting year. The District does not expect GASB 84 to have a significant impact on the financial statements.

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Significant Audit Matters, Continued

Qualitative Aspects of Accounting Practices, Continued

In June 2017, GASB issued Statement No. 87, *Leases* (GASB 87). GASB 87 defines a lease as a contract that conveys control of the right to use another entity's nonfinancial asset (the underlying asset) as specified in the contract for a period of time in an exchange or exchange-like transaction. GASB 87 improves accounting and financial reporting for leases by governments by requiring recognition of certain lease assets and liabilities for leases that previously were classified as operating leases and recognized as inflows of resources or outflows of resources based on the payment provisions of the contract. It establishes a single model for lease accounting based on the foundational principle that leases are financings of the right to use an underlying asset. Under GASB 87, a lessee is required to recognize a lease liability and an intangible right-to-use lease asset, and a lessor is required to recognize a lease receivable and a deferred inflow of resources, thereby enhancing the relevance and consistency of information about governments' leasing activities. The requirements of this Statement are effective for reporting periods beginning after June 15, 2021. The District does not expect GASB 87 to have a significant impact on the financial statements.

In June 2018, GASB issued Statement No. 89, *Accounting for Interest Cost Incurred before the End of a Construction Period* (GASB 89). GASB 89 directs that interest costs incurred during the construction period of an asset be expensed in the period incurred. GASB 89 changes previous guidance regarding capitalized construction costs where such costs were typically included in the capitalized cost of the asset constructed and depreciated over time. The District adopted GASB 89 on July 1, 2019, which did not have a significant impact the financial statements.

Significant Audit Matters, Continued

Qualitative Aspects of Accounting Practices, Continued

In June 2020, GASB issued Statement No. 97, *Certain Component Unit Criteria, and Accounting and Financial Reporting for Internal Revenue Code Section 457 Deferred Compensation Plans—an Amendment of GASB Statements No. 14 and No. 84, and a Supersession of GASB Statement No. 32* (GASB 97). The primary objectives of GASB 97 are to (1) increase consistency and comparability related to the reporting of fiduciary component units in circumstances in which a potential component unit does not have a governing board and the primary government performs the duties that a governing board typically would perform; (2) mitigate costs associated with the reporting of certain defined contribution pension plans, defined contribution other postemployment benefit (OPEB) plans, and employee benefit plans other than pension plans or OPEB plans (other employee benefit plans) as fiduciary component units in fiduciary fund financial statements; and (3) enhance the relevance, consistency, and comparability of the accounting and financial reporting for Internal Revenue Code (IRC) Section 457 deferred compensation plans (Section 457 plans) that meet the definition of a pension plan and for benefits provided through those plans. The requirements of GASB 97 that 1) exempt primary governments that perform the duties that a governing board typically performs from treating the absence of a governing board the same as the appointment of a voting majority of a governing board in determining whether they are financially accountable for defined contribution pension plans, defined contribution OPEB plans, or other employee benefit plans and 2) limit the applicability of the financial burden criterion in paragraph 7 of Statement 84 to defined benefit pension plans and defined benefit OPEB plans that are administered through trusts that meet the criteria in paragraph 3 of Statement 67 or paragraph 3 of Statement 74, respectively, are effective at the date of issuance of GASB 97. The requirements of GASB 97 that are related to the accounting and financial reporting for Section 457 plans are effective for fiscal years beginning after June 15, 2021. For purposes of determining whether a primary government is financially accountable for a potential component unit, the requirements of GASB 97 that provide that for all other arrangements, the absence of a governing board be treated the same as the appointment of a voting majority of a governing board if the primary government performs the duties that a governing board typically would perform, are effective for reporting periods beginning after June 15, 2021. Earlier application of those requirements is encouraged and permitted by requirement as specified within GASB 97. The District is currently evaluating the impact that the adoption of GASB 97 will have on its financial statements.

Significant Audit Matters, Continued

Qualitative Aspects of Accounting Practices, Continued

Accounting estimates are an integral part of the financial statements prepared by management and are based on management's knowledge and experience about past and current events and assumptions about future events. Certain accounting estimates are particularly sensitive because of their significance to the financial statements and because of the possibility that future events affecting them may differ significantly from those expected. The most significant estimates are the useful lives of capital assets and the fair value of investments. We evaluated and tested the estimates in determining that they were reasonable in relation to the financial statements taken as a whole.

The financial statement disclosures are neutral, consistent, and clear.

Difficulties Encountered in Performing the Audit

We encountered no significant difficulties in dealing with management in performing and completing our audit.

Corrected and Uncorrected Misstatements

Professional standards require us to accumulate all known and likely misstatements identified during the audit, other than those that are clearly trivial, and communicate them to the appropriate level of management. Management has corrected all such misstatements. During our audit we proposed several adjustments to the financial statements.

Disagreements with Management

For purposes of this letter, a disagreement with management is a disagreement on a financial accounting, reporting, or auditing matter, whether or not resolved to our satisfaction, that could be significant to the financial statements or the auditors' report. We are pleased to report that no such disagreements arose during the course of our audit.

Management Representations

We have requested certain representations from management that are included in the management representation letter dated December 21, 2020.

Significant Audit Matters, Continued

Management Consultations with Other Independent Accountants

In some cases, management may decide to consult with other accountants about auditing and accounting matters, similar to obtaining a "second opinion" on certain situations. If a consultation involves application of an accounting principle to the District's financial statements or a determination of the type of auditors' opinion that may be expressed on those statements, our professional standards require the consulting accountant to check with us to determine that the consultant has all the relevant facts. To our knowledge, there were no such consultations with other accountants.

Other Audit Matters or Issues

We generally discuss a variety of matters, including the application of accounting principles and auditing standards, with management each year prior to retention as the District's auditors. However, these discussions occurred in the normal course of our professional relationship and our responses were not a condition to our retention.

Other Matters

We applied certain limited procedures to the management's discussion and analysis and the required supplementary information that supplements the financial statements. Our procedures consisted of inquiries of management regarding the methods of preparing the information and comparing the information for consistency with management's responses to our inquiries, the financial statements, and our knowledge we obtained during the audit of the financial statements. We did not audit such information and do not express and opinion or provide any assurance on such information.

Other Required Communications

We as independent auditors are required to:

a. Communicate significant deficiencies and material weaknesses in internal control to those charged with governance.

b. Report directly to the audit committee (or equivalent) any fraud that causes a material misstatement of the financial statements and any fraud involving senior management. Fraud perpetrated by lower-level employees is also to be reported if it resulted in an individually significant misstatement.

c. Report illegal acts or noncompliance with laws or regulations that come to our attention (except those that are clearly inconsequential).

We have nothing to report.

Restriction on Use

This information is intended solely for the use of the Board of Directors and management of the District, and federal and state agencies and is not intended to be, and should not be, used by anyone other than these specified parties.

Sincerely,

Finley & Cook, PLLC

Central Oklahoma
Master Conservancy District

Financial Statements

June 30, 2020 and 2019
(With Independent Auditors' Report Thereon)

FINLEY & COOK
CERTIFIED PUBLIC ACCOUNTANTS

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

FINANCIAL STATEMENTS

Table of Contents

FINLEY & COOK
CERTIFIED PUBLIC ACCOUNTANTS

INDEPENDENT AUDITORS' REPORT

Board of Directors
Central Oklahoma Master Conservancy District

Report on the Financial Statements

We have audited the accompanying financial statements of the Central Oklahoma Master Conservancy District (the "District"), which comprise the statements of net position as of June 30, 2020 and 2019, and the related statements of revenues, expenses, and changes in net position, and cash flows for the years then ended, and the related notes to the financial statements.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation and fair presentation of these financial statements in accordance with accounting principles generally accepted in the United States; this includes the design, implementation, and maintenance of internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error.

Auditors' Responsibility

Our responsibility is to express an opinion on these financial statements based on our audits. We conducted our audits in accordance with auditing standards generally accepted in the United States and the standards applicable to financial audits contained in *Government Auditing Standards*, issued by the Comptroller General of the United States. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditors' judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditors consider internal control relevant to the District's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the District's internal control. Accordingly, we express no such opinion. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of significant accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

(Continued)

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INDEPENDENT AUDITORS' REPORT, CONTINUED

Opinion

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of the District as of June 30, 2020 and 2019, and the changes in financial position and cash flows for the years then ended in accordance with accounting principles generally accepted in the United States.

Other Matters

Accounting principles generally accepted in the United States require that the management's discussion and analysis on pages I-1 through I-4 and the required supplementary information on pages 28 through 31 be presented to supplement the basic financial statements. Such information, although not a part of the basic financial statements, is required by the Governmental Accounting Standards Board, who considers it to be an essential part of financial reporting for placing the basic financial statements in an appropriate operational, economic, or historical context. We have applied certain limited procedures to the required supplementary information in accordance with auditing standards generally accepted in the United States, which consisted of inquiries of management about the methods of preparing the information and comparing the information for consistency with management's responses to our inquiries, the basic financial statements, and other knowledge we obtained during our audits of the basic financial statements. We do not express an opinion or provide any assurance on the information because the limited procedures do not provide us with sufficient evidence to express an opinion or provide any assurance.

