OKI GROUNDWATER COMMITTEE
December 12, 2018 - 10:00 AM
OKI Board Room
720 East Pete Rose Way (at the corner of Eggleston Avenue)
Cincinnati, Ohio 45202

AGENDA

1. Welcome/Introductions (3 minutes)

2. Announcements

3. Update on Local Groundwater Management Efforts (30 minutes)
   Tim McLelland - Groundwater Consortium, Dave Combs - City of Trenton, Bruce Whitteberry - Cincinnati Water Works

4. OKI Staff Update (5 minutes)

5. “Safeguarding GCWW Water Supply Through Expanded Contingency Planning: Preliminary Results of a Recent Dye Tracer Study” (45 minutes)
   Rich Stuck, Cincinnati Water Works

6. “Harmful algal blooms: Impacts on human health and beyond” (45 minutes)
   Jiyoung Lee, PhD, Ohio State University

7. Other Business

ADJOURNMENT

Next Meeting Wednesday March 20, 2019
Safeguarding GCWW’s Water Supply Through Expanded Contingency Planning: Preliminary Results of a Recent Dye Tracer Study

Richard Stuck, P.G.
Greater Cincinnati Water Works
December 12, 2018
RMTP Treatment Today

Plant Capacity: 240 MGD
Average Pumping: 110 MGD

GCWW’s treatment process at the Richard Miller Plant on the Ohio River

Clarification
Turbidity / Microbial Removal

Natural and Synthetic Organics Removal

Disinfection, Fluoridation, Corrosion Control Inhibitors
Richard Miller Treatment Plant

Intake Area Circa 1900
### Background

<table>
<thead>
<tr>
<th>Greater Cincinnati Water Works</th>
<th>Northern Kentucky Water District</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Richard Miller Treatment Plant</td>
<td>• Ft Thomas Treatment Plant</td>
</tr>
<tr>
<td>• 240 MGD Surface Water Plant</td>
<td>• 44 MGD Surface Water Plant</td>
</tr>
<tr>
<td>• Two intakes on the “Kentucky side” of the Ohio River</td>
<td>• Ft Thomas and Newport Intakes</td>
</tr>
<tr>
<td>• Serve 1.1 million people per day</td>
<td>• Serve 300,000 people per day</td>
</tr>
</tbody>
</table>

Intakes for both treatment plants are located approximately 1 mile downstream of the Combs-Hehl Bridge.
Potential spills on the Combs-Hehl Bridge are one of the highest priority source water quality threats we have identified.

Time-of-travel between bridge and intakes is 15 minutes to 2 hours depending on river flow.
Drains appear to be regularly spaced on both side of each span
Add a piping system under the bridge to collect water or spills from the southwestern portion of the bridge and divert it to the northeastern side for discharge. Spills and impacted water will pass the intakes without being drawn in.
Dye Tracer Study

Primary Goal:
• Determine whether there is enough lateral mixing for a contaminant released to the Ohio side of the river to enter the GCWW or NKWD intakes (i.e., the “proof of concept” goal)

Secondary Goal:
• Determine the overall rate of lateral mixing and how far toward the Ohio side a release needs to be diverted.

The Tracer Study Results will also be used to calibrate a numerical flow model currently being developed by Univ. of Cincinnati Engineering students.
Study Design

• 2-day test, one injection per day
• Inject dye: Day 1 at 450 ft and Day 2 at 700 feet from Ohio bank
• Collect samples at 4 stationary points (each of the 4 intakes) and two boats (transects and depth monitoring).
• Record dye location and movement visually using drone
• Velocity and discharge profiles each day using Acoustic Doppler Current Profiler (ADCP)
• Detailed bathymetric mapping of study reach
Dye Selection

• Rhodamine WT (Red Dye)
  • Approved for potable situations
  • Fluorescent, easily detected by fluorometers
  • Detection level to 0.01 µg/L with field and benchtop meters
  • Highly visible, even at low concentrations
  • Completely miscible in water with specific gravity close to 1
GCWW Intake Sampling
GCWW Submerged Intake Sampling
Day 1: Dye Injection 450 feet From Ohio Bank
Day 1: Halfway to Intake (2000 feet from injection point)
A View from the Water
Day 1: Parallel to Intake (4500 feet from injection point)
Day 1 Results - GCWW Intake

