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March 13, 2017

Ms. Barcy F. McNeal, Secretary
Ohio Power Siting Board
Docketing Division
180 East Broad Street, 11th Floor
Columbus, OH 43215

Re: Case No. 16-1871-EL-BGN
Icebreaker Windpower Inc.
Supplement and Errata to Application filed on February 1, 2017

Dear Ms. McNeal:

Icebreaker Windpower, Inc. ("Applicant") is filing this supplement to the application filed on February 1, 2017 ("Application") in order to provide the Ohio Power Siting Board ("Board") with: corrected and updated numbers; the addition of another turbine model that may be used in the project; information mentioned and promised in the application; and an update on the progress of discussions with the agencies concerning the ecological studies addressed in the Application. Therefore, the Applicant requests that the Board consider the following supplemental information as part of its Application in this matter.

Errata: It has come to the Applicant's attention that there was a typographical error in the Application on page 30 of the narrative under the response to Ohio Administrative Code ("O.A.C.") Rule 4906-4-04(A)(4), Wind Resources. In the last line of that response, the turbine spacing measurements should be corrected to reflect that the "[t]urbines are spaced approximately 756~~768~~ meters (2,480~~2,520~~ feet; 6 Ds) apart...."

Turbine Model: At the time of the submittal of the Application, the Applicant anticipated it would use the Mitsubishi Heavy Industries Vestas Offshore Wind – Vestas 3.45 megawatt ('MW') offshore wind turbine - International Electrotechnical Commission ("IEC") wind class IIA (Vestas V126-3.45 MW IEC IIA). Since that time, the turbine manufacturer has indicated that there is a possibility that the IEC wind class IIB for that same model should be considered an option for the project. As indicated in Exhibit C1 from the Application, the Vestas V126-3.45 MW IEC IIB turbine will have the same dimensions, cut-in speeds, cut-out speed, and specifications described in the Application in response to O.A.C. Rule 4906-4-03(B)(1) for the Vestas V126-3.45 MW IEC IIA turbine. The wind class IIB model is essentially the same turbine, with a different software system. The difference between the turbines is that the Vestas V126-3.45 MW IEC IIA turbine can withstand much higher turbulence than the Vestas V126-3.45 MW IEC IIB turbine. As described in response to O.A.C. Rule 4906-4-08(A)(6) of the Application, the Vestas V126-3.45 MW IEC IIA turbine can withstand an 18% turbulence measured at hub height, while the Vestas V126-3.45 MW IEC IIB turbine can withstand a 12%

turbulence at hub height. Winds in Lake Erie at the project area are within the range of 6 to 8% turbulence. Therefore, Vestas may decide that the Vestas V126-3.45 MW IEC IIA is not necessary, based on winds in the project area. Therefore, the Applicant requests that the Vestas V126-3.45 MW IEC IIB turbine model be added to the list of turbine models acceptable for use in this project.

Turbine Cut-out Speed: The manufacturer recently informed the Applicant that the cut-out wind speed on the turbine models proposed for the project, the Vestas V126-3.45 MW IEC IIA and IIB, has changed; however, the spec sheet reflecting this change is not yet available. Once the new spec sheet is received, the Applicant will provided it to the Board. With this update to the cut-out wind speed, the cut-out speed should be changed to 27.5 meters per second (61.5 miles per hour) in the following places in the Application:

1. Narrative page 6, O.A.C. Rule 4906-4-03(B)(1)(a).

2. Narrative page 12, O.A.C. Rule 4906-4-03(B)(2)(a).

3. Narrative page 84, O.A.C. Rule 4906-4-08(A)(6). The Applicant notes that these numbers were inadvertently redacted in the Application. Therefore, an unredacted version of the original page 84 filed on February 1, 2017, is being provided with this supplemental filing as **Attachment 1.**

4. Narrative page 85, O.A.C. Rule 4906-4-08(A)(7).

5. Exhibit C1, page 15, Facts and Figures, Operating Data.

Aquatic Monitoring: In response to O.A.C. Rule 4906-4-08(B), Ecological Impact, the Applicant provided, as Exhibit O to the Application, the Lake Erie Monitoring Plan dated January 23, 2017 ("Monitoring Plan"). On February 1, 2017, the Ohio Department of Natural Resources, Division of Wildlife (ODNR-DOW) sent a letter to LimnoTech, the Applicant's aquatic resources consultant, indicating that all of the comments provided by ODNR-DOW had been addressed in the Monitoring Plan. In that letter, ODNR- DOW indicated that it would work with the Applicant and the United States Fish and Wildlife Service (USFWS) to develop a memorandum of understanding to implement the Monitoring Plan. That letter is included as **Attachment 2** to this supplemental filing.

In addition, as part of the Application in this case, in response to O.A.C. Rule 4906-4-08(B)(1), the Applicant committed to providing results of the Monitoring Plan once the results were available. In compliance with this commitment, the Applicant has included, as part of this supplement to the Application, **Attachment 3**, Report: Results of 2016 Aquatic Sampling, which contains the results of the aquatic monitoring conducted in 2016.

Bird and Bat Monitoring: The Applicant continues to discuss additional baseline studies and post-construction monitoring plans for birds and bats with ODNR and USFWS. In its Application (Table 8 on page 112), the Applicant submitted a proposed matrix of options that are being considered for baseline studies and post-construction monitoring. The Applicant met with the wildlife agencies to discuss these options and, on February 28, 2017, the agencies sent responsive comments to the Applicant. Those comments are attached to this supplemental filing as **Attachment 4**. The Applicant responded to the agencies on March 6, 2017, and the response is included in this supplemental filing as **Attachment 5**.

The Applicant also notes that, in accordance with its agreement with the agencies, additional bat acoustic monitors will be deployed. Consistent with this understanding, the week of March 13, 2017, weather permitting, monitors will be deployed at two buoys and on the Cleveland Water Intake Crib. The Applicant and the wildlife agencies have also agreed to additional waterfowl aerial surveys with live observers from mid-October to late May prior to and after construction.

In addition, discussions continue between the Applicant and the agencies regarding deployment of an additional bat acoustic monitor, as well as additional radar studies prior to construction. The Applicant is currently in the process of preparing additional information for the wildlife agencies with regard to the viability of deploying radar on a large vessel with a four-point anchor for a spring and fall migration season. Once the agencies have had an opportunity to review this information, the Applicant expects to continue discussions with the agencies in an effort to resolve the issue of radar baseline studies.

Sediment Studies: Throughout the narrative of the Application and specifically in response to O.A.C. Rule 4906-4-07(C)(2)(b), beginning at page 57, the Applicant addressed the issue of the potential for sediment disturbance. Therefore, the Applicant has included, as part of this supplemental filing, **Attachment 6**, which is a sediment evaluation dated March 10, 2017. This document was prepared by CH2M Hill, Inc. at the request of the Applicant.

Federal Aviation Administration Determination: In response to O.A.C. Rule 4906-4-07(E)(2), on page 65 of the Application narrative, the Applicant committed to provide the final determination from the Federal Aviation Administration (FAA) once the determination was issued. Pursuant to this commitment, as **Attachment 7** to this supplemental filing, the Applicant has included the FAA's determination of no hazard to air navigation, which was issued for all turbine locations on February 22, 2017.

Turbine Specifications: In response to O.A.C. Rule 4906-4-03(B)(2)(a), the Applicant submitted the Turbine Performance Specifications, Exhibit C2, under seal. In the interest of transparency and in order to provide as much information as possible in the public record in this case, the Applicant worked with the turbine manufacturer and obtained an abstract of Exhibit C2 that can be filed in the open record. That General Description 3MW Platform document is included in this supplemental filing as **Attachment 8**.

The original of this supplement to the Application has been filed electronically. In addition, 5 complete paper copies and 10 USB drives containing the supplemental information and errata to the Application have been provided.

We are available, at your convenience, to answer any questions you may have.

Respectfully submitted,

/s/ Christine M.T. Pirik
Christine M.T. Pirik (0029759)
Terrence O'Donnell (0074213)
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Attorneys for Icebreaker Windpower Inc.

Enclosures

Attachment 1

New Page 84 of Application Narrative

overlying mudstone. The bedrock was encountered at an elevation of approximately [redacted] meters (International Great Lakes Datum [IGLD] 85). At the other boring locations, the borings were stopped prior to reaching the bedrock. See Exhibit I for further detail.

(6) Prospects of High Winds in the Area

International standards for wind turbines are developed by working groups of Technical Committee-88 of the IEC, a world-recognized body for standards development. The proposed turbine for the Facility is designed to meet the standards of the IEC-61400 series, and are rated to specific IEC wind classes. As indicated in the turbine brochures included in Exhibit C (submitted under seal), the Vestas 126 is certified for class IIA winds, which are defined by the totality of the conditions detailed below:

- Turbulence intensity,
- Average annual wind speed,
- Average inclined flow,
- Wind speed distribution (Weibull),
- Wind profile,
- Turbulence model,
- Hub height extreme wind speeds – 1 and 50 year,
- Extreme gust speeds,
- Extreme directional change, and
- Extreme wind shear.

For example, during its design life, Class IIA turbines will withstand average wind speeds of up to 8.5 m/s (19 mph) and 18% turbulence as measured at hub height. It is important to note that these IEC standards represent minimum design values.

The Applicant performed a wind classification analysis, including an extreme wind analysis. Based on those results, MVOW (Vestas) determined that the wind regime was suitable for a Class IIA turbine, namely the V126-3.45. Highlights of this report indicated that long-term mean annual wind speeds at turbine hub height and location is [redacted] m/s ([redacted] mph), the maximum 10-minute average wind speed (for a 50-year return period) was calculated to be [redacted] m/s ([redacted] mph), the maximum 10-minute average wind speed for a 1-year return period was calculated as [redacted] m/s ([redacted] mph), and the IEC turbulence category for the site is [redacted]. The proposed turbine has a cut out speed, based on 10-minute exponential average, of 22.5 m/s (50 mph). The Applicant will be able to adjust the pitch of the turbine blades (i.e., blade feathering) to protect the turbine from high

Attachment 2

February 1, 2017
Ohio Department of Natural Resources,
Division of Wildlife Letter

Ohio Department of Natural Resources

JOHN R. KASICH, GOVERNOR — JAMES ZEHRINGER, DIRECTOR

Ohio Division of Wildlife
Raymond W. Petering, Chief
2045 Morse Road, Bldg. G
Columbus, OH 43229-6693
Phone: (614) 265-6300

February 1, 2017

Mr. Edward Verhamme
Project Engineer
LimnoTech
501 Avis Drive
Ann Arbor, MI 48108

Re: LimnoTech Lake Erie Monitoring Plan

Dear Mr. Verhamme:

The purpose of this letter is to formally acknowledge that the January 25, 2017 version of the *LimnoTech Lake Erie Monitoring Plan for the Offshore Wind Project: Icebreaker Wind* received via email on January 25, 2017 meets the requirements of the Ohio Department of Natural Resources (ODNR) Division of Wildlife (Division) Fish Management & Research Group. All Division comments have been addressed in this version of the plan.

The Division will work to develop adaptive language in a forthcoming Memorandum of Understanding (MOU) between ODNR, the United States Fish & Wildlife Service (USFWS), LEEDCo, and LimnoTech that obligates LEEDCo and LimnoTech to fully implement the agreed-to monitoring plan. The MOU will include provisions for an annual performance review, a comprehensive analysis of data, and an option to adjust the monitoring plan based on changes in project design and/or results-driven knowledge gained from the monitoring work.

Please feel free to contact me by email at rich.carter@dnr.state.oh.us or phone at (614) 265-6345 if you have any questions.

Sincerely,

Rich Carter

Rich Carter
Executive Administrator
Fish Management and Research
ODNR-Division of Wildlife

cc: Robert Boyles, Deputy Director – ODNR
Raymond Petering, Chief, Division of Wildlife – ODNR
Scott Hale, Assistant Chief, Division of Wildlife - ODNR
Dr. Scudder Mackey, Chief, Office of Coastal Management – ODNR
Dave Kohler, Wildlife Administrator, Division of Wildlife - ODNR
Travis Hartman, Division of Wildlife - ODNR
Dr. Janice Kerns, Division of Wildlife - ODNR
Megan Seymour, Wildlife Biologist - USFWS

Attachment 3

Report: Results of 2016 Aquatic Sampling

Report: Results of 2016 Aquatic Sampling

Icebreaker Wind

Prepared for:

Icebreaker Windpower, Inc.

March 9, 2017

LimnoTech

Water | Scientists
Environment | Engineers

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LimnoTech
Water Environment | Scientists Engineers

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Ann Arbor, MI 48108
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Report: Results of 2016 Aquatic Sampling

Prepared for:
Icebreaker Wind

Under Contract to:
Icebreaker Windpower, Inc.

March 9, 2017

Prepared by:
LimnoTech
Ann Arbor, Michigan

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FIGURE OF CONTENTS

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1 Introduction

The purpose of this report is to document the field methods, results, and analysis carried out in 2016 to support the Icebreaker Wind project. LimnoTech, under contract to Icebreaker Windpower, Inc., led a multi-disciplinary team of researchers to collect site specific data at the site of and in the vicinity of the proposed Offshore Wind (OSW) demonstration project in Lake Erie.

The report includes the following major sections:

- Project introduction (Section 1)
- Sampling methods (Section 2)
- Results and discussion (Section 3)
- Conclusion (Section 4)
- References (Section 5)
- Appendices

1.1 Project Description

The proposed Icebreaker Wind demonstration project will include installation of six wind turbines, 8 to 10 miles offshore of Cleveland, Ohio in the Central Basin of Lake Erie. The turbines will be placed in water depths ranging from 58 feet to 63 feet, each with a nameplate capacity of 3.45 megawatts (MW) for a total generating capacity of 20.7 MW. The facility is expected to operate for approximately 8,200 hours annually, and have an approximate capacity factor of 41.1%, generating approximately 75,000 megawatt-hours (MWh) of electricity each year. A 2.3-mile buried electric cable will connect the six turbines, and an approximate 9.3-mile buried electric cable will connect the turbines to the Cleveland Public Power Lake Road substation. Figure 1 shows the project location within the Central Basin of Lake Erie offshore of Cleveland and the bathymetric contours.

1.2 Project Team

This section describes the project team in further detail. The project team is led by LimnoTech, an environmental engineering and science firm headquartered in Ann Arbor, MI. As a leader in environmental science and water quality management for nearly three decades, LimnoTech has helped clients assess, create and implement workable strategies for identifying and addressing aquatic impacts on scales both large and small. Our experts offer diverse technical skills, experience, and expertise that enable us to provide a full range of services for monitoring and evaluating these complex environments. The LimnoTech team is led by Ed Verhamme with support from Greg Peterson, Jen Daley, Cathy Whiting, John Bratton, and Greg Cutrell. Additional staff from the Ann Arbor office supported the fieldwork as needed. LimnoTech is responsible for all project deliverables, communication with Icebreaker Windpower, and management of additional team members.

The Ohio State University (OSU) – Stone Lab was established in 1895, and is the oldest freshwater biological field station in the United States. It is the center of Ohio State University's teaching and research on Lake Erie. The lab serves as a base for more than 65 researchers from 12 agencies and academic institutions, all working year-round to solve the most pressing problems facing the Great Lakes. Justin Chaffin, Chris Winslow and Stu Ludsin support the collection of juvenile fish and also process the nutrient and water samples.

The Cornell University Bioacoustics Research Program develops and uses digital technology, including equipment and software, to record and analyze the sounds of fish and wildlife. By listening to wildlife, their research advances the understanding of animal communication and monitors the health of wildlife populations. Policy makers, industries, and governments use this information to minimize the impact of human activities on fish and wildlife and natural environments. Aaron Rice assists with the development of the underwater soundscape/noise survey as well as with data processing and interpretation.

BSA Environmental Services, Inc. is an environmental consulting firm specializing in aquatic plankton and larval taxonomy. John Beaver of BSA assists LimnoTech with processing and identifying organisms from the phytoplankton, zooplankton, and larval fish surveys.

Biosonics is an environmental company that specializes in hydroacoustics. They offer a wide range of scientific equipment for fisheries research and aquatic habitat assessments. They are experts in understanding and post-processing acoustics data and have a wide range of experience throughout the country.