Other Reporting Required by *Government Auditing Standards*

In accordance with *Government Auditing Standards*, we have also issued our report dated December 21, 2020, on our consideration of the District's internal control over financial reporting and on our tests of its compliance with certain provisions of laws, regulations, contracts, and grant agreements and other matters. The purpose of that report is to solely describe the scope of our testing of internal control over financial reporting and compliance and the results of that testing, and not to provide an opinion on the effectiveness of the District's internal control over financial reporting or on compliance. That report is an integral part of an audit performed in accordance with *Government Auditing Standards* in considering the District's internal control over financial reporting and compliance.

Finley & Cook, PLLC

Shawnee, Oklahoma
December 21, 2020

MANAGEMENT'S DISCUSSION AND ANALYSIS

This section of the Central Oklahoma Master Conservancy District's (the "District") annual financial report presents a discussion and analysis of its financial performance for the years ended June 30, 2020 and 2019. Please read it in conjunction with the financial statements which follow this section. The following tables summarize the net position and changes in net position of the District for 2020 and 2019.

Statements of Net Position

	June 30, 2020	June 30, 2019
Assets:		
Current assets	$ 3,084,150	2,789,801
Capital assets, net	11,350,852	9,048,555
Net pension asset	266,750	296,618
Other noncurrent assets	4,344,816	4,269,128
Total assets	19,046,568	16,404,102
Deferred outflows of resources related to the pension plan	68,153	79,548
Liabilities:		
Current liabilities	1,113,495	330,257
Long-term debt, less current maturities	2,016,356	615,230
Total liabilities	3,129,851	945,487
Deferred inflows of resources related to the pension plan	94,117	142,058
Net position:		
Invested in capital assets, net	9,196,144	8,338,899
Restricted	50,000	50,000
Unrestricted	6,644,609	7,007,206
Total net position	$ 15,890,753	15,396,105

Statements of Revenues, Expenses, and Changes in Net Position

	Years Ended June 30, 2020	2019
Operating revenues:		
Operations and maintenance	$ 1,985,900	2,011,380
Electric power	236,191	456,759
Total operating revenues	2,222,091	2,468,139
Operating expenses:		
Pumping power	484,429	456,759
Salaries and benefits	595,501	473,160
Other operating expenses	813,116	891,908
Total operating expenses	1,893,046	1,821,827
Operating income	329,045	646,312
Non-operating revenue	165,603	234,194
Changes in net position	494,648	880,506
Net position, beginning of year	15,396,105	14,515,599
Net position, end of year	$ 15,890,753	15,396,105

Overview of the Financial Statements

The three financial statements are as follows:

- Statement of Net Position—This statement presents information reflecting the District's assets, deferred outflows of resources, liabilities, deferred inflows of resources, and net position. Net position represents the amount of total assets, deferred outflows of resources, less total deferred inflows of resources, and liabilities. The statement of net position is categorized as to current and noncurrent assets and liabilities. For purposes of the financial statements, current assets and liabilities are those assets and liabilities with immediate liquidity or which are collectible or becoming due within 12 months of the statement date.

- Statement of Revenues, Expenses, and Changes in Net Position—This statement reflects the operating revenues and expenses, as well as non-operating revenues and expenses, during the fiscal year. Major sources of operating revenues are operations and maintenance, and electric power revenue; and major sources of operating expenses are salaries and benefits, and pumping power expense. Major sources of non-operating income are from investment and interest income. The change in net position for an enterprise fund is the equivalent of net profit or loss for any other business enterprise.

Overview of the Financial Statements, Continued

- Statement of Cash Flows—The statement of cash flows is presented using the direct method of reporting which reflects cash flows from operating, capital and related financing, and investing activities. Cash collections and payments are reflected in this statement to arrive at the net increase or decrease in cash and cash equivalents for the fiscal year.

Financial Highlights

- The decrease in total operating revenues of approximately $246,000 in 2020 compared to the prior year was primarily due to decreased electric power revenue. The decrease in total operating revenues of approximately $213,000 in 2019 compared to the prior year was due to decreased operations and maintenance revenues and electric power revenue.

- The increase in total operating expenses of approximately $71,000 in 2020 compared to the prior year was due primarily to an increase in salaries and benefits of approximately $123,000 and pumping power of approximately $27,000, offset by a decrease in maintenance of approximately $51,000 and professional services of approximately $21,000. The decrease in total operating expenses of approximately $105,000 in 2019 compared to the prior year was due primarily to a decrease in pumping power.

- Total non-operating revenues decreased approximately $68,000 in 2020 compared to the prior year, mainly resulting from a decrease in investment and interest income of approximately $82,000 and a decrease in gain on sale fixed assets of approximately $20,000, offset by a decrease in shoreline stabilization expense of $39,000. Total non-operating revenues increased approximately $385,000 in 2019 compared to the prior year, mainly resulting from an increase in investment and interest income of approximately $267,000, an increase in grant revenues of approximately $39,000, a gain on sale of fixed assets of approximately $34,000, and an increase in other revenues of approximately $84,000, offset by an increase in shoreline stabilization expense of approximately $122,000 and a decrease of water reuse study expense of approximately $83,000.

- During 2020, the District's net pension asset was approximately $267,000, deferred outflows of resources approximated $68,000, and deferred inflows of resources approximated $94,000. During 2019, the District's net pension asset was approximately $297,000, deferred outflows of resources approximated $80,000, and deferred inflows of resources approximated $142,000.

Capital Assets

As of June 30, 2020, the District had invested approximately $20,675,000 in capital assets, including dam and reservoir, land improvements, construction in progress, pipelines, pumping plant, buildings and structures, vehicles, equipment, and construction in progress. Net of accumulated depreciation, the District's net capital assets at June 30, 2020, approximated $11,351,000. As of June 30, 2019, the District had invested approximately $18,014,000 in capital assets, including dam and reservoir, land improvements, construction in progress, pipelines, pumping plant, buildings and structures, vehicles, and equipment. Net of accumulated depreciation, the District's net capital assets at June 30, 2019, approximated $9,049,000. Additional details concerning the District's capital assets can be found in the financial statements (see Note 3).

The District's infrastructure assets, which are reported using the modified approach for depreciation, consisted of dam and reservoir related assets. The infrastructure assets are typically required to have annual condition assessments performed by the U.S. Department of the Interior's Bureau of Reclamation. The condition assessment assigned to the assets was 99 in each of the last two issued assessment reports. A rating of 80 or greater is considered to be a "Good" rating. The District's objective is to maintain a "Good" condition assessment rating.

Debt Administration

As of June 30, 2020 and 2019, the District had notes payable of approximately $2,155,000 and $710,000, respectively, with the Oklahoma Water Resources Board.

Additional details concerning the District's long-term debt can be found in the financial statements (see Note 4).

Contacting the District's Management

This financial report is designed to provide patrons and interested parties with a general overview of the District's finances and to demonstrate the District's accountability for its finances. If you have questions about this report or need additional financial information, contact:

Kyle Arthur, General Manager
Central Oklahoma Master Conservancy District
12500 Alameda Drive
Norman, OK 73026
Telephone: 405-329-5228

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

STATEMENTS OF NET POSITION

June 30,		*2020*	*2019*
Assets			
Current assets:			
Cash and cash equivalents	$	2,590,564	2,098,219
Grants receivable		32,500	-
Assessments receivable—the Cities—Energy Project, current portion		64,567	64,570
Accounts receivable		372,048	605,919
Accrued interest receivable		24,471	21,093
Total current assets		3,084,150	2,789,801
Noncurrent assets:			
Assessments receivable—the Cities—Energy Project		520,802	615,230
Investments		3,779,237	3,607,898
Debt issuance costs		44,777	46,000
Net pension asset		266,750	296,618
Capital assets, net		11,350,852	9,048,555
Total noncurrent assets		15,962,418	13,614,301
Total assets		19,046,568	16,404,102
Deferred outflows of resources:			
Deferred amounts related to the pension plan		68,153	79,548

(Continued)

See Independent Auditors' Report.
See accompanying notes to financial statements.

STATEMENTS OF NET POSITION, CONTINUED

June 30,	*2020*	*2019*
Liabilities and Net Position		
Current liabilities:		
Accounts payable	957,095	216,666
Compensated absences payable	17,151	18,130
Accrued interest payable	897	1,035
Long-term debt, current portion	138,352	94,426
Total current liabilities	1,113,495	330,257
Noncurrent liabilities:		
Long-term debt, less current maturities	2,016,356	615,230
Total liabilities	3,129,851	945,487
Deferred inflows of resources:		
Deferred amounts related to the pension plan	94,117	142,058
Net position:		
Invested in capital assets, net	9,196,144	8,338,899
Restricted	50,000	50,000
Unrestricted	6,644,609	7,007,206
Total net position	$ 15,890,753	15,396,105

See Independent Auditors' Report.
See accompanying notes to financial statements.