Cyclops 7 Fluorometer Results
GCWW Intake Pier
October 22, 2018 (Day 1 Test)

Fluorescence, ug/L as Rhodamine WT (includes background)

River Water Temperature, °C

[Graph showing changes in fluorescence and temperature over time]

Intake Pier Fluorometer Results (Day 1)  Dye Injection Time  Projected Arrival time
Day 1 Results - Submerged Intake

Trilogy Fluorometer Results
GCWW Ohio River Pump (ORP)
October 22, 2018 (Day 1)
Day 1 Results - Intakes

Trilogy Fluorometer Results
NKWD ORPS 1
October 22, 2018 (Day 1)
Day 1 Results - Intakes

Cyclops 7 Fluorometer Results
NKWD ORPS 2 Intake (Newport)
October 22, 2018

(Instrument 7377-207380)
Day 2: Dye Injection 700 feet from Ohio Bank
Day 2: Dye Tracing Transects
Day 2: Half Way to Intake
Day 2: Transect Number 8
Fluorometer Results

Cross Plume Transect 3
2223 ft downstream of injection point

Note: The peak concentrations at 1000 RFU are for illustration purposes only. The actual concentration exceeded the instrument's ability to read.
Day 2: Parallel to Intake
Day 2: Transect Number 8
Fluorometer Results

Cross Plume Transect 8
4158 ft downstream of injection point

Distance from the Kentucky Bank, ft
Transects 12, 13 and 14
Day 2: Transects 12, 13, and 14

Fluorometer Results

Newport Intake Time Series
Approximately 8155 ft downstream of injection point
Day 2: GCWW Intake Pier

Cyclops 7 Fluorometer Results
GCWW Intake Pier
October 23, 2018 (Day 2 Test)

Measuring point is approximately 4,540 feet downstream from injection point

River speed = 1.8 mph
River speed = 1.5 mph

Dye Injection Time
Projected Arrival Time
Intake Pier Fluorometer Results (Day 2)
Day 2: NKWD Intake Pier

Trilogy Fluorometer Results
NKWD ORPS 1
October 23, 2018 (Day 2)

Relative Fluorescence Units, RFU/µL

- Fluorometer Results
- Dry-Docking Time
- Projected Arrival Times

Day 2: NKWD Intake Pier

Trilogy Fluorometer Results
NKWD ORPS 2
October 23, 2018 (Day 2)
Day 2 Plume Outline
Preliminary Observations

• The Day 1 results were complicated by an unrelated detection and instrument malfunctions.
• Dye was not detected at either GCWW Intake.
• Possibility that very low dye concentrations were observed at both NKWD intakes on Day 2.
• Dye was not observed reaching either bank within the study reach.
• Maximum measured plume width on Day 2 was 472 ft wide.
• Plume edges became more gradational after approximately 4500 ft.
Conclusion

• The preliminary results of the dye study support the basic premise that if pollutants spilled on the Combs Hehl Bridge were diverted toward the Ohio side of the river most, if not all, of the contaminants would flow past the intakes without being pulled into the treatment plant.
Harmful Algal Blooms: Impacts on Human Health and Beyond

JIYOUNG LEE

Professor
Division of Environmental Health Sciences, College of Public Health
Department of Food Science & Technology

Ohio-Kentucky-Indiana Groundwater Committee Meeting
Cincinnati, OH
December 12, 2018
Research Theme

Microbial and their metabolites contamination in environments that leads to human exposure and its linkage to health outcome
Drinking water
Recreational water
Wastewater & Storm water

PATHOGENS

Irrigation water

Health outcomes:
gastrointestinal illness (e.g. dysbiosis),
chronic & acute toxicity