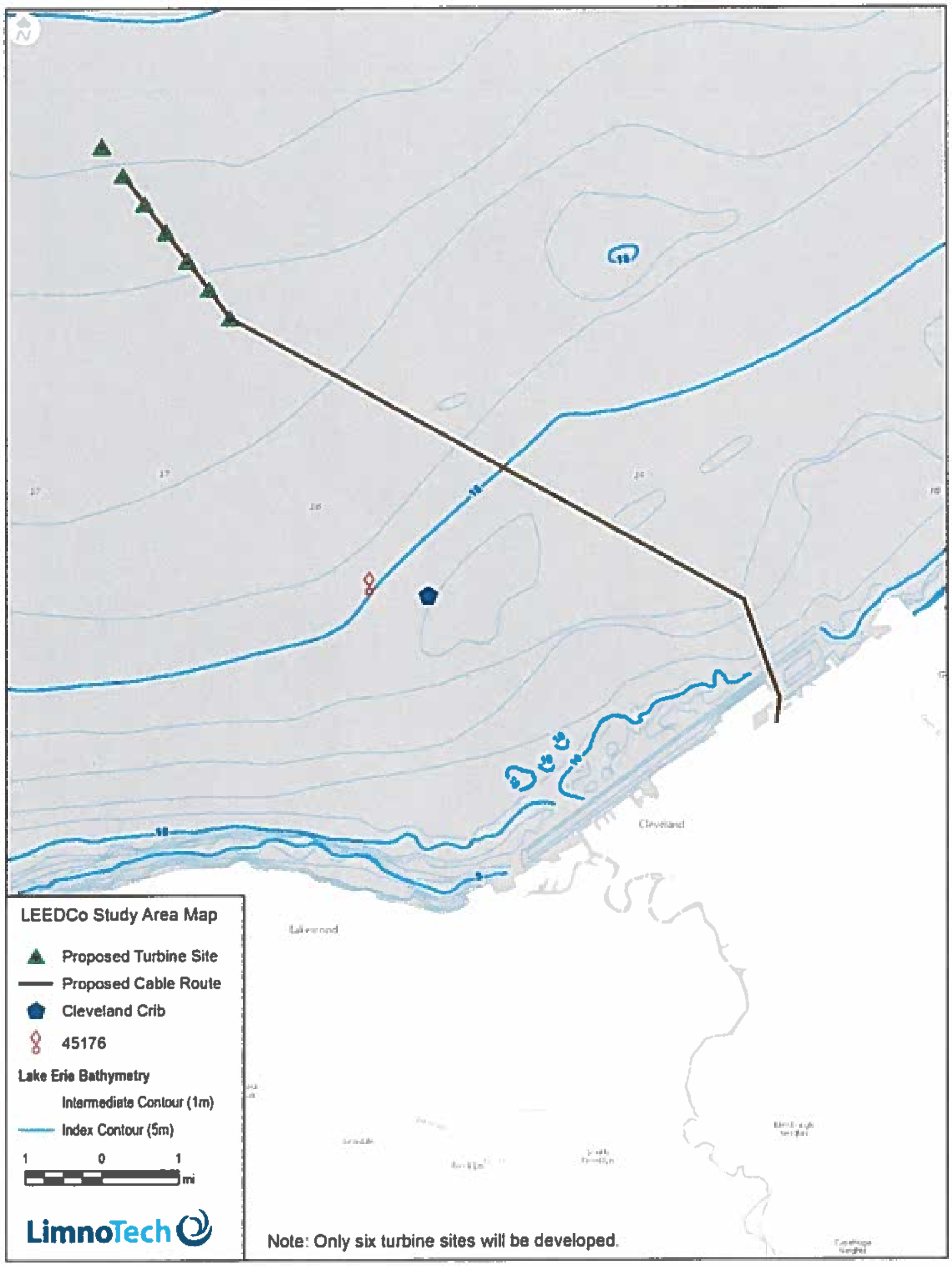

Figure 1. Project location map.

1.3 Agency Coordination

LimnoTech coordinated with the Ohio Department of Natural Resources (ODNR) and U.S. Fish and Wildlife Service (USFWS) to develop a 2016 monitoring program to assess ecological resources at the proposed project site and initiate the baseline characterization monitoring. Meetings were held on the following dates to discuss the proposed project and the 2016 Sampling Plan:

- April 11 – Initial in-person meeting in Columbus, OH with Ohio Power Siting Board (OPSB), ODNR, and USFWS to review proposed project and identify key monitoring objectives.
- May 3 – Meeting in Columbus, OH at ODNR headquarters with OPSB (phone), and USFWS to review proposed 2016 Sampling Plan and finalize key monitoring objectives for the Icebreaker Wind site.
- August 11 – Meeting in Sandusky, OH at ODNR field station with OPSB (phone), and USFWS (phone) to discuss fish behavior and velocity monitoring.
- September 14 – Phone call with ODNR to review 2016 Sampling Plan with ODNR staff.

The monitoring conducted in 2016 forms the basis for a multi-year monitoring program to assess potential project impacts through the construction and post-construction monitoring periods, which is discussed in the 2016 Monitoring Plan (LimnoTech, 2017). The plan was prepared in response to the requirements of the ODNR "Aquatic Sampling Protocols for Offshore Wind Development for the Purpose of Securing Submerged Land Leases" (ODNR, 2013) (the ODNR Protocol). The ODNR Protocol describes specifically what types of data ODNR stipulates to be collected as part of a submerged lands lease agreement. By letter dated February 1, 2017, the ODNR Division of Wildlife indicated that all of its comments were addressed in the Monitoring Plan (attached as Appendix D). The USFWS participated in discussions to design the study protocol and 2016 Monitoring Plan.

Icebreaker Windpower will work to develop adaptive language in a forthcoming Memorandum of Understanding (MOU) between ODNR, the USFWS, Icebreaker Windpower, and LimnoTech that obligates Icebreaker and LimnoTech to fully implement the agreed-to monitoring plan. The MOU will include provisions for an annual performance review, a comprehensive analysis of data, and an option to adjust the monitoring plan based on changes in project design and/or results-driven knowledge gained from the monitoring work.

1.4 Reports and Memorandum

The following reports and memorandum were completed in 2016 and 2017. Copies of each item were emailed to ODNR and USFWS throughout the season. The list is presented here to document the deliverables completed as part of the 2016 sampling season.

- Report: Lake Erie Monitoring Plan –January 25, 2017
- Memorandum: Summary of Current Information Related to Electromagnetic Field Impacts –June 29, 2016
- Quarterly Report: Quarterly Report for Aquatic Sampling –July 25, 2016
- Memorandum: Recreational Boat Slip Assessment –September 26, 2016
- Quarterly Report: Quarterly Report for Aquatic Sampling - November 21, 2016
- Report: Aquatic Ecological Resource Characterization and Impact Assessment - January 24, 2017
- Report: 2016 Aquatic Data Report (this document)

2 Sampling Methods

This section reviews the sampling methods for each major monitoring category. The methods presented in this section were included in the 2016 Sampling Plan (LimnoTech, 2017) and approved by ODNR. Any deviation from the sampling plan is noted in each section.

2.1 Stations

Sampling stations are listed below in Table 1 and a graphical depiction of the stations is shown in Figure 2. Table 2 lays out, by category, which stations or transects were sampled for each type of monitoring. The GPS coordinates for each sampling station are included in Table 2. The transects are located down the center (C) of the project grid, and to the east (E), and west (W) in adjacent Reference areas. The transects have a southeast to northwest orientation, and are aligned down the axis and parallel to the proposed turbines. Transect C extends from stations ICE1 to ICE7, transect W extends from stations REF2 to REF3, and transect E extends from stations REF4 to REF6.

Table 1. Sampling stations by sample type.

		Reference Stations (REF)						Turbine Stations (ICE)							Transects		
	Task Description	1	2	3	4	5	6	1	2	3	4	5	6	7	C	E	W
Fish Community	Mobile Acoustic														x	x	x
	Larval Fish	x							x				x				
	Juvenile	x							x				x				
	Zooplankton	x	x	x	x	x	x		x		x		x				
	Phytoplankton	x	x	x	x	x	x		x		x		x				
	Benthos	x							x				x				
Physical	Chemistry (discrete)	x	x	x	x	x	x		x		x		x				
	Chemistry (discrete sonde profiles)	x	x	x	x	x	x	x	x	x	x	x	x	x			
	Chemistry (continuous)	x						x (DO)	x (DO)		x			x (DO)			
	Substrate Mapping	See substrate mapping section															
	Hydrodynamic	x									x						
Fish Behavior	Acoustic telemetry	See acoustic telemetry section for map															
	Fixed Acoustic	x								x							
	Noise	x									x						
	Aerial Surveys	See aerial survey section for description of locations															

Table 2. Table of sampling stations and latitude and longitude

Turbine Station	Latitude	Longitude	Depth (feet)	Reference Station	Latitude	Longitude	Depth (feet)
ICE1	41.60072	-81.80055	58	REF1	41.60867	-81.8255	61
ICE2	41.60616	-81.80602	59	REF2	41.62539	-81.8421	63
ICE3	41.61159	-81.8115	60	REF3	41.59184	-81.8089	58
ICE4	41.61702	-81.81697	61	REF4	41.60899	-81.7915	58
ICE5	41.62246	-81.82245	61	REF5	41.62493	-81.8081	61
ICE6	41.62789	-81.82793	62	REF6	41.6399	-81.8237	63
ICE7	41.63333	-81.8334	63	Nearshore*	41.55016	-81.76528	53

*Nearshore station was selectively sampled in 2016. See notes in each section.

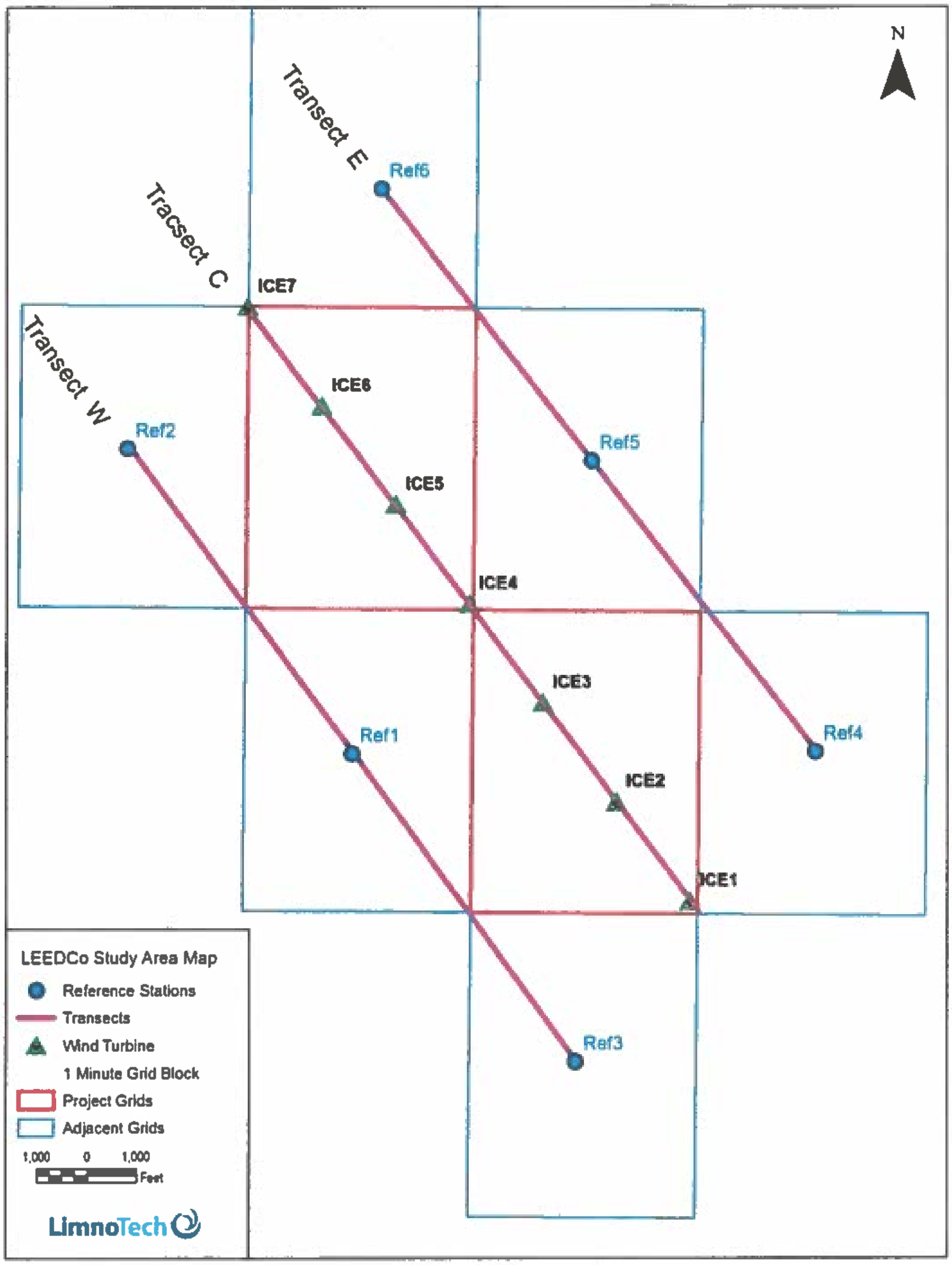

Figure 2. Map of project area, proposed turbine locations, sampling stations, and transects.

2.2 Field Events Summary

Table 3 provides a listing of the exact dates that each of the field tasks were completed for each month. Copies of field notes for each date are included in Appendix B.

Table 3. Dates of field activities by sample type for the current interim report

Sampling Category		May	June	July	August	September	October
Fish Community							
	Hydroacoustic	23-May	2-Jun	5-Jul	23-Aug	6-Sep	3-Oct
	Larval Fish	24-May	26-Jun	20-Jul	--	--	--
	Juvenile	21-May	--	--	8-Aug	--	3-Oct
	Zooplankton	10-May	16-Jun	7-Jul	17-Aug	7-Sep	19-Oct *
	Phytoplankton	10-May	16-Jun	7-Jul	17-Aug	7-Sep	19-Oct *
	Benthos	9-May	--	--	--	--	19-Oct
Physical							
	Chemistry (discrete)	10-May	16-Jun	7-Jul	17-Aug	7-Sep	19-Oct *
	Chemistry (continuous)	11-May	15-Jun	6-Jul	18-Aug	8-Sep	19-Oct
	Substrate Mapping	--	--	--	August	--	--
	Hydrodynamic	11-May	15-Jun	6-Jul	17-Aug	8-Sep	19-Oct
Fish Behavior							
	Fixed Acoustics	--	--	--	23-Aug	6-Sep	3-Oct
	Noise	11-May	15-Jun	6-Jul	17-Aug	8-Sep	19-Oct
	Acoustic Telemetry	--	--	--	--	--	19-Oct, 31-Oct
	Aerial Surveys	20-May, 22-May	5-Jun, 6-Jun, 30-Jun	3-Jul	28-Aug, 29-Aug	18-Sept, 21-Sept	15-Oct, 24-Oct

*Due to inclement weather only REF1, REF3, and REF6 and ICE4 and ICE6 were sampled.

2.3 Fish Community/Lower Trophic

LimnoTech undertook sampling of the fish and lower trophic community (zooplankton, phytoplankton, benthos) throughout the spring, summer and fall of 2016 to gain baseline data on existing conditions. This data can be compared to sampling conducted during and post construction project phases to determine if the project is having any potential impacts on the fish and lower trophic communities in the project area.

2.3.1 Hydroacoustic

Hydroacoustic monitoring was conducted monthly from May to October 2016 to assess the density and seasonal abundance of juvenile and adult fish. Sampling was completed on three transects, one down the center of the project grid and turbine locations, and two transects in adjacent grid cells to serve as reference areas. The map in Figure 2 shows the location of the acoustic transects (Transects W, C and E). Collection methods and sampling design followed the Standard Operating Procedure for Fisheries Acoustic Surveys in the Great Lakes (FASGL; Parker-Stetter et al., 2009). A BioSonics DT-X portable echo sounder surface unit with an emitting frequency of 120kHz with a 6° split beam transducer was pole-mounted and towed along the sampling transects at appropriate speeds (~4-5 mph). Equipment was calibrated prior to each survey following manufacturer protocols. Whenever possible the event was completed in calm conditions, a half hour after sunset and within five days of the new moon. The monthly hydroacoustic sampling was originally scheduled to begin in June. The plan was modified to begin in May, therefore the May hydroacoustic sampling was conducted later in the month (not within five days of the new moon). Unforeseen circumstances (i.e. inclement weather) precluded sampling within five days of the new moon during the month of August. Data

Photo 1. Hydroacoustic data collection.

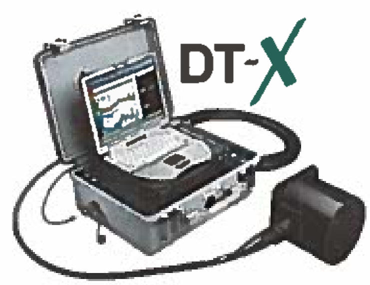

Photo 2. Biosonics DT-X instrument.

analysis and fish density calculations were determined using Echoview software according to the Fisheries Acoustics Surveys in the Great Lakes (FASGL; Parker-Stetter 2009) guidelines.

2.3.2 Larval Fish

Larval fish sampling was conducted once per month during 2016, in May, June and July. Three replicate 5-minute tows were completed at two Turbine Stations (ICE2 and ICE6) and one Reference Station (REF1). A 1X2m frame, 500 micron neuston net was used to collect the fish according to the ODNR ichthyoplankton sampling protocols. Following collection, samples were concentrated and preserved in 95% ethanol. Samples were brought to the BSA Environmental lab, where they were separated for taxonomic identification. The main output from this task was an assessment of the density and composition of larval fishes within the project area and the adjacent areas.

Photo 3. Larval fish monitoring using the neuston net.

2.3.3 Juvenile Fish

Juvenile fish sampling was conducted once per month in May, August and October. Three replicate 10 minutes tows were conducted at two Turbine Stations (ICE2, ICE6) and one Reference Station (REF1). Following the sampling event the OSU boat captain indicated that the GPS coordinates from the ICE6 location from the initial trawling event in May might have been incorrectly entered into the boat GPS system. The location was actually due East of the coordinates they received by approximately one mile. Since the surrounding area in the vicinity of the project location is similar in topography we do not anticipate this minor error in positioning impacted the collection results. The August and October events were collected at the correct ICE6 location. A flat-bottom otter trawl with a 10.7 meter head rope and 12-mm bar mesh in the cod end was originally proposed as the dimensions that would be used to complete the bottom trawls according to ODNR bottom trawl techniques. However, given the limited availability of a net with these specifications, a 9.4 m foot rope; 7.8 m head rope; 12 mm bar mesh size in the cod end net was used for the 2016 season. A net mensuration study was completed during the October survey to help determine the appropriate scale factor to account for the smaller net used in 2016. Trawl catches were sorted by species and where appropriate age-category (AC 0-3, based on the ODNR Age Break protocol) and enumerated. A subsample of 30 individuals per species and age category were measured for total length (nearest mm) and weight (nearest 0.1 g). During days with larger waves, weights were estimated in the field and a subset of species preserved (in formalin) was brought back to the lab for more precise measurements.