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

STATEMENTS OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION

Years Ended June 30,	*2020*	*2019*
Operating revenues:		
Operations and maintenance	$ 1,985,900	2,011,380
Electric power	236,191	456,759
Total operating revenues	2,222,091	2,468,139
Operating expenses:		
Salaries and benefits	595,501	473,160
Maintenance	124,069	174,960
Utilities	37,663	31,017
Insurance and bond	66,146	62,894
Administrative supplies	16,347	21,934
Professional services	43,380	63,656
Pumping power	484,429	456,759
Water monitoring	133,377	144,974
Depreciation	392,134	392,473
Total operating expenses	1,893,046	1,821,827
Operating income	329,045	646,312
Non-operating revenues and (expenses):		
Grant revenue	32,500	39,466
Investment and interest income	204,668	286,513
Gain on sale of fixed assets	14,427	33,831
Interest expense	(11,639)	(3,764)
Shoreline stabilization expense	(83,221)	(121,989)
Other, net	8,868	137
Net non-operating revenues	165,603	234,194
Changes in net position	494,648	880,506
Net position, beginning of year	15,396,105	14,515,599
Net position, end of year	$ 15,890,753	15,396,105

See Independent Auditors' Report.
See accompanying notes to financial statements.

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

STATEMENTS OF CASH FLOWS

Increase (Decrease) in Cash and Cash Equivalents

Years Ended June 30,	*2020*	*2019*
Cash flows from operating activities:		
Cash received from assessments to the Cities	$ 2,455,962	2,547,095
Cash payments for goods and services	(164,982)	(913,194)
Cash payments for salaries and benefits	(603,159)	(556,408)
Net cash provided by operating activities	1,687,821	1,077,493
Cash flows from capital, noncapital, and related financing activities:		
Acquisition and development of capital assets	(2,751,103)	(201,241)
Proceeds from sale of capital assets	71,099	33,831
Proceeds from long-term debt	1,539,477	-
Repayment of debt obligations	(94,426)	(94,361)
Interest paid	(10,554)	(3,902)
Shoreline stabilization	(83,221)	(121,989)
Other, net	5,492	(6,397)
Net cash used in capital, noncapital, and related financing activities	(1,323,236)	(394,059)
Cash flows from investing activities:		
Principal received on assessments receivable	94,431	100,151
Investment and interest income received	148,879	153,352
Purchase of investments	(1,018,124)	(569,884)
Redemption of investments	902,574	500,000
Net cash provided by investing activities	127,760	183,619
Net increase in cash and cash equivalents	492,345	867,053
Cash and cash equivalents at beginning of year	2,098,219	1,231,166
Cash and cash equivalents at end of year	$ 2,590,564	2,098,219

(Continued)

See Independent Auditors' Report.
See accompanying notes to financial statements.

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

STATEMENTS OF CASH FLOWS, CONTINUED

Increase (Decrease) in Cash and Cash Equivalents

Years Ended June 30,	*2020*	*2019*
Reconciliation of operating income to net cash provided by operating activities:		
Operating income	$ 329,045	646,312
Adjustments to reconcile operating income to net cash provided by operating activities:		
Depreciation	392,134	392,473
Changes in deferred amounts related to pensions	(36,547)	137,551
Change in operating assets and liabilities:		
Accounts receivable	233,871	78,956
Net pension asset	29,868	(220,829)
Accounts payable	740,429	42,998
Compensated absences payable	(979)	32
Net cash provided by operating activities	$ 1,687,821	1,077,493

See Independent Auditors' Report.
See accompanying notes to financial statements.

(1) SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Organization and Nature of Operations

The Central Oklahoma Master Conservancy District (the "District") is a governmental organization established pursuant to Oklahoma Statute by order of the Cleveland County District Court entered on September 30, 1959. Its primary purpose is to distribute raw water from Lake Thunderbird to the cities of Del City, Midwest City, and Norman (collectively, the "Cities") for municipal, domestic, and industrial use. The District manages and operates the dam, facilities, land, and rights of way under an agreement with the United States. The District also provides flood control, fish and wildlife benefits, and recreational opportunities. The District was obligated to repay the United States for a portion of the construction cost (considered to be cost related to municipal and industrial water supply), with interest, for which it assessed the member cities annually based on a stated formula. The members of the District's Board of Directors are nominated by the Cities and appointed by the Cleveland County District Court.

Reporting Entity

The financial statements presented herein include only the operations of the District and do not include the assets, liabilities, or results of operations of the Cities serviced.

Basis of Accounting

The District prepares its financial statements on the enterprise fund basis using the economic measurement focus and the accrual basis of accounting. Revenues are recognized when earned and expenses are recognized when the obligation is incurred.

Financial Statement Presentations

The District follows the provisions of the Governmental Accounting Standards Board Statement No. 34, *Basic Financial Statements—and Management's Discussion and Analysis—for State and Local Governments* (GASB 34), in preparing its financial statements.

Cash and Cash Equivalents

For purposes of the statements of cash flows, the District considers all highly liquid investments with an original maturity of 3 months or less to be cash and cash equivalents.

(1) SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES, CONTINUED

Investments

The District's investments are recorded at fair value.

Accounting principles generally accepted in the United States establish a fair value hierarchy for determination and measurement of fair value. The hierarchy is based on the type of valuation inputs needed to measure the fair value of an asset. The hierarchy is generally as follows:

Level 1—unadjusted quoted prices in active market, for identical assets.

Level 2—quoted prices for similar assets or inputs that are observable or other forms of market corroborated inputs.

Level 3—pricing based on best available information including primarily unobservable inputs and assumptions market participants would use in pricing the asset.

In addition to the above three levels, if an investment does not have a readily determined fair value, the investment can be measured using net asset value (NAV) per share (or its equivalent). Investments valued at NAV are categorized as NAV and not listed as Level 1, 2, or 3.

Capital Assets

Capital assets are stated at cost and depreciated on the date they are placed into service. Depreciation is computed using the straight-line method over the estimated useful lives of the assets. The estimated useful lives are 20–25 years for buildings and structures, pumping plant, and pipelines; 7 years for vehicles and office equipment; and 20 years for the Energy Project equipment (a $2,400,000 energy savings construction project) and fencing and equipment.

The District considers the dam and reservoir related assets to be infrastructure assets, which are reported using the modified approach for depreciation. Under the modified approach, infrastructure assets are not required to be depreciated as long as certain requirements, as defined by GASB 34, are met. All expenditures made for infrastructure assets, using the modified approach, are expensed in the period incurred, except for expenditures considered to be for additions or improvements.

Intangible Assets

The District believes its only intangible assets consist of certain rights of way, all of which were received prior to July 2009. Since the District is considered to be a Phase 3 government under GASB 34, the District is not required to retroactively apply GASB Statement No. 51, *Accounting and Financial Reporting for Intangible Assets*. Therefore, the District has not accounted for and reported its right-of-way intangible assets.

See Independent Auditors' Report.

(1) SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES, CONTINUED

Compensated Absences

The District's employees can accrue a maximum of 360 hours of vacation pay. Upon termination, accrued, unpaid hours will be paid at the employee's hourly rate then in effect. Sick leave can be accrued at a rate of 12 days per year (8 hours for every full month of service), but is not paid upon termination.

Income Taxes

Because the District is a governmental institution pursuant to Title 82, Chapter 5 of the Oklahoma Statutes, as amended, the District is exempt from federal and state income taxes.

Concentrations

The District is located in Norman, Oklahoma, and serves the Cities and, therefore, is reliant on the Cities' ability to meet their obligations.

Contingencies

The District carries appropriate insurance with regard to comprehensive general liability, comprehensive automobile liability, personal injury, general property, and workers' compensation insurance.

Equity Classifications

Equity is classified as net position and displayed in three components:

Invested in Capital Assets, Net—Consists of capital assets, net of accumulated depreciation, less the balance of debt incurred to finance the acquisition, construction, or improvement of the related capital assets.

Restricted—Consists of net position with constraints placed on the use either by i) external groups such as creditors, grantors, contributors, or laws or regulations of other governments or ii) law through constitutional provisions or enabling legislation.

Unrestricted—Consists of all other net position that do not meet the definition of "Invested in Capital Assets, Net" or "Restricted."

Revenues

The District considers all assessments charged to the Cities to fund its normal operations as operating revenues. Assessments to the Cities to fund capital or special projects, and grants or other contracts received from federal and state agencies, are considered to be non-operating income.

See Independent Auditors' Report.

(1) SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES, CONTINUED

Federal Grant Revenues and Expenditures

The District's federal grant revenues are primarily expenditure driven, in that prior to requesting grant monies, expenditures are incurred.

Use of Estimates in Preparing Financial Statements

The preparation of financial statements in conformity with accounting principles generally accepted in the United States requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from those estimates.

Defined Benefit Pension Plan

For the purposes of measuring the net pension (asset) liability, deferred outflows of resources and deferred inflows of resources related to pensions, and pension expense, information about the fiduciary net position of the Employee Retirement System of Central Oklahoma Master Conservancy District (the "Plan") and additions to/deductions from the Plan's fiduciary net position have been determined on the same basis as they are reported by the Oklahoma Municipal Retirement Fund (OkMRF). For this purpose, benefit payments are recognized when due and payable in accordance with the benefit terms. Investments are reported at fair value based on published market prices. Detailed information about the OkMRF plan's fiduciary net position is available in the separately issued OkMRF financial report.