ONE WATER

Soil
Food

Enteric pathogens
Cyanobacteria & toxins

Antibiotic resistance
Microbial community

TRANSMISSION DYNAMICS & EXPOSURE PATHWAYS
Harmful cyanobacterial blooms:
Cyanobacteria in freshwater

- Anabaena
- Aphanizomenon
- Cylindrospermopsis
- Lyngbya
- Nodularia
- Trichodesmium
- Planktothrix
- Microcystis
Cyanotoxins

Hepatotoxins

- Microcystin-LR
- Nodularin

Cytotoxin

- Cylindrospermopsin (7R)

Neurotoxins

- Anatoxin-a
- Saxitoxin
- BMAA

Dermatotoxins

- Lyngbyatoxin A
- Aplysia toxin
Microcystin

- cyclic peptides
- Water soluble
- Persistent (stable and resistant)
- Produced by various cyanobacteria, including *Microcystis*, *Planktothrix*, etc.
- Bind covalently to protein phosphatases (type 1 and 2A), thus disrupting cellular control processes.
- Once ingested, microcystin travels to the liver, via the bile acid transport system, where most is stored.
- Some remains in the blood stream and may contaminate tissue.
- Tumor promoter (IARC)
Microcystin – LR: Adverse Health Effects

- Potent liver toxicant

- Irritant – skin, eyes, stomach

- Possible male reproductive toxicity?

Needs further study…


Julia Dady, 2013
Cyanotoxins and cancers

Detection of microcystins, a blue-green algal hepatotoxin, in drinking water: primary liver cancer epidemiological studies in Serbia

Yoshio Ueno, Akihiro Hasegawa, Ho-Dong Park, Shun-Zhang Yang

Relationship Between Microcystin in Drinking Water

Research on the relationship between microcystin in drinking water and primary liver cancer epidemiology in Serbia

Zorica Svirčev, Svetislav Krstić, Marica Miladinov-Mikov, Vladimir Batić, and Milka Vidović
WHO guideline

Microcystin:
- 1 µg/L (ppb) in drinking water
- 20 ppb for recreational waters
US EPA: Drinking water health advisory (10-day)

<table>
<thead>
<tr>
<th></th>
<th>Bottle-fed infants and pre-school children</th>
<th>School-age children and adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcystin</td>
<td>0.3 µg/L</td>
<td>1.6 µg/L</td>
</tr>
<tr>
<td>Cylindrospermopsin</td>
<td>0.7 µg/L</td>
<td>3.0 µg/L</td>
</tr>
</tbody>
</table>

Recreational water guideline: microcystin 4 µg/L
## Ohio toxin-based advisory

<table>
<thead>
<tr>
<th></th>
<th>Do Not Drink</th>
<th>Do Not Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children under 6</strong></td>
<td>0.3 µg/L</td>
<td>1.6 µg/L</td>
</tr>
<tr>
<td><strong>Children 6 and older and adults</strong></td>
<td>1.6 µg/L</td>
<td>20 µg/L</td>
</tr>
<tr>
<td><strong>Recreation</strong></td>
<td>20 µg/L</td>
<td>300 µg/L</td>
</tr>
<tr>
<td><strong>Microcystin</strong></td>
<td>0.3 µg/L</td>
<td>1.6 µg/L</td>
</tr>
<tr>
<td><strong>Anatoxin-a</strong></td>
<td>20 µg/L</td>
<td>20 µg/L</td>
</tr>
<tr>
<td><strong>Cylindrospermopsin</strong></td>
<td>0.7 µg/L</td>
<td>3.0 µg/L</td>
</tr>
<tr>
<td><strong>Saxitoxin</strong></td>
<td>0.2 µg/L</td>
<td>0.2 µg/L</td>
</tr>
</tbody>
</table>

* No Contact Advisory Thresholds
Toledo water crisis (2014): microcystin in drinking water

- Large precipitation events during spring and early summer lead to large nutrient runoff in the Maumee river.
- The transport of these nutrient into the Western Basin of Lake Erie lead to large HAB’s and high concentrations of MC.
- 400,000 people were left without drinking water as the city instituted a state of emergency.
  - 272 dialysis patients impacted in 6 DaVita facilities.
  - 11 home dialysis patients impacted.
- Millions of dollars were spent to improve Toledo’s drinking water treatment systems.
Cyanobacteria blooms vs. public health in US
Cyanobacteria blooms and non-alcoholic liver disease: evidence from a county level ecological study in the United States