Photo 4. Juvenile fish trawling.

Photo 5. Sample of fish collected during the juvenile trawl.

2.3.4 Zooplankton

Zooplankton sampling was conducted monthly from May to October 2016. Samples were collected at six Reference Stations and three Turbine Stations. Sampling protocols followed the Lake Erie Coordinated Lower Trophic Level Assessment. Briefly, a weighted zooplankton net (0.5 m in diameter, 64 micron mesh), with a flow meter was used to complete the sampling. The net was lowered to the lake bottom and then pulled up so the plankton were collected along the way down and up. The net was washed with filtered water so all plankton were within the collection jar. Samples were concentrated through a 64 micron screen and preserved with 5% Lugols's Iodine solution, which was the preservative recommended by BSA Environmental. Samples were stored in 200 mL jars and three 2 to 5 mL sub-samples were removed for plankton identification to taxonomic genus and enumerated. Any exotic species were identified to species level. Laboratory protocols for identification, enumeration and biomass estimates followed the methods that BSA Environmental Services has been using for several years.

Photo 6. Water quality sampling.

2.3.5 Phytoplankton

Phytoplankton sampling was conducted monthly from May to October 2016. Samples were collected at six Reference stations and three Turbine stations. Sampling and laboratory protocols followed the Lake Erie Coordinated Lower Trophic Level Assessment. An integrated tube sampler at two times the Secchi depth was used to complete the sampling. Samples were concentrated and preserved with 4% Lugols solution. Samples were processed according to the BSA Environmental Services Laboratory method, which follows the (OSU) Aquatic Ecological Lab processing protocols.

2.3.6 Benthos

Sampling was conducted at one Reference Station and two Turbine Stations, in May and October of 2016. Sampling and laboratory protocols followed the Lake Erie Coordinated Lower Trophic Level Assessment. Three replicate grabs of bottom sediment were collected using a PONAR grab sampler. Benthos were removed, preserved, sorted to the nearest taxonomic order or aquatic functional group and enumerated.

Photo 7. Samples of benthos collected in May 2016.

2.4 Physical Habitat

Physical habitat sampling included characterizing bottom sediments, water currents, nutrients, and trends of light attenuation, temperature, and dissolved oxygen. These parameters are being monitoring to track changes in environmental conditions to assist with interpretation of trends that might be occurring in other biological data collected as part of this study. The trends reflect the dynamic nature of Lake Erie and not necessarily the impact from the Icebreaker Wind project.

2.4.1 Water Chemistry: Discrete

Discrete water sampling was conducted simultaneously with the collection of zooplankton and phytoplankton by three researchers. During each sampling event one researcher recorded and took integrated samples of water chemistry while another researcher prepped bottles for water samples, made notes, and measured photosynthetic active radiation (PAR). PAR measures the intensity of light in the band that are used by phototrophs (e.g. can excite chlorophyll). The third researcher measured Secchi depth and collected zooplankton.

Sampling the water column chemistry was conducted using an integrated tube with an inner diameter of 5/8 inch. The tube was lowered to the lake bottom and emptied into a stainless steel bucket to sub-sample water for two-1L bottles for chlorophyll-*a* and two-250 mL bottles for total phosphorus (TP) and total nitrogen (TN). Samples were collected at six reference stations (Ref 1 to 6) and three turbines stations (ICE2, ICE4, ICE6). The samples were collected monthly from May to October 2016. The only exception to the sampling was due to inclement weather on October 19 when only REF1, REF3, and REF6 and ICE4 and ICE6 were sampled. Sampling and laboratory protocols followed the Lake Erie Coordinated Lower Trophic Level Assessment. Samples were bottled and placed in an iced cooler along with a chain of custody form before sending the coolers overnight to the OSU's Stone Laboratory. Once the samples arrived at Stone Laboratory chlorophyll-*a* was immediately filtered through a Whatman GF-C filter using low vacuum pressure and initially measured using a fluoroprobe. Final chlorophyll-*a* concentrations were determined by placing the filtered samples into dimethyl sulfoxide "DMSO", heated, centrifuged, with absorbance being measured at 665, 649, and 580.

Beginning in August the integrated tube sampler material was switched from a rubber hose to a crosslinked polyethylene hose to decrease possible chemical leaching that was observed at low levels in an equipment blank. Equipment blanks (deionized water run through both types of hoses and into separate sample bottles) and sample blanks (deionized water poured directly into a sample bottle) were collected in August and sent to the National Center for Water Quality Research at Heidelberg University for analysis of total phosphorus concentrations.

Each water chemistry sampling station was supplemented with water clarity measurements using a Secchi disk and PAR. A Secchi disk was lowered into the water column until it was not visible to measure water transparency. A LI-COR LI-193 spherical submersible light meter was lowered on a LI-2009S lowering mount from the water surface at 0.5 -1.0 meters increments. PAR was displayed on a LI-250A and written in the field form to calculate light extinction.

In May profiles of temperature, dissolved oxygen, pH, conductivity, turbidity, chlorophyll-a, and blue-green algae were measured from the lake surface to the bottom by using an YSI EXO2 sonde at every sampling station. Beginning in June vertical profiles were collected at each turbine location during every discrete sampling event.

All field probes were calibrated prior to the first measurement. All sampling containers and field probes were thoroughly rinsed prior to each collection.

2.4.2 Water Chemistry: Continuous

Replicated stations were installed at ICE4 and REF1 in May to measure continuous dissolved oxygen, PAR, and water temperature. Once ODNR modified the sampling plan in July additional temperature and dissolved oxygen (DO) sensors (miniDO$_2$T) were deployed in July and August at ICE1, ICE2, and ICE7.

HOBO water temperature Pro V2's were deployed at stations ICE4 and REF1 to measure temperature at the water surface and one meter from the lake bottom once every ten minutes. Paired with the bottom water temperature both stations were equipped with YSI 600 OMS loggers with a DO sensor to record once every hour. To measure PAR at ICE4 and REF1 a submersible Odyssey logger was deployed approximately 14.3 meters above the lake bottom at both stations and recorded measurements every ten minutes. MiniDO$_2$T sensors deployed at ICE1, ICE2, and ICE7 measured and recorded temperature and

DO every ten minutes one meter from the lake bottom. An YSI EXO1 with a DO probe was initially installed at ICE2 on August 17, 2016. It was replaced on August 22, 2016 with a miniDO$_2$T sensor.

All field probes were calibrated prior to the first measurement and maintained throughout the field season.

Two instrument problems arose during 2016 that resulted in a deviation from the 2016 Sampling Plan. During maintenance on June 15, 2016 it was discovered that the DO logger at REF1 was not initialized to sample and record data prior to the initial launch on May 11, 2016. We also found the ICE4 PAR wiper was damaged in August, therefore the PAR sensor had to be re-installed without a wiper. The sensor was still relatively clean during a maintenance visit on September 6, 2016, but PAR values dropped sharply in the days after this visit due to biofouling of the sensor face from sediments and algae. Therefore data after September 6, 2016 is suspect at this station. A new wiper could not be delivered in time to be replaced in the field. A spare wiper will be kept on hand during the 2017 field season to avoid any future similar issues.

2.4.3 Substrate Mapping

A side-scan sonar survey of the lakebed within and adjacent to the Icebreaker Wind site was completed on June 24, 2015 by VanZandt Engineering. A total area of about 6,700 feet (2,050 m) by 100 feet (305 m) was surveyed in the project area. The line spacing for the survey was 30 meters with a 50 meter range for each side, which gave over 100 percent overlap of sonar coverage line to line. An Imagenex 872 YellowFin side-scan sonar system with digital data acquisition software was used to collect the side-scan data. An additional side scan sonar survey conducted by Canadian Seabed Research (CSR) of the proposed transmission line path was completed in August 2016 (CSR 2016). The CSR study included a complete geophysical investigation of the project area including sediment characteristics and bottom type evaluations.

2.4.4 Hydrodynamic

Two ADCPs were deployed from May through October 2016 to monitor lake currents. One ADCP (Nortek AWAC AST 1MHz Aquadopp Z-cell) was deployed at the center turbine location (ICE 4) and the second ADCP (RDI Workhorse Sentinel 1200kHz) was deployed at REF 1. Both ADCPs were attached to an anchor and placed in a cage mount with buoys attached to keep the ADCP vertical. The ADCPs measured lake currents on an hourly basis in one meter increments from the surface to the bottom of the lake. Both ADCPs were re-deployed October 31 for the winter to sample water movement prior to and during the presence of ice, once every three hours.

Photo 8. REF1 ADCP mooring.

2.5 Fish Behavior

Fish behavior and movements are driven by several factors. Fish often make daily movements between feeding and resting habitats, seasonal movements to summer and winter habitat and annual movements to spawning areas. Fish also respond to direction and rate of water movement by their lateral line which contains nerve endings and acts as radar, allowing the fish to detect the size, shape, direction and speed of objects. Fishes may trade-off food acquisition to decrease the risk of predation, so that a habitat with lower food availability may be used to reduce risk. Understanding normal fish behavior and movement is critical to being able to predict how a population may respond to variable environmental conditions. The purpose of the sampling in this case is to understand whether the turbines and associated structures have any impact on fish behavior and movement.

2.5.1 Acoustic Telemetry

Acoustic telemetry will be used to determine whether installation of the turbines and submerged inter-array and export electric transmission cables could affect fish behavior during and post-construction. An acoustic telemetry system involves two main components: the moving transmitter tags attached to fish that broadcast a unique numeric ID and the fixed hydrophone receivers that log the unique ID as fish pass by. Icebreaker Windpower supported the installation of a local array of hydrophone receivers near the project site and transmission line.

Prior to deployment of the acoustic receivers, a small subset of receivers was deployed for a short period to perform a range test on Wednesday, October 19, 2016. This test was conducted over an 8 hour period in wave conditions that ranged from calm to 2 feet. A test transmitter from VEMCO was secured to a mooring line and positioned in the middle of the water column (30 feet off the bottom). Following the range testing, the full array was installed on October 31, 2016. Each receiver was suspended above the bottom using a 75 pound anchor, underwater floats, and a 200 foot drag line placed on the lake bottom (Figure 3). The drag line will be used for annual instrument retrieval and data downloading. To ensure on-going testing and verification of the system, two acoustic (sentinel) tags were installed permanently within the receiver array, roughly 500 meters from the closet receiver. These tags will allow continual range testing to occur.

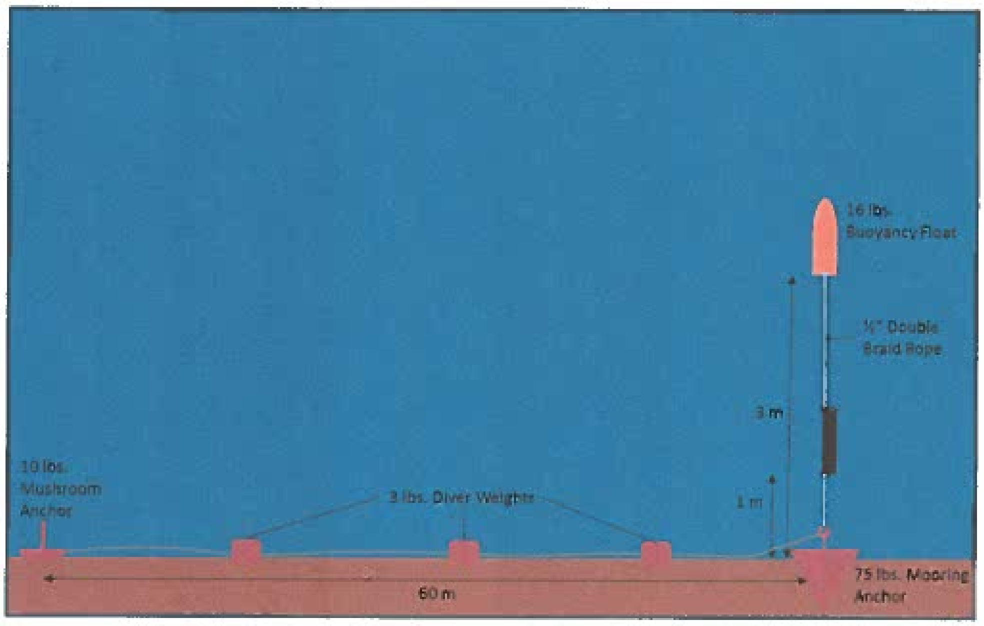

Figure 3. Acoustic telemetry mooring design.

The receiver array was designed to have two rows of hydrophones (26 total), one on each side of the turbine/transmission line as depicted in Figure 4. This configuration was designed to monitor the behavior of tagged fish in and around the turbine site and transmission line with sufficient density to capture fish moving through the turbine and transmission sites. This array configuration minimizes monitoring gaps within the study area and the double line of receivers array provides a better understanding of individual fish track as it moves from one side of the project site to the other. The distance between receivers along each transect is approximately 1,350 meters. The distance between the two parallel receiver lines is approximately 1,000-1,200 meters.

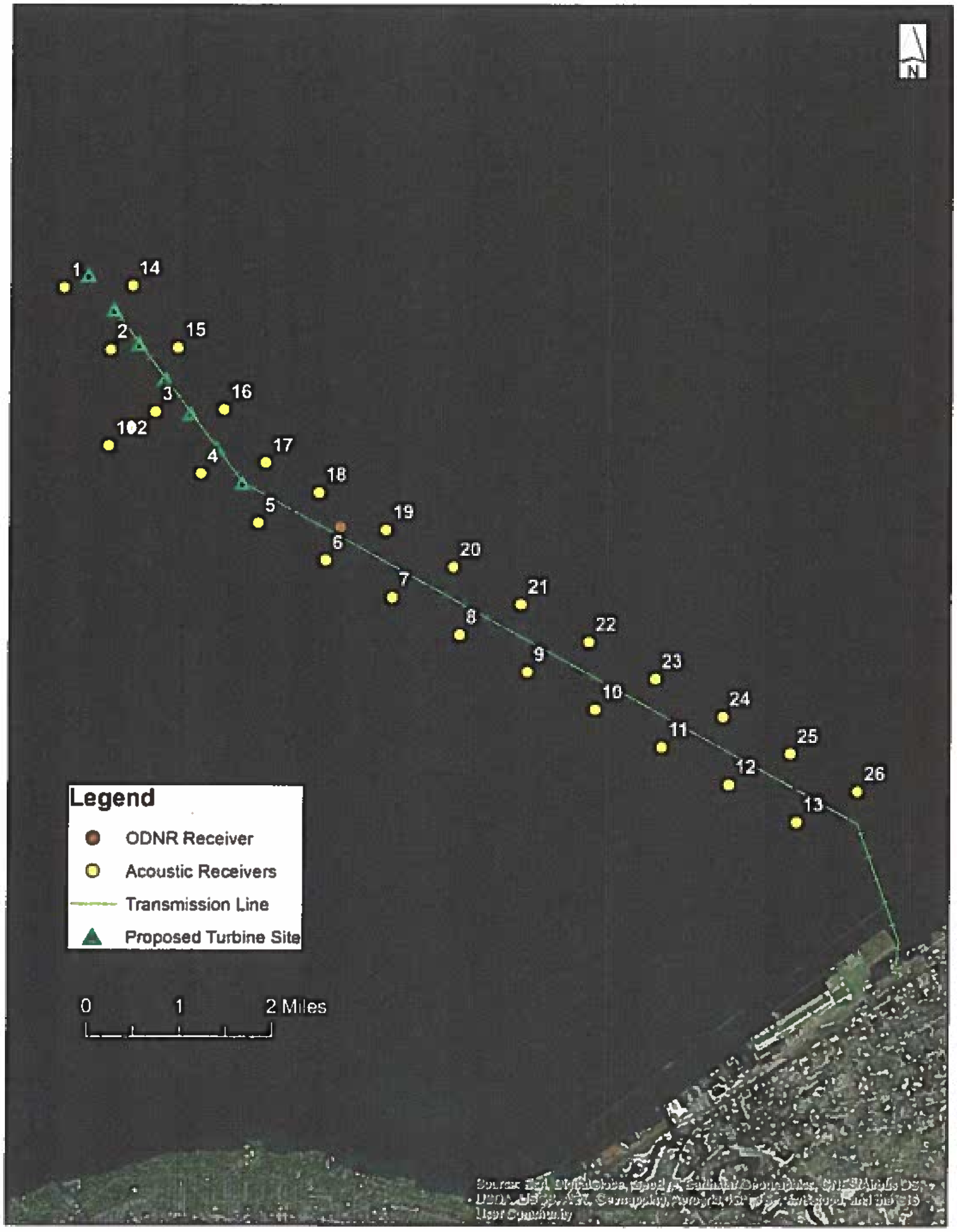

Figure 4. Map of the deployed array configuration. The yellow dots represent the receivers, the green triangles the turbines and the green line the transmission line. Receiver #102 is actually the location of the test transmitters.