Recent Accounting Pronouncements

In January 2017, GASB issued Statement No. 84, *Fiduciary Activities* (GASB 84). GASB 84 improves guidance regarding the recognition and reporting of fiduciary activities. GASB 84 identifies four types of reportable fiduciary fund types, including 1) pension (and other employee benefit) trust funds, 2) investment trust funds, 3) private-purpose trust funds, and 4) custodial funds. GASB 84 outlines the accounting and disclosure requirements for operating structures that qualify as a fiduciary activity. The District will adopt GASB 84 effective July 1, 2020, for the June 30, 2021, reporting year. The District does not expect GASB 84 to have a significant impact on the financial statements.

(1) SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES, CONTINUED

Recent Accounting Pronouncements, Continued

In June 2017, GASB issued Statement No. 87, *Leases* (GASB 87). GASB 87 defines a lease as a contract that conveys control of the right to use another entity's nonfinancial asset (the underlying asset) as specified in the contract for a period of time in an exchange or exchange-like transaction. GASB 87 improves accounting and financial reporting for leases by governments by requiring recognition of certain lease assets and liabilities for leases that previously were classified as operating leases and recognized as inflows of resources or outflows of resources based on the payment provisions of the contract. It establishes a single model for lease accounting based on the foundational principle that leases are financings of the right to use an underlying asset. Under GASB 87, a lessee is required to recognize a lease liability and an intangible right-to-use lease asset, and a lessor is required to recognize a lease receivable and a deferred inflow of resources, thereby enhancing the relevance and consistency of information about governments' leasing activities. The requirements of this Statement are effective for reporting periods beginning after June 15, 2021. The District does not expect GASB 87 to have a significant impact on the financial statements.

In June 2018, GASB issued Statement No. 89, *Accounting for Interest Cost Incurred before the End of a Construction Period* (GASB 89). GASB 89 directs that interest costs incurred during the construction period of an asset be expensed in the period incurred. GASB 89 changes previous guidance regarding capitalized construction costs where such costs were typically included in the capitalized cost of the asset constructed and depreciated over time. The District adopted GASB 89 on July 1, 2019, which did not have a significant impact the financial statements.

(1) SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES, CONTINUED

Recent Accounting Pronouncements, Continued

In June 2020, GASB issued Statement No. 97, *Certain Component Unit Criteria, and Accounting and Financial Reporting for Internal Revenue Code Section 457 Deferred Compensation Plans—an Amendment of GASB Statements No. 14 and No. 84, and a Supersession of GASB Statement No. 32* (GASB 97). The primary objectives of GASB 97 are to (1) increase consistency and comparability related to the reporting of fiduciary component units in circumstances in which a potential component unit does not have a governing board and the primary government performs the duties that a governing board typically would perform; (2) mitigate costs associated with the reporting of certain defined contribution pension plans, defined contribution other postemployment benefit (OPEB) plans, and employee benefit plans other than pension plans or OPEB plans (other employee benefit plans) as fiduciary component units in fiduciary fund financial statements; and (3) enhance the relevance, consistency, and comparability of the accounting and financial reporting for Internal Revenue Code (IRC) Section 457 deferred compensation plans (Section 457 plans) that meet the definition of a pension plan and for benefits provided through those plans. The requirements of GASB 97 that 1) exempt primary governments that perform the duties that a governing board typically performs from treating the absence of a governing board the same as the appointment of a voting majority of a governing board in determining whether they are financially accountable for defined contribution pension plans, defined contribution OPEB plans, or other employee benefit plans and 2) limit the applicability of the financial burden criterion in paragraph 7 of Statement 84 to defined benefit pension plans and defined benefit OPEB plans that are administered through trusts that meet the criteria in paragraph 3 of Statement 67 or paragraph 3 of Statement 74, respectively, are effective at the date of issuance of GASB 97. The requirements of GASB 97 that are related to the accounting and financial reporting for Section 457 plans are effective for fiscal years beginning after June 15, 2021. For purposes of determining whether a primary government is financially accountable for a potential component unit, the requirements of GASB 97 that provide that for all other arrangements, the absence of a governing board be treated the same as the appointment of a voting majority of a governing board if the primary government performs the duties that a governing board typically would perform, are effective for reporting periods beginning after June 15, 2021. Earlier application of those requirements is encouraged and permitted by requirement as specified within GASB 97. The District is currently evaluating the impact that the adoption of GASB 97 will have on its financial statements.

Date of Management's Review of Subsequent Events

Management has evaluated subsequent events through December 21, 2020, the date which the financial statements were available to be issued.

(2) CASH AND CASH EQUIVALENTS AND INVESTMENTS

Custodial Credit Risk—Deposits

Custodial credit risk is the risk that in the event of a bank failure, the District's deposits may not be returned to it. The District's deposit policy for custodial credit risk is described as follows:

> The District requires that balances on deposit with financial institutions be insured by the FDIC or collateralized by securities held by the cognizant Federal Reserve Bank, or be invested in U.S. government obligations in the District's name.

Custodial Credit Risk—Investments

As of June 30, 2020, the District held cash deposits of approximately $2,072,000 in a money market account that is not insured by the FDIC. As of June 30, 2019, the District held cash deposits of approximately $1,815,000 in a money market account that is not insured by the FDIC. This investment is not considered to be a custodial credit risk since the money market is invested in U.S. Treasury securities and U.S. government agency securities. The money market account had an S&P rating of AAA at both June 30, 2020 and 2019, and an average maturity of the underlying investments of 39 days as of both June 30, 2020 and 2019. At June 30, 2020 and 2019, the District did not have any money in money market accounts that were not fully insured by the FDIC or collateralized. The money market accounts are included in cash and cash equivalents on the statements of net position. The underlying investments of the money market accounts include short-term, high quality, fixed-income securities issued by banks, corporations, and the U.S. government or its agencies.

Investments are made under the custody of the General Manager, as approved by the District's Board of Directors, in accordance with the District's investment policy.

The investment policy permits investments in U.S. Treasury bills, notes, and bonds and obligations fully insured or unconditionally guaranteed by the U.S. government or any of its agencies or instrumentalities; U.S. government agency securities; corporate debt and mortgage-backed pass-through securities with ratings of Aaa, AAA, or the equivalent; collateralized or insured certificates of deposit; bankers' acceptances; commercial paper with a rating of at least A-1 or the equivalent; obligations of state and local governments; money market and short-term bond funds with a rating of AAA or equivalent; and obligations of a foreign government with a rating of A-1 or the equivalent.

Custodial credit risk is the risk that, in the event of the failure of a counterparty, the District will not be able to recover the value of its investments. Investment securities are exposed to custodial risk if they are uninsured, are not registered in the name of the District, or are held by a counterparty or the counterparty's trust department but not in the name of the District. At June 30, 2020 and 2019, the investment balances of approximately $3,779,000 and $3,608,000, respectively, were uncollateralized.

See Independent Auditors' Report.

(2) CASH AND CASH EQUIVALENTS AND INVESTMENTS, CONTINUED

Interest Rate Risk and Credit Risk

Interest rate risk is the risk that changes in interest rates will adversely affect the fair value of an investment. Investments held for longer periods are subject to increased risk of adverse interest changes. The District does not have a formal policy that limits investment maturities as a means of managing its exposure to fair value losses arising from increasing interest rates. Fixed-income securities are subject to credit risk. The District places no limit on the amount the District may invest in any one issuer. Credit quality rating is one method of assessing the ability of the issuer to meet its obligation. The following tables provide information concerning interest rate risk and credit risk.

At June 30, the District had the following investments and maturities:

	Investment Maturities (in Years)			
Investment Type	Less Than 1	1 or More, Less Than 5	5 or More	Fair Value
2020				
Corporate bonds—domestic	$ -	1,625,980	1,922,857	3,548,837
Corporate bonds—foreign	-	230,400	-	230,400
	$ -	1,856,380	1,922,857	3,779,237
2019				
Corporate bonds—domestic	$ -	1,272,463	1,967,064	3,239,527
Corporate bonds—foreign	-	218,371	-	218,371
Mortgage-backed securities	-	150,000	-	150,000
	$ -	1,640,834	1,967,064	3,607,898

See Independent Auditors' Report.

(2) CASH AND CASH EQUIVALENTS AND INVESTMENTS, CONTINUED

Interest Rate Risk and Credit Risk, Continued

The following table provides information concerning credit risk at June 30, 2020:

S&P 500 Rating	Fair Value	Percentage of Total Fixed Income Investments at Fair Value
AAA	$ 283,662	8%
AA-	146,207	4%
A	181,633	5%
A-	1,054,197	28%
BBB+	729,282	19%
BBB	566,433	15%
BBB-	587,423	15%
BB	230,400	6%
	$ 3,779,237	100%

The following table provides information concerning credit risk at June 30, 2019:

S&P 500 Rating	Fair Value	Percentage of Total Fixed Income Investments at Fair Value
AAA	$ 253,609	7%
AA+	150,000	4%
AA	139,224	4%
A+	251,693	7%
A	175,521	5%
A-	539,350	15%
BBB+	1,063,908	29%
BBB	816,222	23%
BB	218,371	6%
	$ 3,607,898	100%

See Independent Auditors' Report.