Feng Zhang1, Jiyoung Lee1,2,3*, Song Liang4,5 and CK Shum6,7

Abstract

Background: Harmful cyanobacterial blooms present a global threat to human health. There is evidence suggesting that cyanobacterial toxins can cause liver damage and cancer. However, because there is little epidemiologic research on the effects of these toxins in humans, the excess risk of liver disease remains uncertain. The purpose of this study is to estimate the spatial distribution of cyanobacterial blooms in the United States and to conduct a Bayesian statistical analysis to test the hypothesis that contamination from cyanobacterial blooms is a potential risk factor for non-alcoholic liver disease.
Bloom coverage in US

% percentage of the county area covered by blooms

• 65 significant spatial clusters, which include 432 counties ($p<0.05$)
• Counties in the clusters also showed higher bloom coverage than counties from the non-clusters (Wilcoxon signed-rank test, $p<0.001$).

• The global association is positive and significant (P<0.05)
• The risk from non-alcoholic liver disease increased by 0.3% with each 1% increase in bloom coverage in the affected county after adjusting for age, gender, educational level and race.

What does it mean?

• In the US, if the bloom coverage per county increases by 1%, the estimated number of deaths per year will increase by about 440.

• The results show that bloom coverage was a significant factor influencing the rate of nonalcoholic liver diseases.

• This study is not about causal relationship. Further studies are needed.
HABs in small lakes

Tile drainage

Dr. Joan Slonczewski
Dr. Siobhan Fennessy
Tile Drainage and Anthropogenic Land Use Contribute to Harmful Algal Blooms and Microbiota Shifts in Inland Water Bodies

Igor Mrdjen,† Siobhan Fennessy,‡ Alex Schaal,‡ Richard Dennis,‡ Joan L. Slonczewski,‡ Seungjun Lee,† and Jiyoung Lee*,†§

†Division of Environmental Health Sciences, College of Public Health, The Ohio State University, 1841 Neil Avenues, Columbus, Ohio 43210, United States
‡Department of Biology, Kenyon College, 202 North College Road, Gambier, Ohio 43022, United States
§Department of Food Science and Technology, The Ohio State University, Columbus, Ohio 43210, United States

Supporting Information

ABSTRACT: Freshwater harmful algal blooms (HABs), driven by nutrient inputs from anthropogenic sources, pose unique risks to human and ecological health worldwide. A major nutrient contributor is agricultural land use, specifically tile drainage discharge. Small lakes and ponds are at elevated risk for HAB appearance, as they are uniquely sensitive to nutrient input. HABs introduce exposure risk to microcystin (MC), hepatotoxic and potentially carcinogenic cyanotoxins. To investigate the impact of anthropogenic land use on small lakes and ponds, 24 sites in central Ohio were sampled over a 3-month period in late summer of 2015. MC concentration, microbial community structure, and water chemistry were analyzed. Land use intensity, including tile drainage systems, was the driver of clustering in principle component analysis, ultimately contributing to nutrient deposition, a driver of HABs.
Source of eutrophication

- Human land use (sp. agriculture) contributes large quantities of nutrients to watersheds through point & non-point source runoff

- Specifically, the use of tile drainage systems has been linked to highly concentrated nutrient runoff in agricultural regions

Slide credit (Igor Mrdjen)
Tile Drainage and Eutrophication

- Nutrient loading of this nature has been studied in the Maumee River watershed.
- Studies of tile drainage have largely focused on its effects in large watersheds.