2.5.2 Fixed Acoustics

Fixed hydroacoustic sampling was conducted on the same nights as the mobile acoustic surveys were conducted. Fixed surveys were completed by anchoring the boat for one hour at ICE3 and for one hour at REF1. The equipment and data settings remained the same as the mobile survey (section 2.3.1), with the exception that the collection ping rate was increased from five pings per second to 10 pings per second. Fixed acoustic data was collected monthly from August through October. The monthly hydroacoustic sampling plan was modified in late July to include monthly fixed hydroacoustics, therefore the sampling did not begin until August 2016. Data analysis and fish density calculations were determined using Echoview software according to the FASGL guidelines (Parker-Stetter et al. 2009).

2.5.3 Noise Production

Two underwater sound recorders were deployed on May 11, 2016 two meters from the bottom of the lake using Ocean Instruments Smart Hydrophone Soundtraps at stations REF1 and ICE4. The hydrophones recorded sound at 72 kHz for 30 minutes every hour. They were attached to an anchored four meter suspended rope to limit sound from mooring hardware.

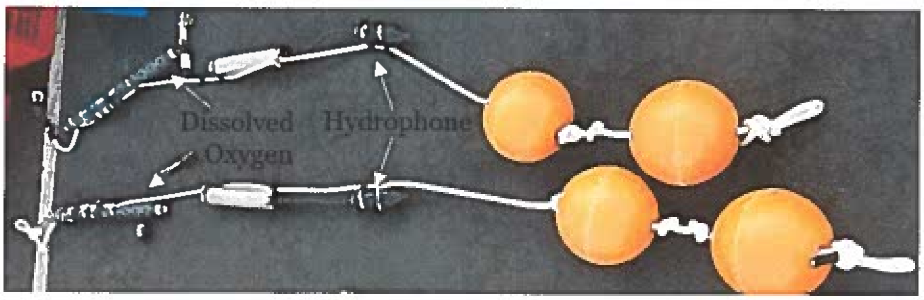

Photo 9. DO and hydrophone sensor setup.

Acoustic data were processed within the SEDNA toolbox (Dugan et al. 2011) in MATLAB using a Hann window with zero overlap, a fast Fourier transform (FFT) size with 1 second time resolution and 1 Hz frequency resolution (Dugan et al., 2011; Estabrook et al., 2016). Each sound file was calibrated with the appropriate sensor characteristics. Table 4 below shows each dataset that was analyzed from each site.

Table 4. Recording durations, recording unit and sensitivity of audio data collected in Lake Erie.

Recording Start	Recording Stop	Sound Trap Serial Number	Sensitivity
REF1			
5/11/16	6/15/16	671100952	171.3 dB re: 1 µPa
6/16/16	7/6/16	671100952	171.3 dB re: 1 µPa
7/7/16	7/24/16	671100952	171.3 dB re: 1 µPa
7/24/16	9/6/16	671100952	171.3 dB re: 1 µPa
9/7/16	10/20/16	671117327	171.8 dB re. 1 µPa
ICE4			
5/11/16	6/15/16	671117327	171.8 dB re: 1 µPa
6/16/16	7/4/16	671117327	171.8 dB re: 1 µPa
7/7/16	8/17/16	671117327	171.8 dB re: 1 µPa
8/22/16	9/6/16	671117327	171.8 dB re: 1 µPa
9/7/16	10/19/16	671100952	171.3 dB re: 1 µPa

Most bioacoustic analysis relies on spectrograms (representation of the sound magnitude as frequency versus time) to detect individual calls that are typically on the order of seconds to minutes. Analyzing acoustic data from long-term surveys becomes very time consuming and often requires subsampling (Thomisch et al., 2015). Fine-scale analysis of spectrograms or listening to the data are not the best approach for looking at large scale changes over extended deployments at multiple locations (Sueur et al., 2012). An alternative method is to look at long-term patterns of acoustic activity that represent many months of sound in a single image. These long-term spectrograms (or long-term spectral averages; LTSAs) are created by integrating slices of a specified time interval throughout the recording and they show diel or seasonal patterns of acoustic activity that often cannot be seen at finer time scales. Using the SEDNA and Triton software packages for MATLAB (Dugan et al., 2011; Wiggins et al., 2010), LTSAs encompassing the entire survey period for each site were evaluated for the occurrence of fish chorusing activity. Spectrograms were created with the *pwelch* algorithm in 1 Hz bins and 10.24 s time slices, an FFT of 512 points and a 1 h integration time. With these representations, it is possible to see diel and seasonal trends in biological, anthropogenic and environmental acoustic activity at the ecosystem scale.

2.5.4 Aerial Surveys of Boating

Aerial surveys were conducted to monitor use of the project site and surrounding areas by recreational boaters.

Photo 10. Photo taken from Aerial Associates Photography on July 7, 2016.

Aerial surveys were scheduled offshore of Cleveland two times a week (one weekday and one weekend day), every three weeks from May 1 to November 1, 2016. Survey days were selected to coincide with days that ODNR was conducting creel surveys at area boat launches as well as when weather was adequate to fly safely, which generally were days suitable for boating. Aerial Associates Photography departed from Ann Arbor Municipal Airport to count commercial and recreational boats while taking high quality photographs to reference their location. Each 5-minute survey block has an ID and the numeric part of the ID (911 and 912) corresponds to the 10-minute size survey blocks that are used by ODNR to conduct boating surveys in Lake Erie. Boat activity was spatially grouped into 5-minute grids over Lake Erie with all Turbines falling within grid "911-NW" (Figure 5).

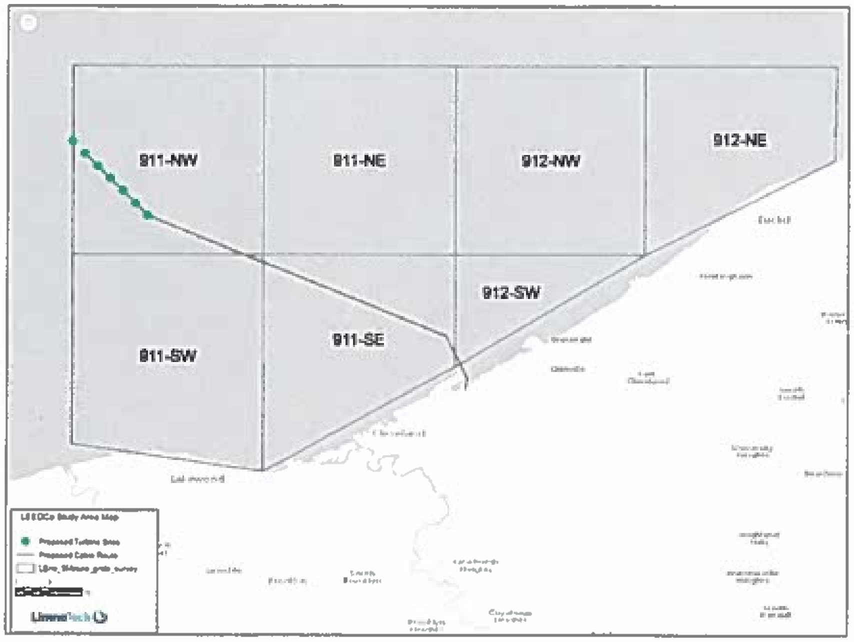

Figure 5: 5-minute grids offshore Cleveland for grouping boat activity.

2.6 Other Activities

2.6.1 Electromagnetic Field Review

LimnoTech conducted a review of current research and information regarding any potential impact of Electromagnetic Fields (EMFs) on fish movement and behavior (LimnoTech, 2016a). The memorandum, dated June 29, 2016, drew from studies conducted in the Great Lakes, other parts of the United States, and overseas. Specific details of the buried electric cable proposed for the Icebreaker Wind project were considered to provide an assessment of the likely impact to fish for this project.

2.6.2 Marina Boat Counts

In addition to the aerial survey of boaters, a recreational boat slip study was conducted in 2016 to count and classify power and sail boats in the recreational harbors, marinas, and yacht clubs in Lorain, Cuyahoga, and Lake Counties (LimnoTech, 2016b). Aerial imagery, with an on ground pixel resolution of approximately six inches, was obtained for 16 key harbor areas in the three county area surrounding Cleveland, Ohio on the morning of Wednesday, August 3, 2016. The imagery was captured by Aerial Associates under contract to LimnoTech using a Leica DMC III and post-processed to create a tiled image mosaic. For each of the 16 distinct harbor areas, LimnoTech staff delineated every visible boat slip and marked it as either empty or containing a power or sail boat. For slips containing a boat, a polyline was drawn from its stern to bow to allow for length measurements of each boat.

2.6.3 Impact Assessment

LimnoTech prepared a report that summarizes the site specific data collected in 2016 as part of a site characterization study and potential impact assessment (LimnoTech, 2017a). The potential impact assessment was done utilizing a weight of evidence approach based on information presented from the following sources:

1. Review of risk factor maps created by ODNR to specifically map out key aquatic habitats and areas of low and high potential impact from offshore wind across the Ohio Waters of Lake Erie.
2. Review of recent reports authored by experts from around the Great Lakes region as part of the Great Lakes Wind Collaborative (GLWC) to identify categories of impacts from offshore wind in the Great Lakes.
3. Review of other studies and reports from similar projects in Lake Erie, on the east coast of the U.S., and abroad where offshore wind turbines have been installed in freshwater.
4. Collection of site specific ecological data in 2016 at the proposed project site to validate the impact assessments contained in GLWC reports and in ODNR's risk analysis maps.

3
Results and Discussion

3.1 Fish Community/Lower Trophic

3.1.1 Hydroacoustic

Overall, adult and juvenile fish densities were similar between the three mobile transects, which included one transect down the center of the project location and two transects in nearby areas to serve as a reference. Although transects were similar within months, there was a significant decline in total density across months. The results from the mobile hydroacoustic surveys are summarized in Figure 6 and Figure 7.

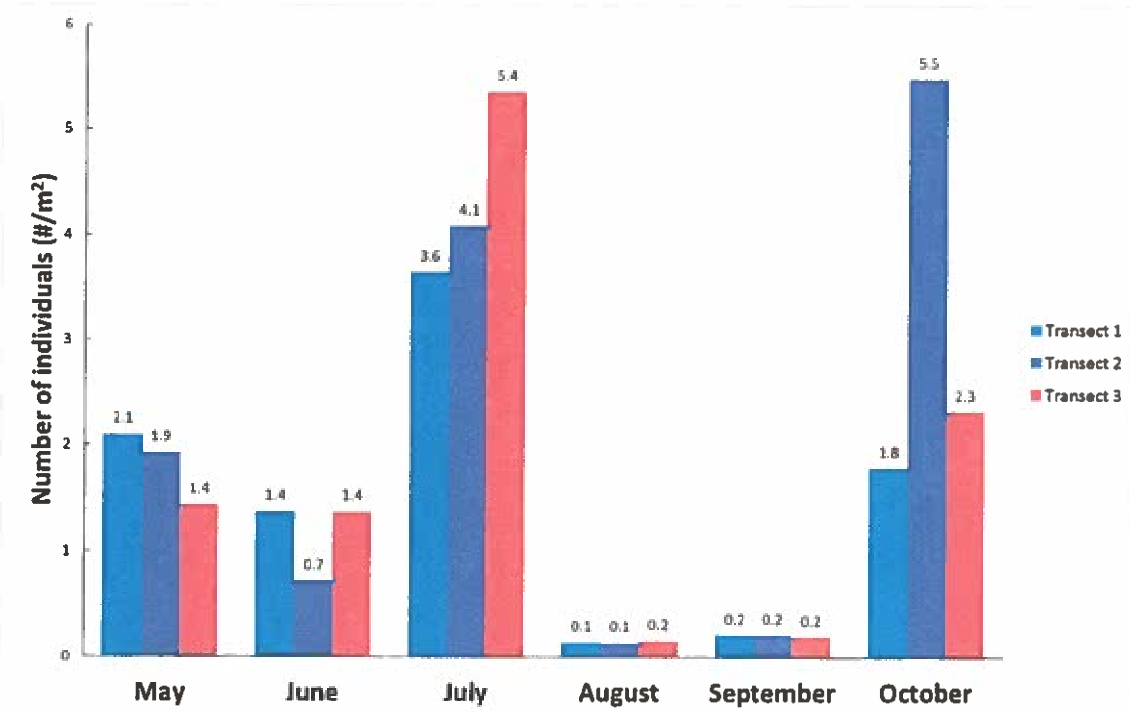

Figure 6. Summary of the mobile hydroacoustics across six months in 2016 for total density, individuals (#) per m² across each transect.

There was a considerable (5-30 fold) reduction in fish density in August and September compared to the other months. This trend is consistent with the absence of fish observed in the August juvenile trawls and follows the depletion in dissolved oxygen. During the July 5, 2016 event DO levels were still between 4-6 mg/L, whereas during the August and September events DO was nearly depleted (0-1 mg/L). This coincides with fish physiology estimates, which state that fish become distressed between 2-4 mg/L and DO levels less than 2 mg/L may be lethal to many species. It is therefore not surprising that most fish moved away from these regions during the late summer-early fall due to the presence of hypoxic waters.

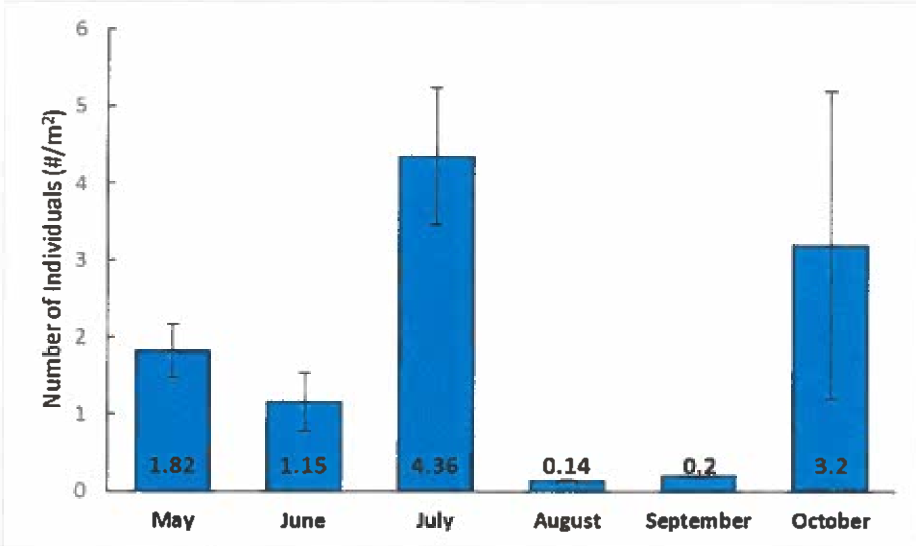

Figure 7. Summary of the mobile hydroacoustics across six months in 2016 for total density, individuals (#) per m² (Mean ± SD).

3.1.2 Larval Fish

The results from the larval fish collections are summarized in Table 5. There were no larval fish collected in the May or July events, and only five larval fish were collected in June. Overall, across all 29 trawls conducted in 2016, only five fish were collected. We also collected a sample near the Cleveland intake crib in June, which contained a total of 16 larval fishes. The relatively large number of larval fish found in the vicinity of the crib and closer to shore indicated that there was likely very low larval fish offshore near the project site. We consulted with ODNR prior to the July event (Jeff Tyson via email on July 19) about the methods and no change in collection methods was suggested as ODNR suspected that larval fish densities were also low at the project site due to its distance from shore.

Table 5. Ichthyoplankton results from the May, June and July 2016 sampling events.

Site	Date	Average (SD)
ICE2	5/24/2016	0 (0)
REF1	5/24/2016	0 (0)
ICE6	5/24/2016	0 (0)
ICE2	6/26/2016	< 1 (1)
REF1	6/26/2016	< 1 (1)
ICE6	6/26/2016	< 1 (1)
ICE2	7/20/2016	0 (0)
REF1	7/20/2016	0 (0)
ICE6	7/20/2016	0 (0)
Nearshore	*6/26/2016*	*16 (NA)*

3.1.3 Juvenile Fish

In the May 2016 event, the species composition was relatively consistent across all locations and replicates. White perch, yellow perch, and rainbow smelt dominated the trawls. Walleye, goby, and emerald shiners were collected in select trawls in low numbers (n=0-4). The results from this sampling event are summarized in Figure 8.

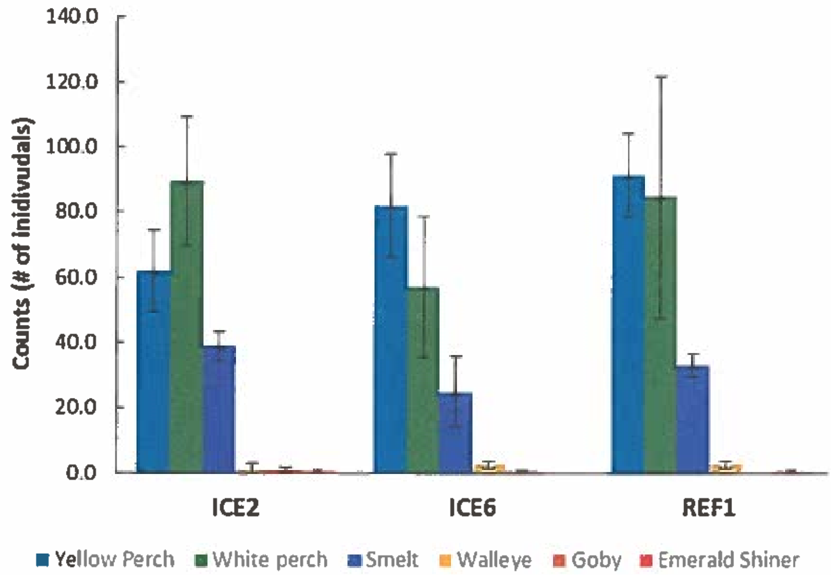

Figure 8. The mean (± SD) for each species collected at each location (n=3 replicate trawls) on the May 21, 2016 event.