(2) CASH AND CASH EQUIVALENTS AND INVESTMENTS, CONTINUED

Investments Measured at Fair Value

Fair values of investments by hierarchy level are presented below:

Investments by Fair Value Level	Amounts Measured at Fair Value	Quoted Prices in Active Markets for Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
June 30, 2020				
Corporate bonds—domestic	$ 3,548,837	-	3,548,837	-
Corporate bonds—foreign	230,400	-	230,400	-
	$ 3,779,237	-	3,779,237	-
June 30, 2019				
Corporate bonds—domestic	$ 3,239,527	-	3,239,527	-
Corporate bonds—foreign	218,371	-	218,371	-
Mortgage-backed securities	150,000	-	150,000	-
	$ 3,607,898	-	3,607,898	-

The District holds a diversified mix of debt instruments through an investment manager. Generally, the District holds a mix of domestic and foreign corporate bonds and mortgage-backed securities. The District's debt securities are classified in Level 2 of the fair value hierarchy, valued using a matrix pricing technique determined by a third party. This method values securities based on their relationship to benchmark quoted prices.

(3) CAPITAL ASSETS

Following are the changes in capital assets for the years ended June 30:

	Balance at June 30, 2019	Additions	Retirements	Transfers	Balance at June 30, 2020
Capital assets not being depreciated:					
Dam and reservoir	$ 4,605,177	-	-	-	4,605,177
Land improvements	38,375	-	-	-	38,375
Construction in progress:					
Del City pipeline replacement	498,941	2,574,597	-	-	3,073,538
Total capital assets not being depreciated	5,142,493	2,574,597	-	-	7,717,090
Other capital assets:					
Vehicles	679,813	55,110	-	-	734,923
Pipelines	4,269,079	-	-	-	4,269,079
Pumping plant	1,593,952	-	-	-	1,593,952
Office equipment	92,020	6,985	-	-	99,005
Buildings and structures	1,222,254	-	-	-	1,222,254
Energy Project equipment	2,536,613	-	-	-	2,536,613
Fencing and equipment	2,478,016	114,411	(90,674)	-	2,501,753
Total other capital assets	12,871,747	176,506	(90,674)	-	12,957,579
Accumulated depreciation:					
Vehicles	(460,632)	(54,078)	-	-	(514,710)
Pipelines	(3,638,948)	(42,727)	-	-	(3,681,675)
Pumping plant	(1,566,864)	(2,356)	-	-	(1,569,220)
Office equipment	(88,824)	(2,462)	-	-	(91,286)
Buildings and structures	(515,798)	(46,335)	-	-	(562,133)
Energy Project equipment	(1,268,309)	(126,831)	-	-	(1,395,140)
Fencing and equipment	(1,426,310)	(117,345)	34,002	-	(1,509,653)
Total accumulated depreciation	(8,965,685)	(392,134)	34,002	-	(9,323,817)
Capital assets, net	$ 9,048,555	2,358,969	(56,672)	-	11,350,852

See Independent Auditors' Report.

(3) CAPITAL ASSETS, CONTINUED

	Balance at June 30, 2018	Additions	Retirements	Transfers	Balance at June 30, 2019
Capital assets not being depreciated:					
Dam and reservoir	$ 4,605,177	-	-	-	4,605,177
Land improvements	38,375	-	-	-	38,375
Construction in progress:					
Del City pipeline replacement	401,701	97,240	-	-	498,941
Total capital assets not being depreciated	5,045,253	97,240	-	-	5,142,493
Other capital assets:					
Vehicles	670,546	74,224	(64,957)	-	679,813
Pipelines	4,269,079	-	-	-	4,269,079
Pumping plant	1,593,952	-	-	-	1,593,952
Office equipment	89,192	2,828	-	-	92,020
Buildings and structures	1,222,254	-	-	-	1,222,254
Energy Project equipment	2,536,613	-	-	-	2,536,613
Fencing and equipment	2,467,347	26,948	(16,279)	-	2,478,016
Total other capital assets	12,848,983	104,000	(81,236)	-	12,871,747
Accumulated depreciation:					
Vehicles	(470,698)	(54,891)	64,957	-	(460,632)
Pipelines	(3,596,221)	(42,727)	-	-	(3,638,948)
Pumping plant	(1,564,508)	(2,356)	-	-	(1,566,864)
Office equipment	(87,716)	(1,108)	-	-	(88,824)
Buildings and structures	(469,463)	(46,335)	-	-	(515,798)
Energy Project equipment	(1,141,478)	(126,831)	-	-	(1,268,309)
Fencing and equipment	(1,324,363)	(118,226)	16,279	-	(1,426,310)
Total accumulated depreciation	(8,654,447)	(392,474)	81,236	-	(8,965,685)
Capital assets, net	$ 9,239,789	(191,234)	-	-	9,048,555

See Independent Auditors' Report.

(4) LONG-TERM DEBT

Long-term debt activity for the years ended June 30 was as follows:

	Balance at June 30, 2019	Additions	Reductions	Balance at June 30, 2020	Amounts Due Within 1 Year
Drinking Water SRF Series 2007 note payable	$ 709,656	-	(94,426)	615,230	94,428
Drinking Water SRF Series 2019 note payable	-	1,539,478	-	1,539,478	43,924
	$ 709,656	1,539,478	(94,426)	2,154,708	138,352

	Balance at June 30, 2018	Additions	Reductions	Balance at June 30, 2019	Amounts Due Within 1 Year
Drinking Water SRF Series 2007 note payable	$ 804,017	-	(94,361)	709,656	94,426

Drinking Water SRF Series 2007 Note Payable

The District has a Drinking Water State Revolving Fund (SRF) Series 2007 note payable from the Oklahoma Water Resources Board through its "Drinking Water SRF Financing Program." The Drinking Water SRF Series 2007 note payable has an annual interest rate of 0.50%, matures on September 15, 2026, and is secured by the District's revenues. Semiannual interest and principal payments are due on March 15 and September 15. The note has certain financial, restrictive, and negative covenants that the District must meet. As of June 30, 2020, the District was in compliance with such covenants.

(4) LONG-TERM DEBT, CONTINUED

Drinking Water SRF Series 2019 Note Payable

In July 2019, the District entered into a $5,643,680 Drinking Water SRF Series 2019 note payable agreement with the Oklahoma Water Resources Board through its "Drinking Water SRF Financing Program" to finance its Del City aqueduct replacement. The Drinking Water SRF Series 2019 note payable has an annual interest rate of 1.60% and an annual fee of 0.50% through maturity, which is the earlier of i) either the earlier of March 15 or September 15 preceding 15 years after the completion of the construction project or ii) September 15, 2035. As of June 30, the District had borrowed $1,539,477 on the note. The Drinking Water SRF Series 2019 note payable has certain financial, restrictive, and negative covenants that the District must meet. As of June 30, 2020, the District was in compliance with such covenants.

Future payments of principal and interest of the District's long-term debt for the next 5 years and to maturity are as follows:

Year		Total	Interest	Principal
2021	$	157,475	19,123	138,352
2022		217,147	33,427	183,720
2023		216,745	31,070	185,675
2024		216,377	28,673	187,704
2025		215,991	26,236	189,755
2026–2035		1,404,928	135,426	1,269,502
	$	2,428,663	273,955	2,154,708

(5) ASSESSMENTS RECEIVABLE

In connection with the District's Energy Project, the District entered into contracts with the City of Norman and the City of Del City, in which the two cities agreed to repay their share of the note payable related to the project through an assessment receivable. The assessments mirror the terms of the Drinking Water SRF Series 2007 note payable. See Note 4 for the respective terms. The assessments are secured by gross revenues received from the sale of water by the respective cities. The balance of the assessments receivable for the Energy Project at June 30, 2020 and 2019, was $585,369 and $679,800, respectively.

See Independent Auditors' Report.

(6) DEFINED BENEFIT PENSION PLAN

Plan Description

The District participates in OkMRF, an agent multiple public employer retirement system (PERS) defined benefit pension plan. The Plan provides pensions for all regular, full-time employees. The OkMRF plan issues a separate financial report and can be obtained from OkMRF or from their website: https://www.okmrf.org/financial. PERS is a retirement system that provides benefits to employees of one or more state or local governmental entities. An agent PERS maintains pooled administrative and investment functions for all participating entities. The authority to establish and amend the benefit provisions of the plans that participate in the OkMRF is assigned to the respective employer entities, which is the District's Board of Directors. Actuarial valuations are performed each year on July 1.

Benefits Provided

The Plan provides retirement, disability, and death benefits. Retirement benefits for employees are calculated as 3% of the employee's average 5 highest consecutive years of salaries out of the last 10 years of service multiplied by the number of years of credited service. Employees with 10 or more years of vesting service can retire at the age of 65 or at the age of 55 with 80 points. Points are equal to age plus completed years of service. The Plan allows for early retirement at the age of 55 with 10 years of vested service. The early retirement benefit is the normal retirement benefit reduced 5% per year for commencement prior to the normal retirement age. All employees are eligible for disability benefits after 10 or more years of service. Disability benefits are determined in the same manner as normal retirement benefits and are payable upon disablement without an actuarial reduction for early payment. In-service death benefits equal 50% of the normal retirement benefit payable to the spouse until death or remarriage, or 50% of the normal retirement benefit payable to the elected beneficiary for 5 years certain (for non-married employees). An employee who deceases or terminates service with the District prior to vesting may withdraw his or her contributions, plus any accumulated interest.