Slide credit (Igor Mrdjen)
HABs in Small Lakes and Ponds

24 sites in Knox Co., OH were sampled and graded on human land use

Nutrient Concentrations Were Correlated with Cyanobacterial Concentrations

Significance of FC

- Receives direct inflow of tile drainage from nearby agricultural field
- Minimal surface run-off
- Surrounded by dense vegetation
- Site for gatherings, fishing, and recreational activities
Exposure to cyanotoxins

Ingestion, inhalation, dermal contact
Ongoing Work

Microcystin

Chronic toxicity
(C. Weghorst)

Acute toxicity
(J. Lee)

Biomarkers
(T. Knobloch)

Stress response (gut microbiome)
(J. Lee)
Microcystin & *Microcystis*: exposure via ingestion

Liver lesions seen in necropsied mice:

A) 3mm lesion, showing angiogenesis, found in mouse ingesting MC-LR water
B) 5mm lesion seen in mouse ingesting MC-LR water
C) Lesion (15mm) demonstrating angiogenesis in mouse treated with MC-LR water
D) 5mm lesion found in mouse exposed to Microcystis extract

Igor Mrdjen, Chris Weghorst, Tom Knobloch and Jiyoung Lee (unpublished data)
Liver lesion proportion by MC-LR and *Microcystis* extract

Igor Mrdjen, Chris Weghorst, Tom Knobloch and Jiyoung Lee (unpublished data)
Cyanobacterial Toxins in Freshwater and Food: Important Sources of Exposure to Humans

Jiyoung Lee, Seungjun Lee, and Xuewen Jiang

1Division of Environmental Health Sciences, College of Public Health, The Ohio State University, Columbus, OH 43210; email: lee.3598@osu.edu
2Department of Food Science and Technology, The Ohio State University, Columbus, OH 43210; email: jiang.1188@osu.edu
3Environmental Science Graduate Program, The Ohio State University, Columbus, OH 43210; email: lee.5178@osu.edu

Keywords
cyanotoxin, fish, fresh produce, exposure routes, toxin treatment

Abstract
A recent ecological study demonstrated a significant association between an increased risk of nonalcoholic liver disease mortality and freshwater cyanobacterial blooms. Moreover, previous epidemiology studies highlighted a relationship between cyanotoxins in drinking water with liver cancer and damage and colorectal cancer. These associations identified...
Microcystin accumulation in food?

MICROCYSTIN: It May Not Just Be In The Water

Twineline (2017) vol.39/no.1

Stu Ludsin
Jay Martin
MC conc. in fish from Lake Erie’s western basin

- Yellow perch
- White perch
- Walleye
• Walleye: highest amount of MC in tissues (71 ng MC/g)
• MC levels in white perch: depend on local bloom conditions
Cyanotoxin exposure routes

Microcystin and Your Food

Researchers at The Ohio State University are looking at exposure to this toxin from a different angle.
When grown with environmentally relevant MC concentration..
Fate of microcystin

Microcystin accumulates in fresh produce & soil

Translation to potential health risk?

<table>
<thead>
<tr>
<th>Child exposure</th>
<th>Low Risk</th>
<th>Moderate Risk</th>
<th>High Risk</th>
<th>Microcystin (ppb)</th>
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<tbody>
<tr>
<td></td>
<td>0.004</td>
<td>0.004</td>
<td>0.04</td>
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<table>
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<th>Adult exposure</th>
<th>Low Risk</th>
<th>Moderate Risk</th>
<th>High Risk</th>
<th>Microcystin (ppb)</th>
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<td></td>
<td>0.004</td>
<td>0.004</td>
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<td>0.006</td>
<td>0.05</td>
<td>10</td>
</tr>
</tbody>
</table>
How about crops?
Crop Productivity

Length

Mass

Diameter

Crop Productivity

Length | Mass | # of beans

![Graphs showing length, mass, and number of beans against cyanotoxin concentration in irrigation water (ppb).](image)

Timely monitoring & bloom control
Tools for monitoring cyanotoxins

- Phycocyanin is a better predictor for microcystin levels than chl-a.
Monitoring for many lakes?

For large number of lakes and multi-year monitoring: 1) satellite remote sensing is useful; and 2) validation with in situ measurements is needed.