The August event occurred when the thermocline was located 3-4 meters off the bottom, and was generally devoid of fish. The DO sensors deployed at ICE1 measured 0.45 mg/L and ICE7 measured 0.3 mg/L. These concentrations are below the level where fish could survive on the lake bottom (i.e. < 2-4 mg/l). Across all nine replicate tows only seven fish total were caught (six larger yellow perch and one large freshwater drum). Based on the severe bottom water hypoxia present during this sampling, it was likely that these fish were caught when the net was moving up or down through the water column. The results from this sampling event are summarized in Figure 9.

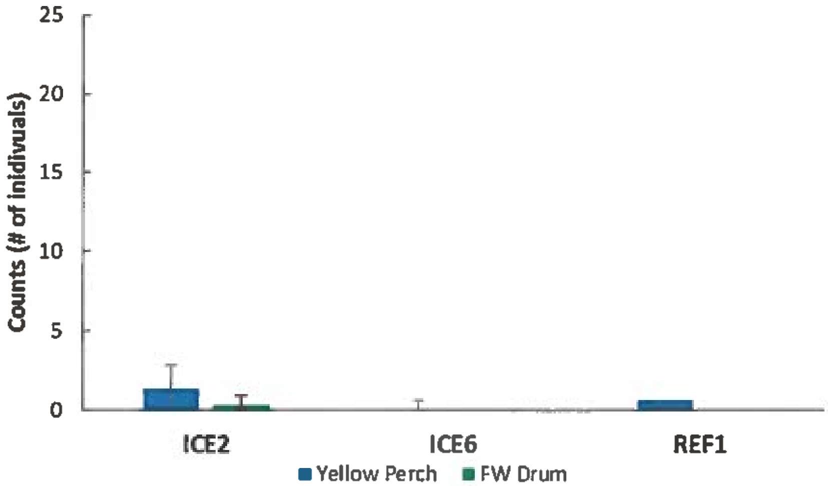

Figure 9. The mean (± SD) for each species collected at each location (n=3 replicate trawls) on the August 8, 2016 event.

The thermocline and associated bottom hypoxia had dissipated for the October 3, 2016 event. The species composition for this last event was relatively consistent across all locations and replicates. Smelt dominated all trawls, followed by white perch, and yellow perch. Freshwater drum, walleye, goby, ghost shiner and white bass were collected in select trawls in lower numbers. The results from the three replicate surveys at each location are summarized in Figure 10.

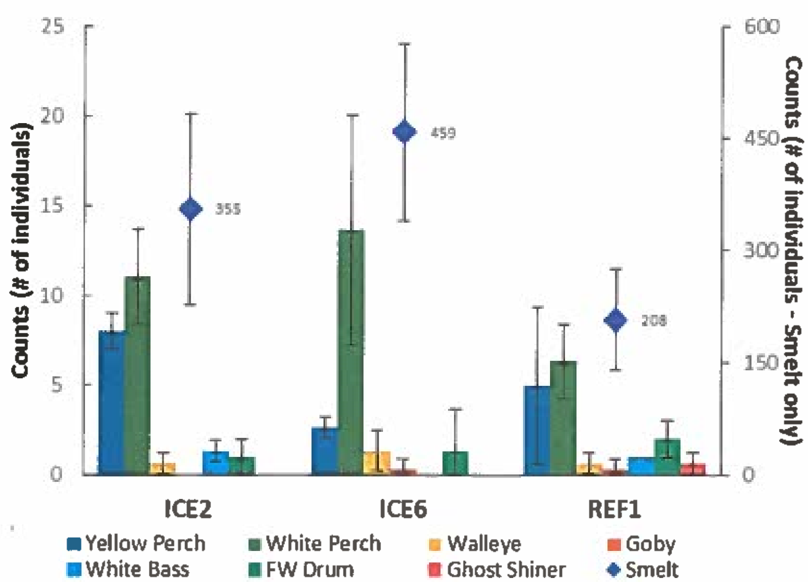

Figure 10. The mean (± SD) for each species collected at each location (n=3 replicate trawls) on the October 3, 2016 event. NOTE: Smelt values are on the right y-axis.

The combined results from the three replicate surveys at each location across the three events are summarized in Table 6.

Table 6. Summary of the juvenile fish sampling results from the 2016 spring, summer and fall events (Mean ± SD of individual fish).

Fish Species	ICE2			ICE6			REF1		
	May	August	October	May	August	October	May	August	October
Emerald Shiner	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)
Freshwater Drum	0 (0)	0 (1)	2 (2)	0 (0)	0 (0)	4 (1)	0 (0)	0 (0)	2 (1)
Ghost Shiner	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
Goby	1 (1)	0 (0)	0 (0)	0 (1)	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)
Rainbow Smelt	39 (5)	0 (0)	355 (128)	25 (11)	0 (0)	459 (119)	33 (4)	0 (0)	208 (68)
Walleye	1 (2)	0 (0)	1 (1)	3 (1)	0 (0)	2 (1)	3 (1)	0 (0)	1 (1)
White Bass	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)
White Perch	90 (20)	0 (0)	11 (3)	57 (22)	0 (0)	14 (6)	85 (37)	0 (0)	6 (2)
Yellow Perch	62 (13)	1 (2)	8 (1)	82 (16)	0 (0)	3 (1)	91 (13)	1 (1)	5 (4)

3.1.4 Zooplankton

The results from each event are summarized in Table 7, by common numerical metrics, including number of species, numbers/L and the biomass for each month and station. The results were variable across all sites for biomass and numbers/L; however, in general, the species composition remained similar.

Table 7. The number of species, number of organisms/L and the biomass for all zooplankton in each sample - May through October 2016.

	ICE2						ICE4					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	20	14	11	10	14	-	-	14	11	7	10	16
Number/L	1094	933	876	2429	876	-	-	623	699	4915	528	804
Biomass (ug d.w./L)	400	289	162	1680	318	-	-	572	59	246	59	348
	ICE6						REF1					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	14	12	8	16	10	19	17	14	11	9	14	14
Number/L	2688	333	2635	2562	1879	787	1124	564	566	445	1116	825
Biomass (ug d.w./L)	1252	700	596	455	746	359	276	952	250	91	406	225
	REF2						REF3					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	14	15	10	14	9	-	15	13	10	11	11	17
Number/L	1606	2532	951	2061	1446	-	1669	1312	365	1099	1002	819
Biomass (ug d.w./L)	868	1272	119	380	257	-	648	1037	146	360	259	213
	REF4						REF5					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	19	14	11	12	10	-	15	13	10	14	10	-
Number/L	962	506	1472	1661	961	-	2393	318	2377	2022	742	-
Biomass (ug d.w./L)	410	475	185	282	752	-	709	403	337	636	97	-
	REF6						**All Sites**					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	16	16	8	13	13	13	16	14	10	12	11	16
Number/L	1613	953	821	2374	2230	998	1644	897	1196	2174	1198	847
Biomass (ug d.w./L)	580	974	157	323	205	392	643	742	223	495	344	307

The species composition across each month is summarized in Table 8. The native predatory water flea (*Leptodora kindtii*) was present in May and August samples and the invasive, predatory spiny water flea (*Bythotrephes longimanus*) was present in June, July, September, and October samples. This is consistent with the Forage Task Group's findings (FTG, 2016), which stated the densities of the invasive water flea are generally higher from July through September.

Table 8. The species present across all locations from the May through October 2016 sampling events are summarized.

Species	Species	Species	Species
Bosmina longirostris	*Leptodiaptomus ashlandi*	*Skistodiaptomus oregonensis*	*Epischura nevadensis*
Brachionus calyciflorus	*Leptodora kindtii*	*Ascomorpha ecaudis*	*Kertella earlinae*
calanoid copepodid	*nauplii*	*Collotheca sp.*	*Leptodora kindtii*
Conochilus unicornis	*Notholca laurentiae*	*Daphnia sp.*	*Ploesoma hudsoni*
cyclopoid copepodid	*Ploesoma truncatum*	*Kellicotia longispina*	*Trichocerca rattus*
Daphnia galeata	*Polyarthra vulgaris*	*Kertella crassa*	*Trichocerca similis*
Daphnia retrocurva	*Synchaeta spp.*	*Keretella quadrata*	*Tropocyclops prasinus*
Diacyclops thomasi	*veliger quagga*	*Liliferotrocha spp.*	*Trichocerca cylindra*
Dreissena veliger	*Asplanchna priodonta*	*nauplii*	*Bdelloid*
Eurytemora affinis	*Bosmina longirostris*	*Skistodiaptomus*	*Chydorus spp.*
Filinia terminalis	*Bythotrephes longimanus*	*zebra veliger*	*Kellicottia bostoniensis*
Kellicottia longispina	*Corbicula fluminea veliger*	*Brachionus havaensis*	*Trichocerca multicrinus*
Keratella cochlearis	*Gastropus stylifer*	*Conochiloides dossuarius*	*Trichcerca procellus*
Keratella quadrata	*Mesocyclops edax*	*Diaphanosoma brachyrum*	

Overall, zooplankton biomass and composition in the project area is consistent with the ongoing Great Lakes Fisheries Commission (GLFC) monitoring across the basin, suggesting there is no unique zooplankton structure at the project site. Alterations to zooplankton community composition and structure are not anticipated as part of the construction or operation of the Icebreaker Wind project. An ongoing monitoring program will continue to monitor zooplankton populations through all phases of the project.

3.1.5 Phytoplankton

The results from each event are summarized in Table 9, including the numerical metrics, including number of genus, cells/L and the total biovolume for each month and station.

Table 9. The number of genera, number of cells per liter and the total biovolume for all phytoplankton in each sample are summarized from May through October 2016.

	ICE2						ICE4					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Genus	15	12	21	15	19		-	10	14	25	21	32
Cells/L	1.E+07	5.E+05	1.E+07	6.E+06	3.E+06		-	8.E+06	2.E+07	3.E+07	1.E+07	5.E+07
Total Biovolume (um^3/L)	7.E+09	3.E+08	4.E+08	5.E+08	7.E+08		-	8.E+08	3.E+08	3.E+08	4.E+08	2.E+09
	ICE6						REF1					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Genus	12	14	15	22	13	17	18	12	17	18	22	21
Cells/L	1.E+07	2.E+06	5.E+06	9.E+06	7.E+07	3.E+07	9.E+06	3.E+06	8.E+06	8.E+06	9.E+06	4.E+07
Total Biovolume (um^3/L)	3.E+09	8.E+07	3.E+08	5.E+08	9.E+08	3.E+09	2.E+09	3.E+08	4.E+08	7.E+08	2.E+08	4.E+09
	REF2						REF3					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Genus	15	9	16	21	24		18	9	15	12	16	18
Cells/L	8.E+06	3.E+06	8.E+06	5.E+06	2.E+07		1.E+07	5.E+05	6.E+06	4.E+07	6.E+06	5.E+07
Total Biovolume (um^3/L)	3.E+09	7.E+08	2.E+08	1.E+09	3.E+08		9.E+09	4.E+07	5.E+08	2.E+09	5.E+08	2.E+10
	REF4						REF5					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Genus	15	9	21	17	19		22	13	18	15	13	
Cells/L	1.E+07	5.E+05	1.E+07	9.E+06	9.E+06		8.E+06	5.E+05	7.E+06	1.E+07	1.E+07	
Total Biovolume (um^3/L)	3.E+09	1.E+08	1.E+09	5.E+08	3.E+08		2.E+09	1.E+08	5.E+08	7.E+08	8.E+08	
	REF6						**All Sites**					
	May	June	July	August	Sept.	October	**May**	**June**	**July**	**August**	**Sept.**	**October**
Number of Genus	13	11	17	16	14	28	16	11	17	18	18	23
Cells/L	1.E+07	2.E+06	1.E+07	6.E+06	1.E+07	2.E+07	1.E+07	2.E+06	9.E+06	1.E+07	2.E+07	4.E+07
Total Biovolume (um^3/L)	4.E+09	2.E+08	4.E+08	4.E+08	4.E+08	8.E+08	4.E+09	3.E+08	5.E+08	8.E+08	5.E+08	7.E+09

A summary of the composition of Genus across all months is found in Table 10. In May, August, and October the Bacillariophyta (diatoms) were the dominate plankton. In June, cyanobacteria (blue-green algae) were dominant. Cryptophyta were the dominant plankton in July. Pyrropyta (dinoflagellate) were dominant in September. Cyanobacteria were present in all months, with microcystis only present in September and October.

Table 10. The genera present across all locations from the May through October 2016.

Genus	Genus	Genus	Genus
Asterionella	Crucigenia	Kephyrion	Plagioselmis
Aphanizomenon	Cryptomonas	Kirchneriella	Planktolyngbya
Achnanthidium	Cyclotella	Lagerheimia	Planktothrix
Actinocyclus	Cylindrospermopsis	Lindavia	Pseudanabaena
Ankistrodesmus	Cymatopleura	Lyngbya	Pyramimonas
Aphanizomenon	Cymbella	Mallomonas	Quadrigula
Aphanocapsa	Diatoma	Merismopedia	Rhodomonas
Aulacoseira	Dictyosphaerium	Microcystis	Scenedesmus
Carteria	Dinobryon	Monactinus	Schroederia
Ceratium	Dolichospermum	Monoraphidium	Snowella
Chlamydomonas	Drepanochloris	Mougeotia	Sphaerocystis
Chlorella	Elakatothrix	Navicula	Stephanodiscus
Chlorella	Euglena	Nitzschia	Surirella
Chroococcus	Fragilaria	Ochromonas	Synechococcus
Chrysococcus	Glenodinium	Oocystis	Synedra
Closteriopsis	Gomphonema	Oscillatoria	Tetraedron
Cocconeis	Gomphosphaeria	Pantocsekiella	Tetrastrum
Coelastrum	Gymnodinium	Plagioselmis	

3.1.6 Benthos

The counts (mean ±SD) for each genus are summarized in Table 11. Most of the benthos collected fell into three main groups, Bivalves, Insecta, and Oligochaeta, with a few crustaceans and nematodes in the October sample. Their densities were relatively consistent across the three locations.

Table 11. The mean density (#/m²) and standard deviation (in parentheses) are presented of each taxa across three replicate at each location for the May and October events.

Taxa	May			October		
	ICE2	ICE6	REF1	ICE2	ICE6	REF1
Caecidotea sp.	0 (0)	0 (0)	0 (0)	38 (0)	19 (0)	0 (0)
Chironomus sp.	267 (87)	229 (41)	159 (74)	38 (0)	38 (19)	77 (19)
Corbicula fluminea	657 (334)	376 (74)	606 (320)	0 (0)	0 (0)	0 (0)
Dreisseniidae sp.	0 (0)	0 (0)	0 (0)	19 (0)	19 (0)	0 (0)
Nematomorpha sp.	0 (0)	0 (0)	0 (0)	57 (0)	0 (0)	38 (0)
Oligochaeta	548 (86)	663 (375)	491 (156)	670 (88)	1155 (345)	415 (387)
Procladius sp.	6.4 (9)	13 (18)	19 (15.6)	26 (11)	0 (0)	19 (0)
Sphaeriidae sp.	0 (0)	0 (0)	0 (0)	568 (173)	625 (173)	395 (385)
Tanytarsus sp.	13 (18)	38 (31)	13 (9)	0 (0)	0 (0)	0 (0)

Substrate type is often a key factor in controlling the composition and diversity of the benthic community. The offshore project site (~20 m) consists of primarily silty clay sediments and provides few natural, permanent structures for benthic invertebrates to attach to. While the featureless, silty bottom sediment is likely limiting taxa diversity, the absence of intolerant species (e.g., Mayflies) is also driven by the extended period of hypoxia. Dreissenids (e.g. zebra and quagga mussels) were found as part of this study. These mussels can cause significant biofouling of structures, however low summer DO prevents permanent populations to accumulate below the thermocline (about 40ft depth).

3.2 Physical Habitat

3.2.1 Water Chemistry: Discrete

Discrete grab sampling for water chemistry and water clarity measurements were conducted on May 12, June 16, July 7, August 17, September 7, and October 19, 2016 at REF1-6 and ICE2, ICE4 and ICE6 (

Table 12). The sampling event on May 12, 2016 did not include ICE4 as it was not required by ODNR, but was later added by LimnoTech to provide additional water chemistry results at the same station where continuous measurements are being recorded. Only REF1, REF3, REF6 and ICE4 and ICE6 were sampled in October due to inclement weather. Total Kjeldahl (TKN), TN, nitrate-nitrite, TP, and chlorophyll-*a* are summarized in Table 13. Water clarity results are summarized in Table 14. All water chemistry parameters decreased from May to October with the exception of phosphorus and chlorophyll-*a*, which began to increase in October. Average monthly water clarity was 6.5 feet in May before increasing to 24 feet in July and afterwards decreasing to 10.3 feet in October. An example of a water quality and photosynthetic active radiation profiles at REF 1 are shown in Figure 11 and Figure 12.

The integrated water sampler initially consisted of rubber hose, however after some low level contamination issues were discovered in July the hose was changed to polyethylene. Heidelberg University analyzed a sequence of samples from each hose material as shown in Table 15 below. The results for TP concluded that the equipment blanks (distilled water passed through the hose) averaged 6.2 µg/L for the rubber hose and 1.6 µg/L for the polyethylene hose, and the sample blanks (distilled water poured directly into a sample bottle) averaged 0.8 µg/L (Table 15). As a result the TP results from May, June, and July have a higher method detection limit of at least 7 ug/L All future sampling will utilize an integrated tube sampler made of polyethylene.