Benefit terms provide for annual cost-of-living adjustments to each employee's retirement allowance subsequent to the employee's retirement date. Benefits in payments status are adjusted each July 1 based on the percentage change in the Consumer Price Index, limited to a maximum increase or decrease in any year of 3%.

The Plan allows for normal and optional forms of benefit payments. The normal form of payment is a monthly lifetime annuity with 5 years certain. Disability retirement benefits are paid only under the normal form. Optional forms of payment consist of jointed and 50% survivor annuity, joint and 66⅔% last survivor annuity, and joint and 100% survivor annuity.

(6) DEFINED BENEFIT PENSION PLAN, CONTINUED

Employees Covered Under the Plan

At June 30 the following employees were covered under the Plan:

	2020	2019
Retirees, disabled participants, and beneficiaries currently receiving benefits	3	3
Terminated vested participants	1	1
Active participants	6	6
	10	10

Contributions

The District's Board of Directors has the authority to set and amend contribution rates to the Plan. Participating employees contribute 6% of their annual compensation to the Plan. The District's contribution rates for fiscal years 2020 and 2019 were based on actuarially determined rates plus additional contributions. The rates for the fiscal years 2020 and 2019 were 2.87% and 9.52%, respectively, of covered salary. The District contributed $9,342 and $25,902 in employer contributions to the Plan in 2020 and 2019, respectively.

Total and Net Pension (Asset) Liability

The total pension (asset) liability as of June 30, 2020 and 2019, was determined based on actuarial valuations performed as of July 1, 2019, and July 1, 2018, respectively, which is also the measurement date. There were no changes in assumptions or changes in benefit terms that significantly affected measurement of the total pension (asset) liability as of June 30, 2020 or 2019. There were also no changes between the measurement date of July 1, 2019 and 2018, and the District's report ending date of June 30, 2020 and 2019, that would have a significant impact on the net pension (asset) liability as of June 30, 2020 or 2019.

(6) DEFINED BENEFIT PENSION PLAN, CONTINUED

Actuarial Assumptions

The total pension (asset) liability as of the July 1, 2019 and 2018, actuarial valuation was determined using the following actuarial assumptions, applied to all periods included in the measurement:

Investment return and discount rate:	7.50% for both 2019 and 2018, compounded annually net of investment expense and including inflation
Salary increases:	Varies between 4.50% to 7.50% for both 2019 and 2018
Mortality rates:	UP-1994 Mortality Table with projected mortality improvement by the Scale AA based on the employee's year of birth for both 2019 and 2018
Assumed inflation rate:	2.75% for both 2019 and 2018
Actuarial cost method:	Entry age normal for both 2019 and 2018

The actuarial assumptions used in the July 1, 2019 and 2018, valuations are based on the results of the actuarial experience study, which covers the 5-year period ending June 30, 2016. The experience study report is dated September 29, 2017.

Discount Rate

The discount rate used to value benefits was the long-term expected rate of return on plan investments of 7.50% as of both July 1, 2019 and 2018, since the Plan's net fiduciary position is projected to be sufficient to make projected benefit payments.

The District has adopted a funding method that is designed to fund all benefits payable to participants over the course of their working careers. Any differences between actual and expected experience are funded over a fixed period to ensure all funds necessary to pay benefits have been contributed to the trust before those benefits are payable. Thus, the sufficiency of pension plan assets was made without a separate projection of cash flows.

(6) DEFINED BENEFIT PENSION PLAN, CONTINUED

Discount Rate, Continued

The long-term expected rate of return on pension plan investments was determined using a building-block method in which best-estimate ranges of expected future real rates of return (expected returns, net of pension plan investment expense, and inflation) are developed for each major asset class. These ranges are combined to produce the long-term expected rate of return by weighting the expected future real rates of return by the target asset allocation percentage and by adding expected inflation (2.75% for 2019 and 2018). Best estimates of arithmetic real rates of return for each major asset class included in the Plan's target asset allocation as of both July 1, 2019 and 2018, are summarized in the following table:

Asset Class	Target Allocation	Long-Term Expected Real Rate of Return	Weighted Return
Large cap stocks: S&P 500	25%	5.80%	1.45%
Small/Mid cap stocks: Russell 2500	10%	6.40%	0.64%
Long/Short equity: MSCI ACWI	10%	5.00%	0.50%
International stocks: MSCI EAFE	20%	6.20%	1.24%
Fixed income bonds: Barclay's Capital Aggregate	30%	2.30%	0.69%
Real estate: NCREIF	5%	4.60%	0.23%
Cash and cash equivalents: 3-month Treasury	0%	0.00%	0.00%
Total	100%		
Average real return			4.75%
Inflation			2.75%
Long-term expected return			7.50%

See Independent Auditors' Report.

(6) DEFINED BENEFIT PENSION PLAN, CONTINUED

Changes in the Net Pension (Asset) Liability

Changes in the net pension (asset) liability were as follows:

	Increase (Decrease)		
	Total Pension Liability (a)	Plan Fiduciary Net Position (b)	Net Pension (Asset) Liability (a) - (b)
Balance at June 30, 2018	$ 1,574,459	1,650,248	(75,789)
Changes for the year:			
Service cost	44,582	-	44,582
Interest cost	115,478	-	115,478
Difference between expected and actual experience	(124,141)	-	(124,141)
Contributions—employer	-	115,860	(115,860)
Contributions—employee	-	19,304	(19,304)
Net investment income	-	125,115	(125,115)
Benefit payments, including refunds of employee contributions	(70,782)	(70,782)	-
Administrative expense	-	(3,531)	3,531
Net changes	(34,863)	185,966	(220,829)
Balance at June 30, 2019	1,539,596	1,836,214	(296,618)
Changes for the year:			
Service cost	43,028	-	43,028
Interest cost	113,460	-	113,460
Difference between expected and actual experience	15,614	-	15,614
Assumption changes	22,587	-	22,587
Contributions—employer	-	25,902	(25,902)
Contributions—employee	-	16,325	(16,325)
Net investment income	-	126,379	(126,379)
Benefit payments, including refunds of employee contributions	(54,584)	(54,584)	-
Administrative expense	-	(3,785)	3,785
Net changes	140,105	110,237	29,868
Balance at June 30, 2020	$ 1,679,701	1,946,451	(266,750)

See Independent Auditors' Report.

(6) DEFINED BENEFIT PENSION PLAN, CONTINUED

Sensitivity of the Net Pension (Asset) Liability to Changes in the Discount Rate

The following presents the net pension (asset) liability of the District, calculated using the discount rate of 7.50% as of both July 1, 2019 and 2018, as well as what the District's net pension (asset) liability would be if it were calculated using a discount rate that is 1 percentage point lower or 1 percentage point higher than the current rate at June 30:

	1% Decrease (6.50%)	Current Discount Rate (7.50%)	1% Increase (8.50%)
2020			
Net pension (asset) liability	$ (41,683)	(266,750)	(454,507)
2019			
Net pension (asset) liability	$ (88,300)	(296,618)	(470,116)

Pension Expense and Deferred Outflows of Resources and Deferred Inflows of Resources Related to Pensions

For the years ended June 30, 2020 and 2019, the District recognized pension expense (benefit) of $4,087 and $(55,216), respectively. The District reported deferred outflows of resources and deferred inflows of resources related to pensions from the following sources at June 30:

	2020		2019	
	Deferred Outflows of Resources	Deferred Inflows of Resources	Deferred Outflows of Resources	Deferred Inflows of Resources
Differences between expected and actual experience	$ 12,058	66,561	330	100,725
Changes in assumptions	19,807	-	5,557	-
Net difference between projected and actual earnings on pension plan investments	26,946	27,556	49,183	41,333
District contributions subsequent to measurement date	9,342	-	24,478	-
	$ 68,153	94,117	79,548	142,058

See Independent Auditors' Report.

(6) DEFINED BENEFIT PENSION PLAN, CONTINUED

Pension Expense and Deferred Outflows of Resources and Deferred Inflows of Resources Related to Pensions, Continued

Reported deferred outflows of resources of $9,342 related to pensions resulting from the District contributions subsequent to the measurement date will be recognized as a/an increase/decrease of the net pension (asset) liability in the year ended June 30, 2021. The other amounts reported as deferred outflows of resources and deferred inflows of resources related to pensions will be recognized in pension expense as follows:

Year Ended June 30:		
2021	$	(11,663)
2022		(31,517)
2023		3,823
2024		4,051
	$	(35,306)

(7) DEFINED CONTRIBUTION PLAN

The District has a defined contribution plan and trust, known as the "Employee Retirement System of Central Oklahoma Master Conservancy District in Norman, Oklahoma, Defined Contribution Plan" (the "Contribution Plan"), in the form of The Oklahoma Municipal Retirement System Master Defined Contribution Plan. The Contribution Plan is available only to the General Manager and contains a provision requiring the District to contribute up to 15% of the General Manager's eligible compensation. For the years ended June 30, 2020 and 2019, the District contributed approximately $9,600 and $19,000, respectively, to the Contribution Plan. Benefits depend solely on amounts contributed to the Contribution Plan plus investment earnings.