Original research article

Ten-year survey of cyanobacterial blooms in Ohio’s waterbodies using satellite remote sensing

Tyler Gorham¹, Yuan Yuan Jia², C.K. Shum³, Jiyong Lee⁴,*

¹ College of Public Health, Division of Environmental Health Sciences, The Ohio State University, 1147 Neil Ave, Columbus, OH 43210, USA
² Division of Gastroenterology, School of Medicine, The Ohio State University, 317 S. Oval Mall, Columbus, OH 43210, USA
³ Department of Food Science and Technology, The Ohio State University, 413 USF Music, Columbus, OH 43210, USA

* Corresponding author.

Abstract

Cyanobacterial blooms, or blue-green algae, have been a growing concern in Ohio’s waterbodies due to their potential hazards to human and animal health, as well as their impact on aquatic ecosystems. This study presents a ten-year survey of cyanobacterial blooms in Ohio’s waterbodies using satellite remote sensing. The study analyzed satellite images from 2009 to 2018 and identified 105 bloom events across Ohio’s waterbodies. The majority of these blooms occurred in lakes and reservoirs, with smaller outbreaks observed in streams and rivers. The study also revealed a significant correlation between water temperature and the occurrence of cyanobacterial blooms, with warmer water temperatures leading to increased bloom occurrences. The findings of this study provide valuable insights into the temporal and spatial distribution of cyanobacterial blooms in Ohio’s waterbodies, which can inform effective management strategies to mitigate their effects.
Recent work

• Satellite remote sensing: Most widely used methods of study and surveillance

• Cyanobacteria have a unique reflectance signature as they contain Chlorophyll $a$ (670 nm) and Phycocyanin (620 nm)

• Large area of coverage, speed, and ease of access

• Limitations do exist!!
Unmanned Aerial Vehicle-based remote sensing

- Nears-shore coverage
- Water sampler
- Lab validation
Acknowledgements

lee.3598@osu.edu
https://cph.osu.edu/people/jlee
Welcome/Introductions:
Groundwater Committee Chair Bruce Whitteberry opened the meeting and requested introductions from all attendees.

Announcements:
A reminder that the next meeting date is March 20th 2019.

Update on Local Groundwater Management Efforts:
Tim McLelland - Groundwater Consortium
Tim shared an update on the Fairfield gas depot that exploded due to lightning and has been in the cleanup process over the last few years. The site was a concern because of its proximity to a City of Hamilton well, which had to be closed due to contamination. At this point, most of the contaminants have been cleaned up through extractions and the Hamilton well has been reinstated. The extraction process is expected to conclude in early 2019. The committee noted an interest in further examining this gas depot cleanup as a future presentation.
Tim also shared some of the recent successes of the Groundwater Consortium. For the 21st consecutive year, the Consortium was designated a member of the Groundwater Guardians Communities program. On October 12th, the Groundwater Consortium held the Children’s Water Festival, with participation from 1200 students and a waiting list of 600 students. Another successful event the Consortium participated in was the Race for Global Waters 5k, raising $12,000 for Water for People. The Groundwater Consortium also put on a Great Miami cleanup in which approximately 300 people picked up 9.11 tons of trash. Currently, the Groundwater Consortium is working on updating its website and inventories.

**Dave Combs- City of Trenton**

The City of Trenton is expecting to increase the presence of industries as they continue development of their industrial park. Dave explained that the city has an ion-exchange water treatment plant that pumps 1.1 million gallons per day with two wellfields and four wells, one of which handles up to 500 gallons per minute. Following lightning damage, the plant has invested $12,000 of surge protectors to protect against future storms. Dave shared a recent backflow prevention walkthrough of Magnode, a company recently bought by Shape Corporation, in which two wells were discovered, two septic tanks were crushed and filled in, and a storm pipe was corroded. The EPA was notified of the corroded pipe.