Table 12. Reference, Turbine, and Nearshore locations where discrete chemistry samples were taken from May to October 2016.

		Reference Stations 1-3																	
Task Description		1						2						3					
		May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct
Discrete Chemistry	Chlorophyll	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	Nitrate+NO2	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	Total P	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	TKN	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	PAR Extinction	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	Secchi Depth	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	DO/Temp Profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

		Reference Stations 4-6																	
Task Description		4						5						6					
		May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct
Discrete Chemistry	Chlorophyll	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	Nitrate+NO2	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	Total P	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	TKN	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	PAR Extinction	x	x	x	x	x		x		x	x	x		x	x	x	x	x	x
	Secchi Depth	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	DO/Temp Profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Task Description		Turbine Stations 2						4						6						Nearshore			
		May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct	July	Aug	Sept	Oct
Discrete Chemistry	Chlorophyll	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	Nitrate+NO2	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	Total P	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	TKN	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	PAR Extinction	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	Secchi Depth	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	DO/Temp Profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	

Table 13. 2016 monthly results for Total Kjedahl Nitrogen, Total Nitrogen, Chlorophyll-a, Nitrate+Nitrite, and Total Phosphorus.

Water Chemistry Results

	Total Kjeldahl Nitrogen(mg/L)						Total Nitrogen (mg/L)					
Station ID	May	June	July	August	Sept	Oct	May	June	July	August	Sept	Oct
Ref 1	0.29	0.23	0.30	0.22	0.26	0.29	1.16	0.72	0.76	0.29	0.31	0.35
Ref 1-D	0.24	*	*	*	*	*	1.12	*	*	*	*	*
Ref 2	0.29	0.24	0.30	0.27	0.27	*	1.21	0.65	0.77	0.33	0.33	*
Ref 3	0.26	0.26	0.34	0.31	0.25	0.33	1.01	0.78	0.84	0.42	0.31	0.39
Ref 3-D	*	0.20	0.33	0.29	0.28	0.32	*	0.73	0.83	0.38	0.34	0.37
Ref 4	0.26	0.21	0.27	0.27	0.29	*	1.09	0.70	0.75	0.41	0.36	*
Ref 5	0.27	0.22	0.38	0.22	0.29	*	1.22	0.68	0.96	0.30	0.36	*
Ref 6	0.25	0.25	0.53	0.27	0.24	0.30	1.20	0.63	1.01	0.32	0.31	0.35
Ice 2	0.40	0.25	0.28	0.29	0.25	*	1.23	0.77	0.76	0.40	0.32	*
Ice 4	*	0.21	0.34	0.25	0.32	0.32	*	0.70	0.81	0.32	0.38	0.37
Ice 6	0.38	0.24	0.37	0.24	0.26	0.30	1.33	0.68	0.85	0.29	0.32	0.35
Near Shore	*	*	*	*	0.32	*	*	*	*	*	0.39	*
Field Blank	-0.01	-0.02	0.00	0.04	0.02	0.03	0.00	-0.02	0.00	0.04	0.02	0.04
	MDL: 0.036 mg/L						MDL: 0.038					

	Chlorophyll-a (µg/L)						Nitrate+Nitrite (mg/L)					
Station ID	May	June	July	August	Sept	Oct	May	June	July	August	Sept	Oct
Ref 1	7.49	0.77	1.54	3.13	2.29	13.20	0.878	0.491	0.464	0.066	0.054	0.054
Ref 1-D	7.65	*	*	*	*	*	0.881	*	*	*	*	*
Ref 2	5.78	0.68	1.39	2.67	1.80	*	0.926	0.406	0.471	0.065	0.059	*
Ref 3	6.05	0.83	1.54	3.66	1.52	10.55	0.747	0.521	0.500	0.117	0.058	0.058
Ref 3-D		0.87	1.80	3.22	2.85	12.25	*	0.526	0.491	0.096	0.066	0.054
Ref 4	6.71	0.69	1.81	3.88	1.29	*	0.835	0.478	0.478	0.137	0.065	*
Ref 5	8.86	1.61	1.47	2.77	2.21	*	0.950	0.462	0.579	0.083	0.064	*
Ref 6	7.73	0.75	1.29	2.48	2.43	12.34	0.955	0.386	0.480	0.054	0.061	0.049
Ice 2	8.13	0.75	2.02	2.72	1.83	*	0.829	0.520	0.479	0.101	0.066	*
Ice 4	*	0.83	2.47	1.12	2.73	11.34	*	0.484	0.466	0.068	0.058	0.048
Ice 6	6.55	0.75	1.33	2.43	1.27	12.27	0.952	0.433	0.481	0.056	0.056	0.047
Near Shore	*	*	*	*	2.88	*	*	*	*	*	0.062	*
Field Blank	0.00	0.06	-0.05	-0.06	0.61	0.61	0.011	0.001	0.000	0.005	-0.001	0.005
	MDL: 1.00 µg/L						MDL: 0.002 mg/L					

	Total Phosphorus (µg/L)					
ID	May	June	July	August	Sept	Oct
Ref 1	13.12	12.87	4.74	6.11	4.37	22.43
Ref 1-D	11.86	*	*	*	*	*
Ref 2	14.98	5.76	5.62	6.06	4.85	*
Ref 3	10.98	4.72	5.00	4.94	4.14	20.94
Ref 3-D	*	5.19	4.99	6.13	13.09	20.91
Ref 4	10.78	12.85	6.35	5.92	5.39	*
Ref 5	13.40	12.08	6.30	5.19	5.45	*
Ref 6	12.23	8.84	5.13	9.96	12.71	19.75
Ref 2	16.01	5.03	6.35	6.64	6.64	*
Ref 4	*	7.28	4.27	6.16	9.43	19.96
Ref 6	17.35	5.54	5.64	5.84	4.26	19.85
Near Shore	*	*	*	*	4.96	*
Field Blank	-1.80	-1.24	-0.34	-2.01	-1.32	0.20
	MDL: 3.15 µg/L					
	Values lower than the method detection level					
	Detection limit = 6.2 ug/L (high hose equipment blanks)					

Table 14. 2016 water clarity and light extinction results.

2016 Water Clarity Results

	Secchi Depth (m)						PAR Extinction Coeff. (m^{-1})					
Station ID	May	June	July	August	Sept	Oct	May	June	July	August	Sept	Oct
Ref 1	1.9	7.5	7.3	6.7	4.9	3.4	-0.24	-0.1	-0.09	-0.1	-0.08	-0.21
Ref 2	2.0	8.2	7.5	4.7	5.0	*	-0.2	-0.1	-0.09	-0.11	-0.1	*
Ref 3	2.3	7.9	6.4	5.6	5.2	*	-0.19	-0.15	-0.08	-0.1	-0.1	-0.22
Ref 4	2.2	10.1	7.0	5.5	4.6	*	-0.2	-0.1	**	-0.09	-0.1	*
Ref 5	1.8	7.3	7.9	5.5	4.9	*	-0.26	**	-0.08	-0.09	-0.08	*
Ref 6	1.9	8.1	8.7	4.6	5.5	2.9	-0.22	-0.09	-0.09	-0.08	-0.1	-0.24
Ice 2	2.0	10.4	6.8	5.5	4.7	*	-0.21	-0.1	-0.09	-0.07	-0.09	*
Ice 4	*	*	6.4	5.5	5.2	3.4	*	**	-0.1	-0.08	-0.09	-0.22
Ice 6	1.8	7.2	7.9	5.9	4.9	3.0	-0.22	-0.1	-0.08	**	-0.09	-0.24
Near Shore	*	*	*	*	5.3	*	*	*	*	*	-0.11	*

Note: * denotes no data taken and ** denotes low quality PAR measurements (passing clouds)

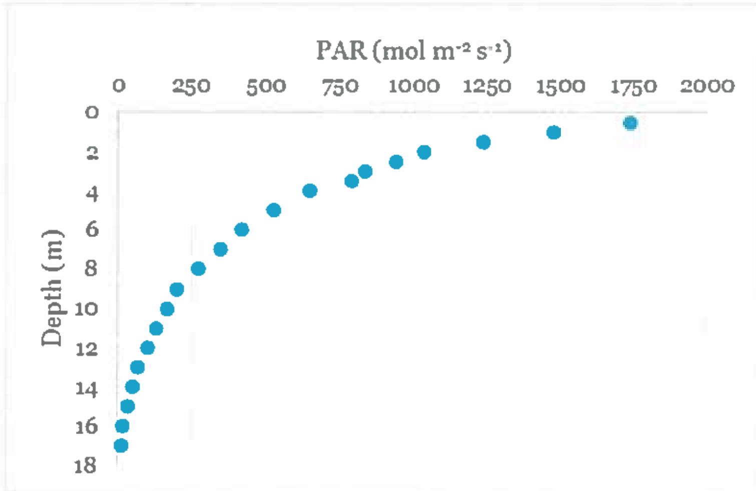

Figure 11: PAR measurements taken on 9/7/2016 at REF1.

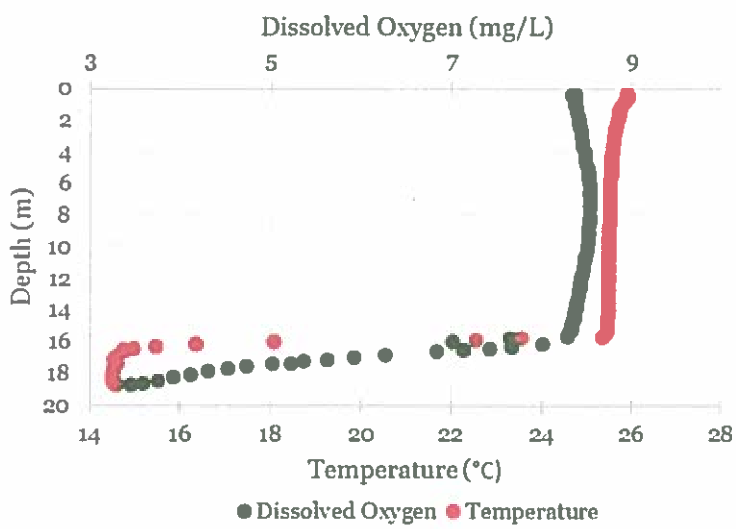

Figure 12: Water temperature and DO profile taken at REF1 on 8/17/2016.

Table 15. Total phosphorus results from the rubber and polyethylene hose and field blanks.

Equipment	TP
	ug/L
Field Blank	1.6
Field Blank	0.0
Rubber Hose	8.6
Rubber Hose	3.8
Polyethylene Hose	1.4
Polyethylene Hose	1.8
MDL	12.0

3.2.2 Water Chemistry: Continuous

A summary of the number of days when data was collected by continuous sensors is provided in Table 16 and 17. DO and temperature data were also retrieved from nearby buoys 45164 and 45176 to provide additional data from nearshore and offshore locations. Buoy 45164 was deployed ten miles northeast of the central turbine location in 70 feet of water and provided hourly water temperature from the surface to 60 feet below the surface at two meter increments. Buoy 45176 was located six miles southeast of the central turbine and measured lake bottom DO and temperature every ten minutes. PAR data are shown in Figure 12. PAR was generally similar between the two sites (ICE4 and REF1), with PAR values slightly higher at the reference site. This may be due to differences in the exact positioning of the sensor in the water column. Further analysis of this difference will continue into the 2017 monitoring year. It should also be noted that the wiper on the ICE4 PAR sensor broke and as a result PAR results at this station should not be compared with REF1. The PAR sensor wiper took six weeks to repair. For the 2016 season we will have a spare wiper on hand to avoid any future gaps in PAR data. Lake bottom DO and temperature from May 11, 2016 to October 19, 2016 are illustrated in Figure 14 and Figure 15. Bottom DO continually dropped until water became anoxic in early-August and did not permanently oxygenate until late-September. Weekly fluctuations in bottom lake temperature increased from offshore to nearshore as temperatures increased until the water column mixed down in late-September (Figure 15). Throughout 2016 surface water temperatures from nearshore to offshore had little deviation (Figure 16). Figure 17 illustrates the increase in temperature gradient from June through August as the thermocline strengthened and reached a maximum two meter temperature change of 11 °C in mid-August.

Table 16. Number of days each month data was collected by continuous sensors at REF1 and ICE4.

	Ref 1						Ice 4					
Task Description	May	June	July	August	Sept	Oct	May	June	July	August	Sept	Oct
Surface Water Temp	21	30	31	31	30	19	21	30	31	31	30	19
Bottom Water Temp	21	30	31	31	30	19	21	30	31	31	30	19
Bottom DO	0	15	31	26	30	19	21	30	31	26	30	19
PAR	21	30	31	31	10	0	21	30	31	31	30	19
Water Current	21	30	31	31	30	19	21	30	31	31	30	19
Background Noise	21	30	31	31	30	19	21	30	29	28	30	19

Table 17: Number of days each month data was collected by continuous sensors at ICE1, ICE2, ICE7.

	Ice 1				Ice 2			Ice 7			
Task Description	July	August	Sept	Oct	August	Sept	Oct	July	August	Sept	Oct
Bottom Water Temp	11	31	30	31	13	30	31	11	30	30	19
Bottom DO	11	31	30	31	13	30	31	11	30	30	19

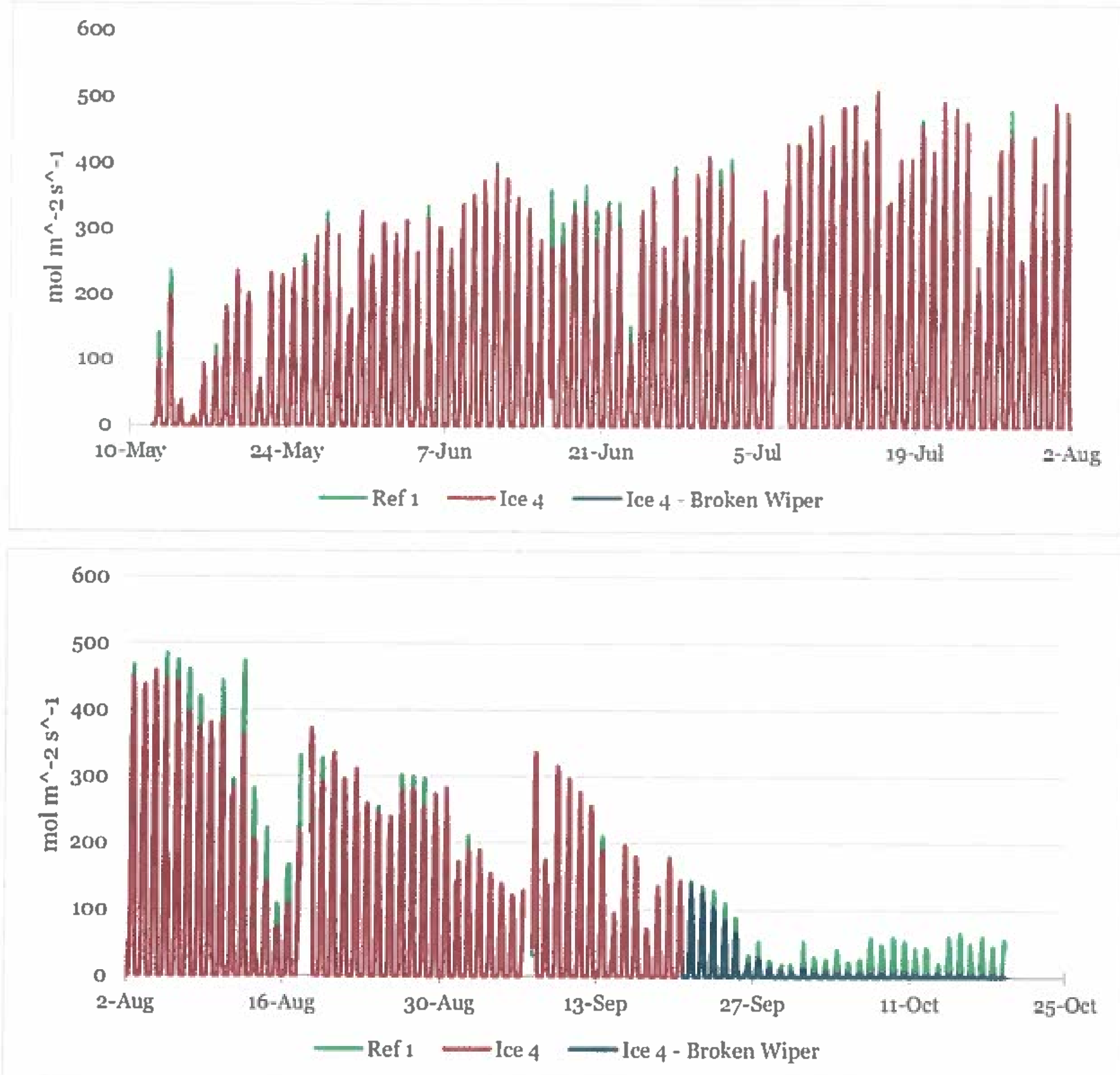

Figure 13: 2016 photosynthetic active radiation at ICE4 and REF1.