(8) DEFERRED COMPENSATION PLAN

The District has a deferred compensation plan (the "Deferred Compensation Plan") as authorized by Section 457(b) of the Internal Revenue Code, as amended by the Tax Reform Act of 1986, and in accordance with the provisions of Sections 1701 through 1706 of Title 74 of the Oklahoma Statutes.

The Deferred Compensation Plan is available to all District employees. Participants may make voluntary contributions up to the maximum permitted by law. The District matches salary deferrals at 50%, up to 3% of the participant's annual compensation. Participants are fully vested in their contributions and the District's contributions. Participants may direct the investment of their contributions and the District's contributions in available investment options offered by the Deferred Compensation Plan. All interest, dividends, and investment fees are allocated to participants' accounts. The District's contribution to the Deferred Compensation Plan in 2020 and 2019 approximated $5,600 and $7,200, respectively.

See Independent Auditors' Report.

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

REQUIRED SUPPLEMENTARY INFORMATION

CONDITION RATING AND ESTIMATE-TO-ACTUAL COMPARISON OF MAINTENANCE OF INFRASTRUCTURE ASSETS

Fiscal Year Ended June 30, 2020

Condition Rating of Infrastructure Assets

	Years Ended June 30,		
	2020	2019	2018
Infrastructure assets (dam and reservoir)	99	99	92

Condition assessments of the infrastructure assets are made by the U.S. Department of the Interior's Bureau of Reclamation (BOR). The BOR typically performs a comprehensive assessment every 3 years and a limited condition assessment for other annual periods. The ratings are based on the BOR's "Facility Reliability Rating System for High and Significant Hazard Dams." The ratings are as follows: Good (rating of 80 or greater); Fair (rating of 60 to 79); and Poor (rating of 59 or less).

Estimate-to-Actual Comparison of Maintenance of Infrastructure Assets

	Years Ended June 30,				
	2020	2019	2018	2017	2016
Estimate	$ 115,000	105,000	95,000	75,500	70,000
Actual	62,076	123,317	112,077	86,993	246,271

See Independent Auditors' Report.

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

SCHEDULE OF CHANGES IN NET PENSION (ASSET) LIABILITY

Fiscal Years Ended June 30,	*2020*	*2019*	*2018*	*2017*	*2016*	*2015*
Total pension liability						
Service cost	$ 43,028	44,582	43,043	29,546	39,199	36,379
Interest cost	113,460	115,478	111,825	108,409	118,178	115,436
Differences between expected and actual experience	15,614	(124,141)	684	(20,798)	(205,605)	-
Assumption changes	22,587	-	11,501	-	-	-
Benefit payments, including refunds of employee contributions	(54,584)	(70,782)	(69,691)	(76,338)	(79,253)	(80,831)
Net change in total pension liability	140,105	(34,863)	97,362	40,819	(127,481)	70,984
Total pension liability, beginning of year	1,539,596	1,574,459	1,477,097	1,436,278	1,563,759	1,492,775
Total pension liability, end of year (a)	$ 1,679,701	1,539,596	1,574,459	1,477,097	1,436,278	1,563,759
Plan fiduciary net position						
Contributions—employer	$ 25,902	115,860	118,989	117,934	82,298	180,423
Contributions—employees	16,325	19,304	15,572	14,953	13,444	13,138
Net investment income	126,379	125,115	180,366	13,452	36,413	168,530
Administrative expenses	(3,785)	(3,531)	(69,691)	(2,684)	(2,672)	(2,508)
Benefit payments, including refunds of employee contributions	(54,584)	(70,782)	(3,125)	(76,338)	(79,253)	(80,831)
Net change in plan fiduciary net position	110,237	185,966	242,111	67,317	50,230	278,752
Plan fiduciary net position, beginning of year	1,836,214	1,650,248	1,408,137	1,340,820	1,290,590	1,011,838
Plan fiduciary net position, end of year (b)	$ 1,946,451	1,836,214	1,650,248	1,408,137	1,340,820	1,290,590
Plan's net pension (asset) liability (a) - (b)	$ (266,750)	(296,618)	(75,789)	68,960	95,458	273,169

The amounts presented for each year-end were determined as of July 1 of the current year.

Only the last 6 fiscal years are presented because data for the prior 4 years is not readily available.

See Independent Auditors' Report.

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

SCHEDULE OF NET PENSION (ASSET) LIABILITY RATIOS

Fiscal Years Ended June 30,	*2020*	*2019*	*2018*	*2017*	*2016*	*2015*
Total pension liability	$1,679,701	1,539,596	1,574,459	1,477,097	1,436,278	1,563,759
Plan fiduciary net position	1,946,451	1,836,214	1,650,248	1,408,137	1,340,820	1,290,590
Plan's net pension (asset) liability	$ (266,750)	(296,618)	(75,789)	68,960	95,458	273,169
Plan fiduciary net position as a percentage of the total pension liability	115.88%	119.27%	104.81%	95.33%	93.35%	82.53%
Covered payroll	$ 306,761	261,961	260,106	244,332	252,604	223,981
Plan's net pension (asset) liability as a percentage of covered payroll	(86.96)%	(113.23)%	(29.14)%	28.22%	37.79%	121.96%

The amounts presented for each year-end were determined as of July 1 of the current year.

Only the last 6 fiscal years are presented because data for the prior 4 years is not readily available.

See Independent Auditors' Report.

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

SCHEDULE OF EMPLOYER CONTRIBUTIONS

Fiscal Years Ended June 30,	*2020*	*2019*	*2018*	*2017*	*2016*	*2015*
Actuarially determined contribution	$ 9,342	24,939	40,367	47,278	66,965	82,298
Contributions in relation to the actuarially determined contribution	9,342	24,478	115,860	118,989	117,934	82,298
Contribution (deficit) excess	$ -	(461)	75,493	71,711	50,969	-
Covered payroll	$ 306,761	261,961	260,106	244,332	252,604	223,981
Contributions as a percentage of covered payroll	3.05%	9.34%	44.54%	48.70%	46.69%	36.74%

The amounts presented for each year-end were determined as of July 1 of the current year.
Only the last 6 fiscal years are presented because data for the prior 4 years is not readily available.

See Independent Auditors' Report.

FINLEY & COOK
CERTIFIED PUBLIC ACCOUNTANTS

**INDEPENDENT AUDITORS' REPORT ON
INTERNAL CONTROL OVER FINANCIAL REPORTING AND
ON COMPLIANCE AND OTHER MATTERS BASED ON
AN AUDIT OF FINANCIAL STATEMENTS PERFORMED IN
ACCORDANCE WITH *GOVERNMENT AUDITING STANDARDS***

Board of Directors
Central Oklahoma Master Conservancy District

We have audited, in accordance with the auditing standards generally accepted in the United States and the standards applicable to financial audits contained in *Government Auditing Standards* issued by the Comptroller General of the United States, the financial statements of the Central Oklahoma Master Conservancy District (the "District") as of and for the year ended June 30, 2020, and the related notes to the financial statements, which collectively comprise the District's basic financial statements, and have issued our report thereon dated December 21, 2020. Our report includes an explanatory paragraph disclaiming an opinion on required supplementary information.

Internal Control Over Financial Reporting

In planning and performing our audit of the financial statements, we considered the District's internal control over financial reporting ("internal control") to determine the audit procedures that are appropriate in the circumstances for the purpose of expressing our opinion on the financial statements, but not for the purpose of expressing an opinion on the effectiveness of the District's internal control. Accordingly, we do not express an opinion on the effectiveness of the District's internal control.

A deficiency in internal control exists when the design or operation of a control does not allow management or employees, in the normal course of performing their assigned functions, to prevent, or detect and correct, misstatements on a timely basis. A material weakness is a deficiency, or a combination of deficiencies, in internal control, such that there is a reasonable possibility that a material misstatement of the District's financial statements will not be prevented, or detected and corrected on a timely basis. A significant deficiency is a deficiency, or a combination of deficiencies, in internal control that is less severe than a material weakness, yet important enough to merit attention by those charged with governance.

Our consideration of internal control was for the limited purpose described in the first paragraph of this section and was not designed to identify all deficiencies in internal control that might be material weaknesses or significant deficiencies. Given these limitations, during our audit we did not identify any deficiencies in internal controls that we consider to be material weaknesses. However, material weaknesses may exist that have not been identified.

(Continued)

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INDEPENDENT AUDITORS' REPORT ON INTERNAL CONTROL OVER FINANCIAL REPORTING AND ON COMPLIANCE AND OTHER MATTERS BASED ON AN AUDIT OF FINANCIAL STATEMENTS PERFORMED IN ACCORDANCE WITH *GOVERNMENT AUDITING STANDARDS*, CONTINUED

Compliance and Other Matters

As part of obtaining reasonable assurance about whether the District's financial statements are free from material misstatement, we performed tests of its compliance with certain provisions of laws, regulations, contracts, and grant agreements, noncompliance with which could have a direct and material effect on the determination of financial statement amounts. However, providing an opinion on compliance with those provisions was not an objective of our audit and, accordingly, we do not express such an opinion. The results of our tests disclosed no instances of noncompliance or other matters that are required to be reported under *Government Auditing Standards*.