**Bruce Whitteberry- Cincinnati Water Works**

Bruce discussed the new five-year business plan that is being implemented to improve the Bolton Wellfield. One issue that Cincinnati Water Works is experiencing is that the Great Miami River is eroding into the well field, which has thirteen wells adjacent to the river. Currently, Cincinnati Water Works is implementing a bank stabilization program; however, the stabilization has been delayed due to the need to obtain an individual permit rather than the Clean Water Act national permit. Therefore, Cincinnati Water Works will continue to monitor the erosion of the river banks until they are properly stabilized. Another factor affecting the wellfield that must be monitored is the Rumpke landfill, as its surface runoff ends up in Banklick Creek which runs through the wellfield. Bruce shared that Rumpke is preparing to expand the landfill, which could improve water quality because of the higher standards and greater protections built into the expansions.

Bruce also encouraged the committee to closely examine a new federal law, America’s Water Infrastructure Act. This act includes additional requirements for utilities. One requirement is that consumer confidence reports must have more understandable language. Depending on the number of customers being served, utilities may also have to release a CCR report twice a year. Another important provision of the act is that utilities will have to complete a risk and resiliency assessment and certify its completion. The date of completion is contingent upon the number of customers served. The act is still being analyzed and the EPA will have to consider how to implement it.

**OKI Staff Update:**
Members were reminded to check the certificate box on the attendance sheet in order to receive certificates. OKI will be creating a survey for the committee members to gather potential topics of interest and gauge willingness to give a local update. Audrey Laiveling, a sophomore at the University of Cincinnati, is OKI’s new water quality intern.

**Presentations:** (For more information on each presentation check out the Groundwater Committee website at [http://www.oki.org/about-oki/committees/groundwater-committee/](http://www.oki.org/about-oki/committees/groundwater-committee/))

**Rich Stuck, Cincinnati Water Works**

*Safeguarding GCWW Supply Through Expanded Contingency Planning: Preliminary Results of a Recent Dye Tracer Study*

Rich shared the results of a recent dye tracer study on the Ohio River conducted by a collaboration of Cincinnati Water Works, Northern Kentucky Water District, ORSANCO, and University of Cincinnati engineering students. The problem that prompted the study is that stormwater on the Combs-Hehl Bridge is discharged directly to the Ohio River below. This bridge sees a large volume of trucks containing hazardous materials. Downstream from this bridge on the Kentucky side is the intakes for the Miller Treatment Plant as well as for Northern Kentucky Water District, so water containing any spilled contaminants from the bridge would enter the plants. The proposed idea was to install a pipe to carry all stormwater to the Ohio side of the bridge to be discharged in the hopes that contaminated water would not reach the intakes on the Kentucky side. This hypothesis was tested using red tracer dye to determine the rate of lateral mixing of contaminants in the river. Boats taking water samples as well as aerial drone footage were used to conduct the study. Based on preliminary results, it appears that pollutants diverted to the Ohio side of the river would flow past the intakes without being pulled into the treatment plants. The UC students will take this data to create a model that would consider changing factors such as flow rate.

**Jiyoung Lee, PhD, Ohio State University**

*Harmful algal blooms: Impacts on human health and beyond*

Dr. Lee presented numerous studies that she has collaborated in on the toxins that are found in the cyanobacteria of harmful algal blooms and their effects on human health. This issue is especially relevant in Ohio because of excessive nutrient runoff due to agriculture. The toxin that Dr. Lee is specifically interested in is microcystin, a resilient toxin that is stable in water and disrupts cellular processes. In 2014, Toledo’s harmful algal bloom led to microcystin in the drinking water. Microcystin particularly affects the liver, where toxins accumulate, and it is a known tumor promoter. In one study, Dr. Lee compared data on the algal bloom coverage of counties across the nation to county clusters of non-alcoholic liver disease; she found a significant correlation between areas with more bloom coverage and liver disease clusters. Dr. Lee demonstrated that humans can also ingest the toxins found in harmful algal blooms through fish because the toxins accumulate in the fish due to biomagnification. Occurrences of harmful algal blooms are projected to increase in the future as eutrophication continues and temperatures
rise, so Dr. Lee emphasizes the need for timely monitoring of blooms. She introduced the idea of using drones to monitor the fluorescence of water as an indicator of beginning blooms.

**Other Business:**
The planned meeting dates for 2019 are June 19, September 18, and December 11.