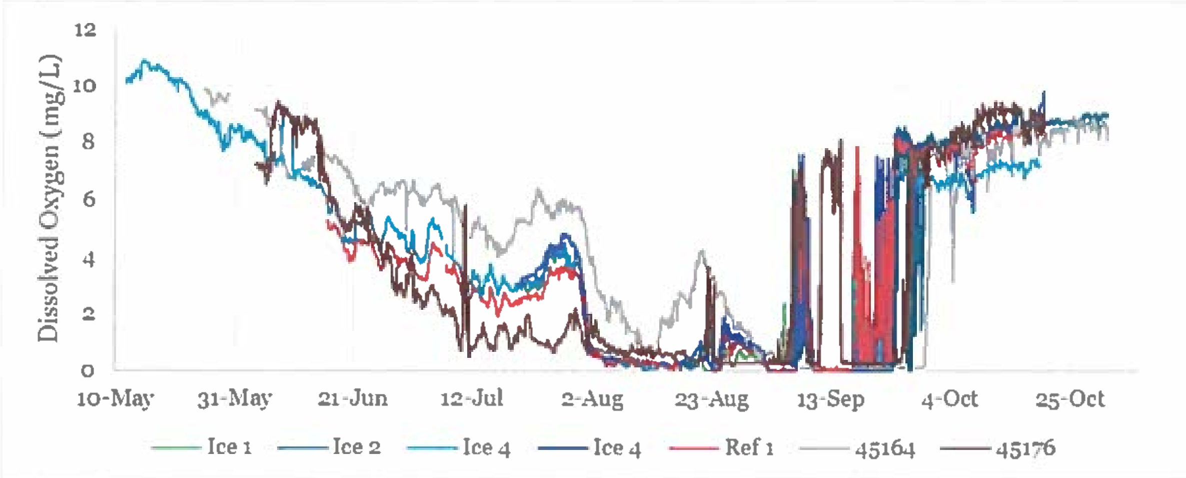

Figure 14: 2016 lake bottom DO at ICE1, ICE2, ICE4, ICE7, REF1, and buoy 45164 and 45176.

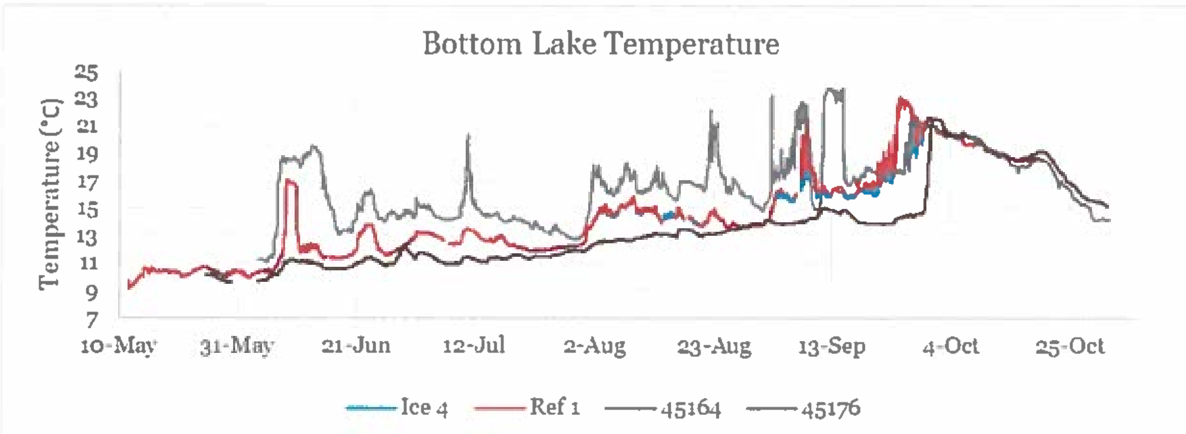

Figure 15: 2016 lake bottom temperature at ICE4, REF1, and buoys 45164 and 45176.

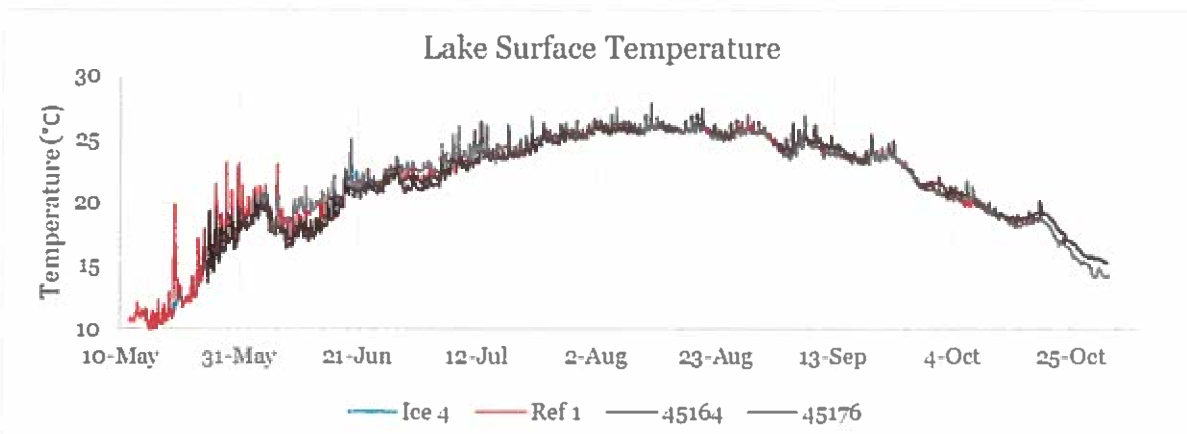

Figure 16: 2016 surface lake temperature at ICE4, REF1, and buoys 45164 and 45176.

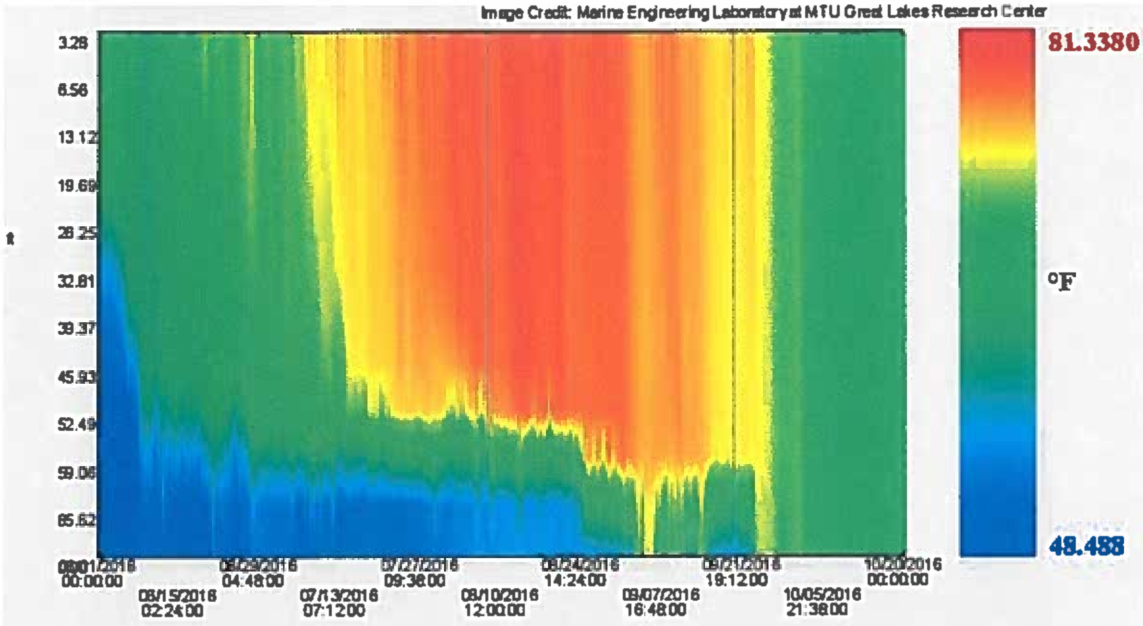

Figure 17: Buoy 45164 water temperature profile from June 1, 2016 to October 20, 2016.

3.2.3 Substrate Mapping

A complete geophysical analysis was conducted by Canadian Seabed Research in August 2016. The full results of that survey are contained in the CSR (2016) report. A snapshot of the output from the sidescan survey is shown below in Figure 18. The dark areas of the figure represent silt and clay, while the light brown areas represent sand and gravel areas. A closer look at the transition point between silt/clay and sand/gravel is shown in Figure 19 below. This figure shows a plan view of the surface sediments. The sidescan sonar data and sediment grab sample data is available upon request and is now included in the digital appendix to this report.

Figure 18. Side scan sonar mosaic of sediment type (dark brown= silt/clay, lt. brown =sand/gravel).

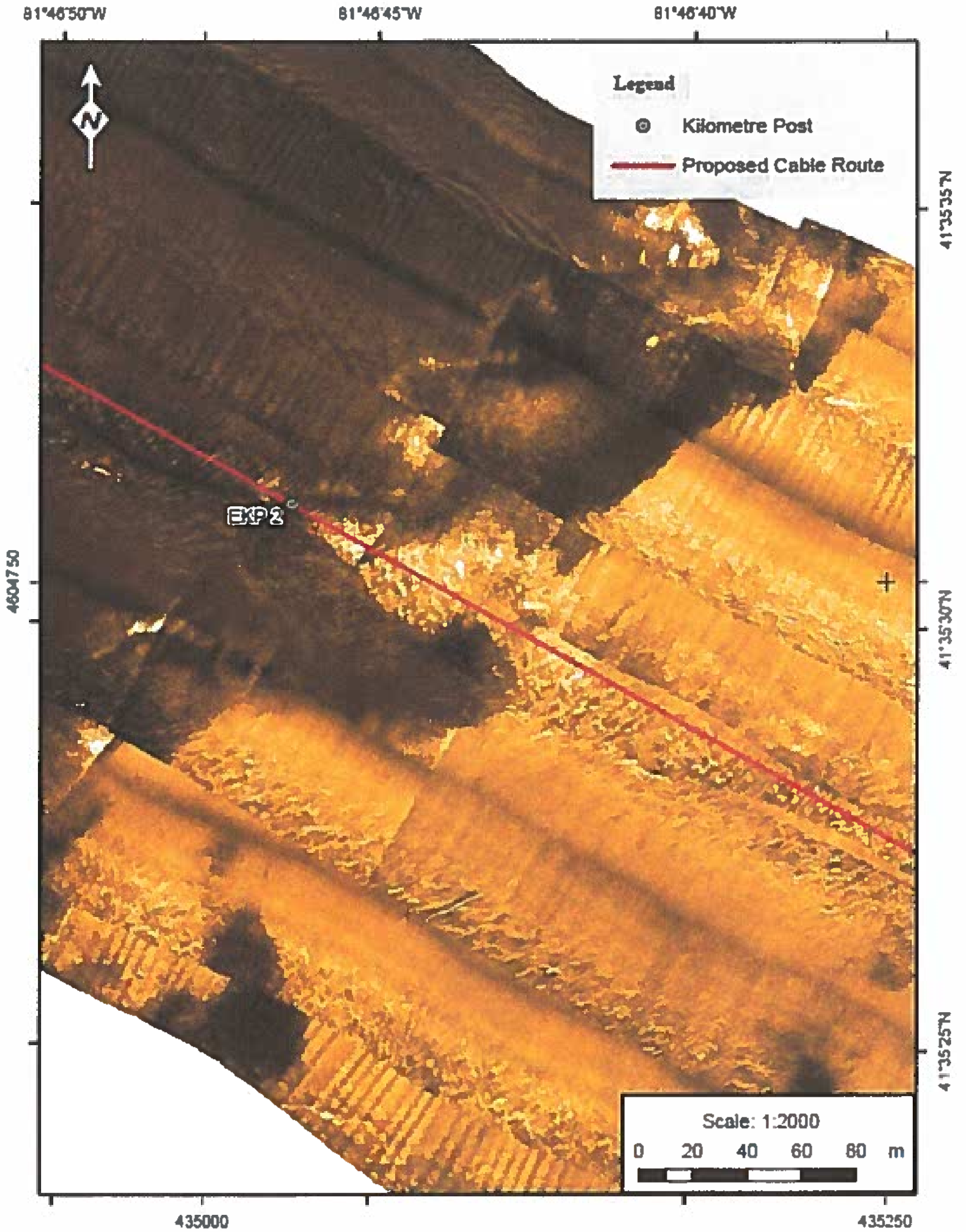

Figure 19. Sidescan sonar data illustrating the boundary between silt/clay and sand/gravel (Source: CSR, 2016 Figure 5.2.1.1)

3.2.4 Hydrodynamic

ICE4 exhibited small deviations between the top and bottom water velocity and direction throughout the year (Figure 20 and Figure 21). As summarized in Table 17, the average current velocity at the bottom of Lake Erie was 0.07-0.08 m/s while the surface was only slightly faster at 0.09 m/s. The average significant wave height and mean wave period for 2016 was 0.43 meters and 2.5 seconds. Winter data will be retrieved during the first field visit in April 2017.

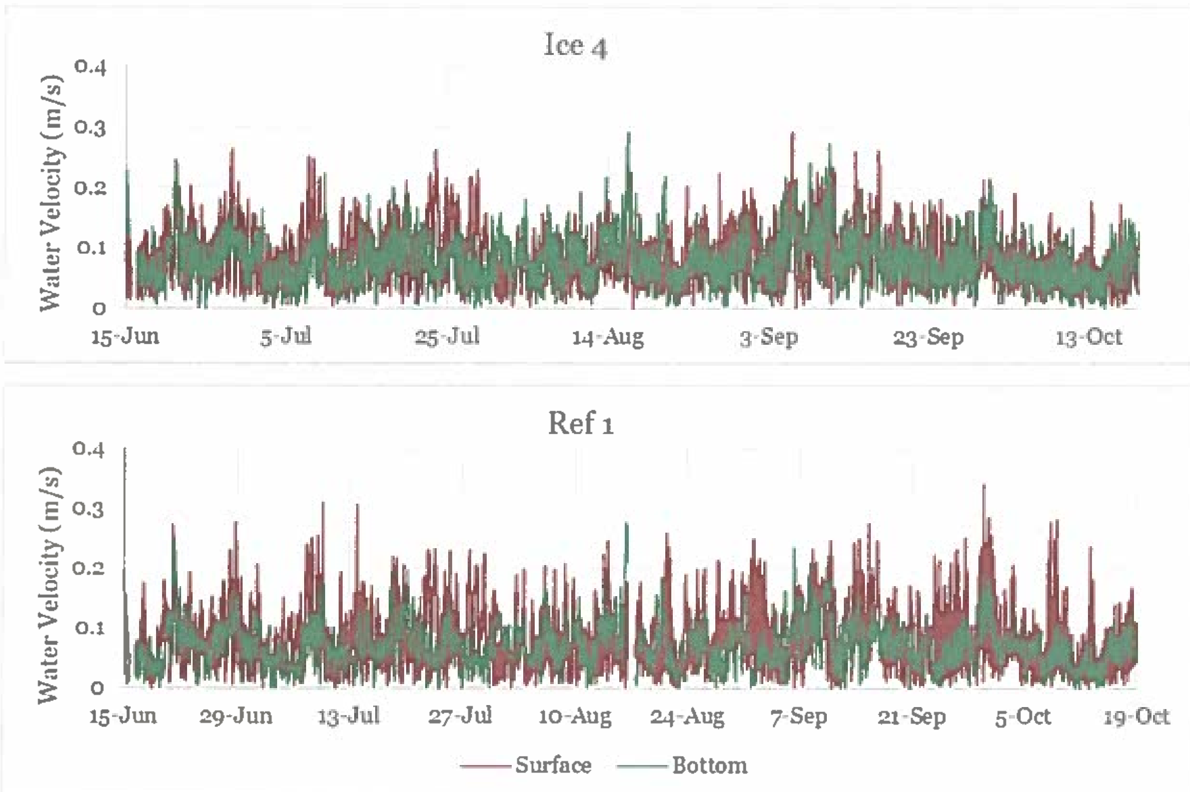

Figure 20: 2016 lake surface and bottom water velocity at ICE4 and REF1.