Purpose of This Report

The purpose of this report is solely to describe the scope of our testing of internal control and compliance and the results of that testing, and not to provide an opinion on the effectiveness of the District's internal control or on compliance. This report is an integral part of an audit performed in accordance with *Government Auditing Standards* in considering the District's internal control and compliance. Accordingly, this communication is not suitable for any other purpose.

Finley & Cook, PLLC

Shawnee, Oklahoma
December 21, 2020

SCHEDULE OF FINDINGS AND RESPONSES

Year Ended June 30, 2020

None noted.

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

SUMMARY SCHEDULE OF PRIOR AUDIT FINDINGS

Year Ended June 30, 2020

None noted.

Resolution

OF

CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT

REGARDING OFFICIAL ACTION

WHEREAS, a quorum of the Board of Directors of the Central Oklahoma Master Conservancy District met in a regular meeting and considered approval of the Annual Report for FY 20-21 to Cleveland County Court.

IT IS HEREBY RESOLVED that the Annual Report for FY 20-21 to Cleveland County Court is approved.

APPROVED by a majority of Board members present on this 7th day of October, 2021.

Item D.7

Background

Matthews Trenching Co., Inc. (the District's construction contractor), and its subcontractor Aegion, have submitted a request for reimbursement of costs associated with unforeseen delays during the Del City Pipeline project. The amount requested is in excess of the original Matthews contract and the corresponding OWRB loan amount.

Key Dates and Events

Original Aegion Mobilization Date: October 19, 2020
Original Aegion Completion Date: January 2, 2021
Actual Aegion Completion Date: April 12, 2021 (due to delays detailed below)

Difference between Original and Actual Completion Dates: 89 Days
Actual Time Onsite/Working during those 89 Days: 28 Days according to Aegion submitted schedule

First Project Delay/Demobilization for Ice Storm: October 2020
Second Project Delay/Demobilization for Extreme Cold Event: February 2021
Third Project Delay/Demobilization for Locating Transition and De-watering for I-240 pull: March 2021

Original Contract

OWRB Loan Amount	$5,643,680.00
Matthews Contract Amount	($5,643,680.00)
Total Change Order Credit to Contract	$125,065.64
Aegion additional charges	($226,596.72)
Matthews additional associated costs (includes mark-up and downtime for crew)	($33,989.51)
Amount Remaining Over Loan Amount	($135,520.59)
Percentage over Original Contract Amount	2.4%

Breakdown of Additional Aegion Charges

Item	Number	Unit Rate	Cost
Additional Crew Mobilization	3 occurrences	$28,000	$84,000.00
Third Party Rental Equipment Charge	28 days	$632.74	$17,716.72
Equipment Stand-by	28 days		

- Wireline unit
- 50-ton winch
- Picker truck
- T500 fusion machine #1 18' pipe
- T500 fusion machine #2 18' pipe
- 824 fusion machine 21/24" pipe

- 18’ roller box
- Total for equipment stand-by $124,880.00

Total Additional Charges for Aegion	$226,596.72

Breakdown of Additional Matthews Charges

5% mark-up allowed by contract for subcontractors	$11,329.84
Associated downtime costs for crew	$22,659.67
Total Additional Charges for Matthews	$33,989.51

Total Additional Charges and Credit

Grand total additional charges	$260,586.23
Total Change Order credit	($125,065.64)
Total for Requested Additional Amount	$135,520.59

RESOLUTION
OF
CENTRAL OKLAHOMA MASTER CONSERVANCY DISTRICT
REGARDING DEL CITY PIPELINE MATTHEWS CONTRACT CHANGE ORDER

WHEREAS, the Central Oklahoma Master Conservancy District (District) borrowed $5,643,680.00 from the Oklahoma Water Resources Board for the Del City Pipeline Project; and

WHEREAS, the District entered into a primary construction contract for the Del City Pipeline Project with Matthews Trenching Company, Inc., herein Matthews, for a total amount of $5,643,680.00; and

WHEREAS, Matthews subcontracted with Aegion Corporation (Aegion or subcontractor) to perform services for certain portions of the pipeline improvement project; and

WHEREAS, due to delays and necessary equipment demobilizations caused by the area-wide ice storm in October 2020, the frigid temperature period in February 2021, and the March 2021 location transition and dewatering for the Interstate 240 pipeline pull, Aegion incurred significant cost overruns relative to their subcontract amount with Matthews; and

WHEREAS, the Project Engineer, Alan Swartz of Alan Plummer & Associates, reviewed all invoices and time statements from Matthews and Aegion relating to the cost overruns due to unforeseen delays and demobilizations and the contract with Matthews regarding contingencies; and

WHEREAS, the Project Engineer negotiated reduced allowable total claims for unforeseen delays to $260,586.23, which includes $226,596.72 for the Aegion claim and $33,989.51 for mark-up and additional related costs for Matthews; and

WHEREAS, after crediting an unused original amount of $125,065.64 from the original contract with Matthews, an additional amount of $135,520.59 is requested by Matthews and recommended by the Project Engineer.

WHEREAS, a quorum of the Board of Directors of the Central Oklahoma Master Conservancy District met in regular meeting, discussed and considered approval of the additional amount to the primary contract with Matthews Trenching Company, Inc., herein Matthews, relating to the Del City Pipeline Improvements Project.

IT IS HEREBY RESOLVED that the additional amount for the Matthews contract in the total amount of $135,520.59 is hereby approved.

IT IS FURTHER RESOLVED that Matthews will pay to Aegion the total sum of $226,596.72 in full settlement of the claimed overrun costs of Aegion, and that Matthews will retain a total of $33,989.51 in full settlement for its mark-up and additional associated costs claim.

APPROVED by a majority of Board members in regular meeting on this 7th day of October, 2021.

____

Amanda Nairn, President

Item E.8

LEGAL COUNSEL REPORT – September 2021

October 7, 2021

September 2 - Attended monthly board meeting

September 13 – Review Legal Addendum draft prepared by Kelley Metcalf for inclusion in annual report

September 27 – Review annual report to be filed with Cleveland County District Court and communication with Kelley Metcalf about need for board approval before filing

September 28 – Review draft October agenda sent from Kelley Metcalf

September 30 - Video conference call with Kyle Arthur and Alan Swartz about Matthews request for change order delay costs of Aegion and Matthews due to weather and related events for Del City pipeline project

Item E.9

Manager's Report – October 2021

- Generator replacement project
    - Replaced breaker on automatic transfer switch
    - Power transferred correctly when line power lost, however did not switch all generators off when line power restored
    - As of publication, we have a schedule visit from ESO to investigate further Monday/Tuesday of the week of October 4
    - Generators can still be manually switched on/off
    - Good news: while testing new breaker, all 8 pumps were able to run with the new generators
- District Manager's retreat
    - Montana the week of September 20th
    - Visit with Reclamation Regional Office staff in Billings
    - Also discussed policy issues to tackle for the upcoming year; specifically possible introduction of legislation
- Mowing coming to an end for the season
    - In good shape
- Dave Carpenter has been working on some upgrades to our SCADA/telemetry system
    - Battery back-ups installed in several locations to help with issues related to power pumps or losses – results in communication errors when it happens
    - Reprogramming Del City SCADA; simplifying and updating
    - Working with Paul Cunningham with Worth Hydrochem, as needed
- BOR grant application
    - Working with BOR on Applied Science grant application
    - Will be for the risk exposure work, specifically the paleohydrology analysis within the new yield model
- Bureau of Reclamation zebra mussel vulnerability assessment
    - Lake Thunderbird does not have a zebra mussel population, to our knowledge
    - Many lakes in Oklahoma do
    - This was a voluntary inspection offered to help the District assess vulnerability of our infrastructure and assets should an infestation occur
- External stakeholder engagement
    - Held zoom interview with a reporter from the OU Daily newspaper to discuss Norman water supply and the District (Chris Mattingly from Norman also participated)
    - Request to present to principal investigators and students working on the NSF/EPSCOR Sustainable Solutions for Oklahoma (S3OK) research project
    - Will be participating in a stakeholder interview to discuss the District with the OU Institute for Quality Communities
        - This institute is evaluating opportunities for enhancements at Lake Thunderbird; working in conjunction with the Norman Chamber and Visit Norman

  - Participated, along with Tim Carr, in the annual C.A.S.T. for Kids at Thunderbird
  - Will be meeting with Big Brothers/Big Sisters representative (Jeff Moody) to discuss opportunities to participate with that organization on October 5th
- Schedule Plant Manager lunch meeting on October 12th
  - Jay Snapp (DC), Mark Roberts (MWC) and Geri Wellborn (Norman)
- Meetings scheduled for October 5th and 6th with OARP members to discuss
  - ARPA stimulus funds and possible opportunities
  - Legislative strategy for upcoming session
- Met with Neal Shock of Shermco to discuss future patronage
  - Had been with another company, now with Shermco
  - Will be refurbishing our old ATS breaker
- Worked on finalizing job descriptions and drafted job opening announcement
- Positive Pay participation and opening a money market account awaiting signatures on documents after this Board meeting