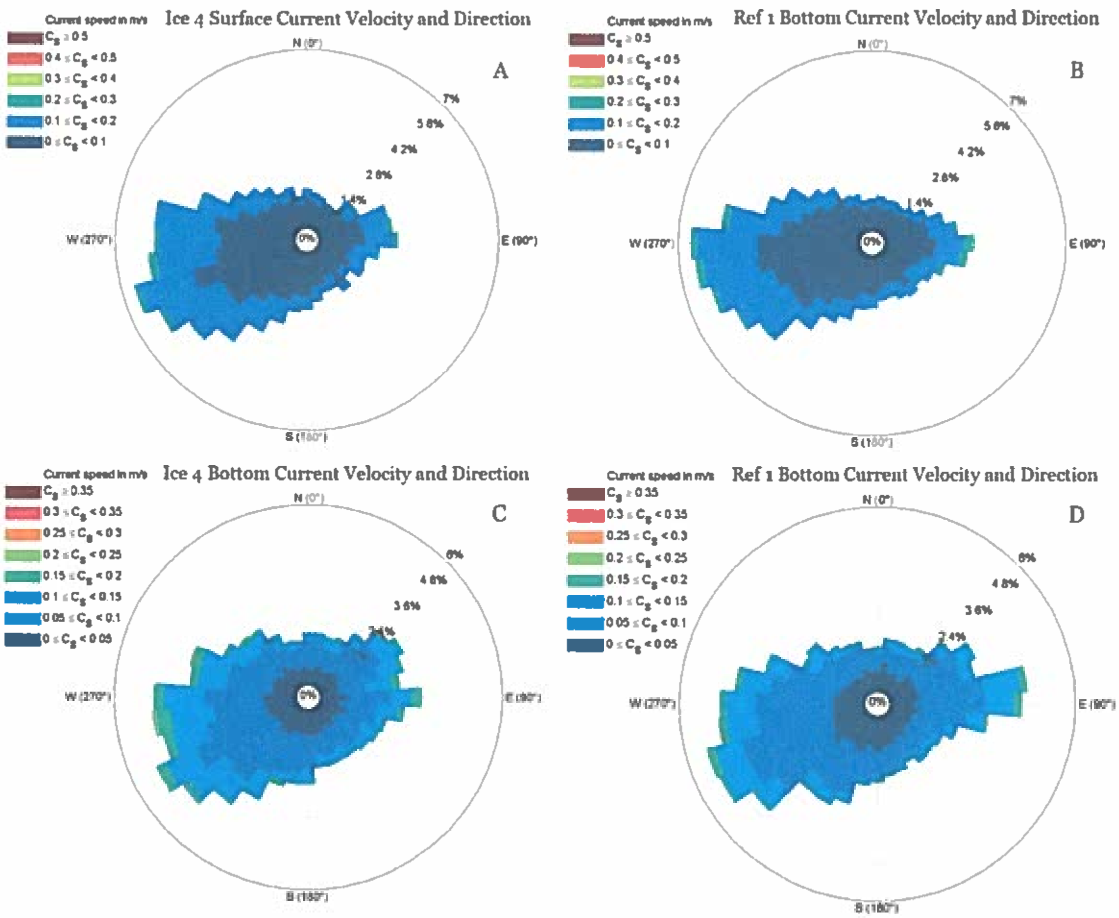

Figure 21: 2016 lake surface and bottom current velocity and direction at ICE4 (A, C) and REF1 (B, D). Spokes represent the frequency of currents moving towards a particular direction.

Table 18: 2016 average and maximum current velocity, wave height, and period at ICE4 and REF1.

	Current Velocity (m/s)				Wave Height (m)		Period (sec)	
	Bottom		Surface					
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
Ice 4	0.078	0.291	0.089	0.384	0.43	2.43	2.48	6.1
Ref 1	0.070	0.277	0.088	0.484	*	*	*	*

Note: * denotes no data taken

3.3 Fish Behavior

3.3.1 Acoustic Telemetry

The results of the range test are summarized in Figure 22, which indicate a greater than 80 detection rate up to our maximum tested distance, which was 1,200 meters away from the transmitter test tag. The detection percent was very high along the entire receiver test array. In addition, during the 8 hour range test, the test receivers picked up two tagged Walleye that were within range and later we discovered these fish were released from Sandusky Bay as part of an ODNR project. A third fish tag was also picked up, but its ID was unavailable in the GLATOS database. The receivers were put out on the final field day of the year. Data will be retrieved during the 2017 field season.

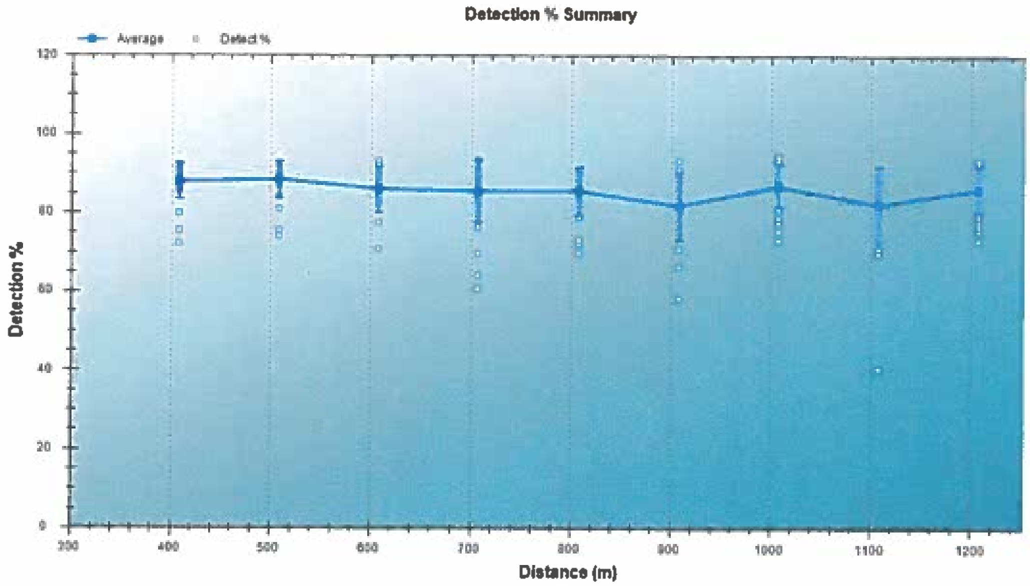

Figure 22. Summary of the detection results from the 8 hour range testing event.

3.3.2 Fixed Acoustics

Overall, the densities were similar between the two fixed locations, which included one at the project location and one to serve as a reference. Although the two locations were similar within months, there was a significant difference in total density across months. The results from the fixed hydroacoustic surveys are summarized in Figure 23.

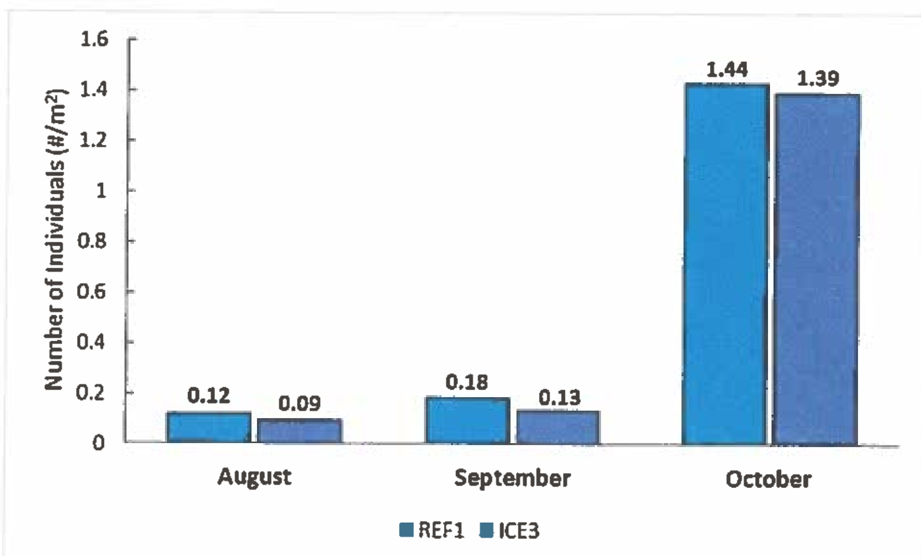

Figure 23. Summary of the average total fish densities, (individuals (#) per m²) for the fixed acoustics.

Similar to the mobile acoustics (Section 3.1.1), fish density was considerably lower in August and September compared to the October fish density. As mentioned in Section 3.1.1, this trend is consistent with the lack of fish observed in the August juvenile trawls and follows the depletion in dissolved oxygen.

3.3.3 Noise Production

The underwater sound data recorded at ICE4 and REF1 was analyzed by Aaron Rice at Cornell University. Relatively high levels of transient noise were observed throughout the entire study period. These are likely associated with passing ships or sporadic biological activity. ICE4 exhibited higher overall sound levels compared to REF1 (Figure 26). Background noise, both abiotic and anthropogenic, was detected and varied in intensity and duration, across the entire survey. Examination of long term spectral averages (LTSAs) spanning the entire survey period shows that REF1 and ICE4 recording locations exhibit a considerable amount of diversity in their respective acoustic environments (Figure 24 and Figure 25). Monthly LTSAs allow individual events to be examined in finer detail (Appendix C) where in many cases it can be concluded that intermittent broadband noise (appearing as short- and medium-duration vertical bands) is the result of passing ships and weather events. Weather events are typically multiple-hour long events and consistent across multiple sites, while ship noise is generally shorter in duration and not uniform across recording locations.

In 2014 Cornell University also deployed hydrophones east and west of the proposed turbine locations near Fairport and Sandusky, Ohio (Figure 27). The Fairport survey was conducted in ODNR's Walleye/Perch Habitat and within a Walleye Larval and Juvenile Production Area off of Sandusky. At both locations in June Cornell recorded seasonal chorusing events of freshwater drum (*Aplodinotus grunniens*) that were not seen in REF1 or ICE4 data, that are located in the Dead Zone and less than a mile from a Walleye/Perch Habitat.

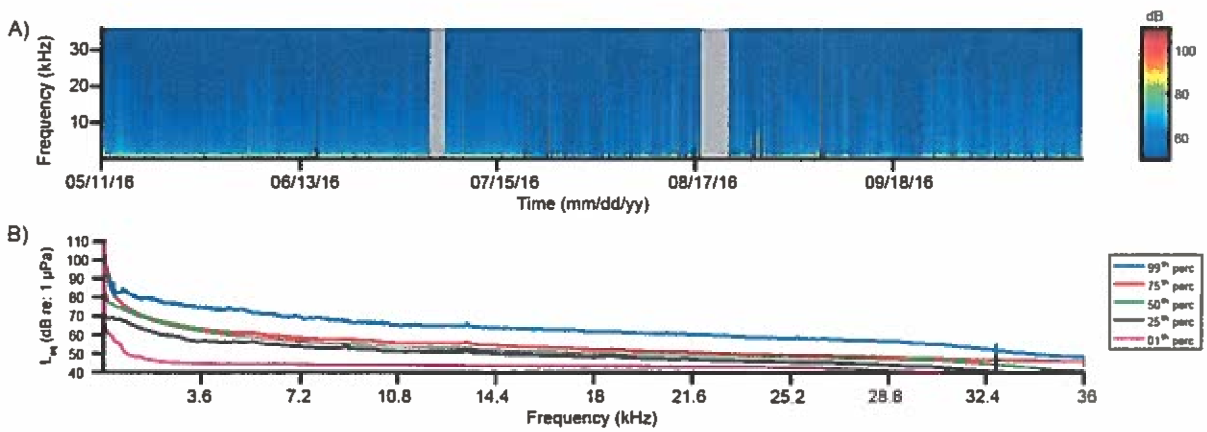

Figure 24: A) Long-term spectral average and B) statistical distribution of power spectra (in L_{eq}) at ICE4 from May 11 through October 19, 2016 for the entire available frequency bandwidth of 0-36 kHz. Spectrogram was created with FFT=512 points and 1 hour integration time. Grey boxes show periods of time with missing data.

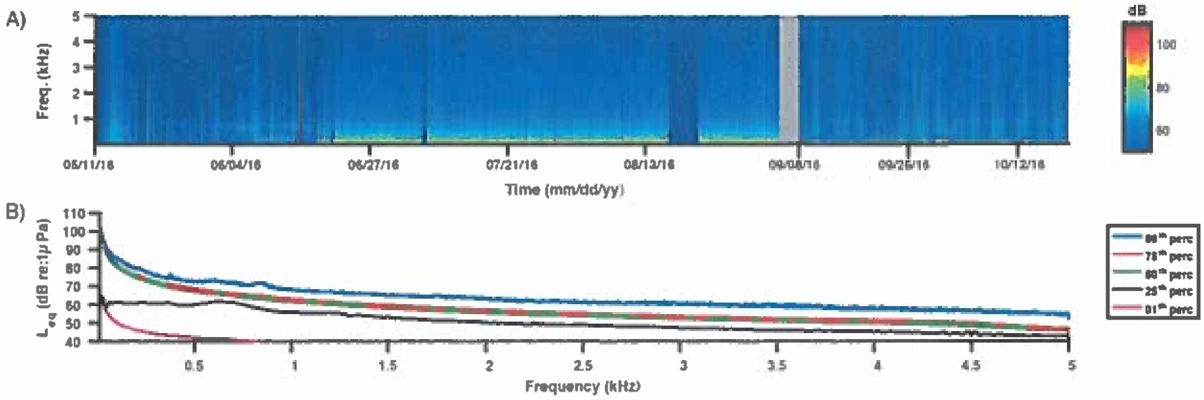

Figure 25: A) Long-term spectral average and B) statistical distribution of power spectra (in Leq) at REF1 from May 11 through October 19, 2016 between 0-5 kHz. Spectrogram was created with FFT=512 points and 1 hour integration time. Grey boxes show periods of time with missing data.

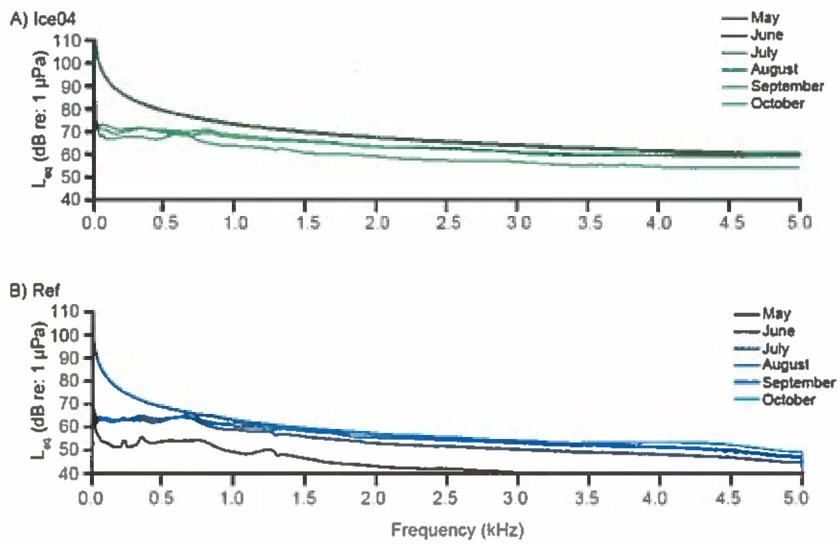

Figure 26: Monthly median power spectral density at A) ICE4 and B) REF1.

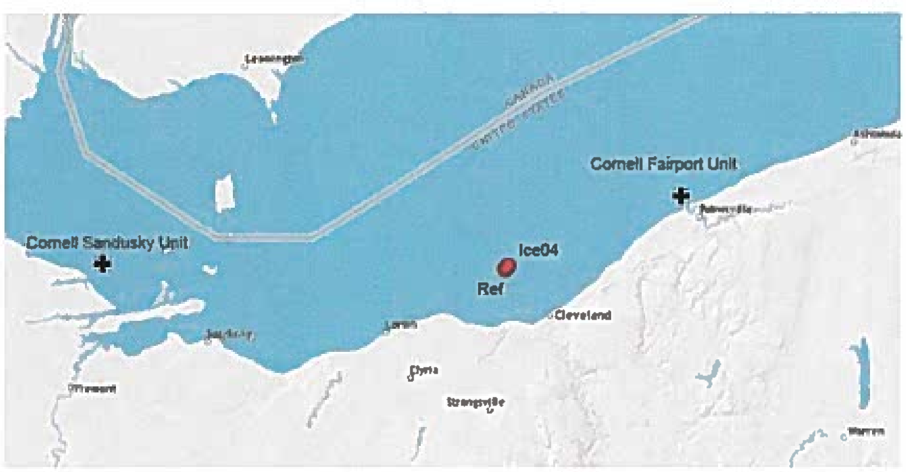

Figure 27: Recording locations of 2016 Ice04 and Ref locations (red circles), relative to previous Cornell acoustic recordings in 2014 (black crosses).

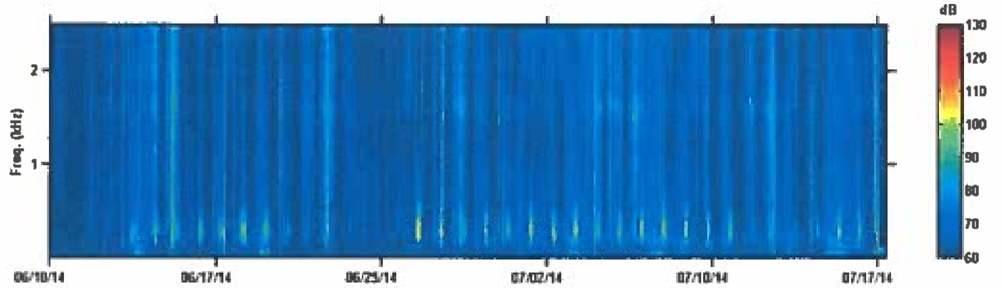

Figure 28: Long-term spectrogram from June 10-July 14, 2014 at recording unit deployed in Lake Erie near Fairport, OH. The freshwater drum nocturnal chorus from is visible between approximately 100-400 Hz.

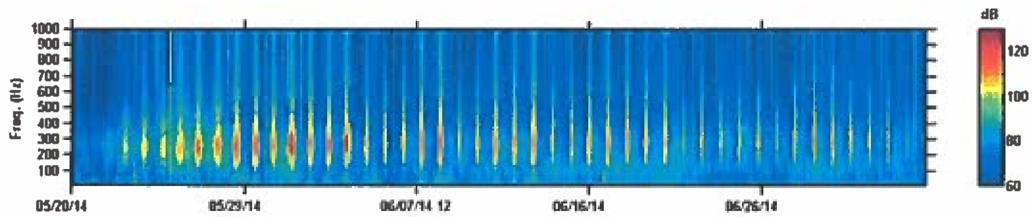

Figure 29: Long-term spectrogram from May 20-July 4, 2014 at recording unit deployed in Lake Erie near Sandusky, OH. The freshwater drum nocturnal chorus from is visible between approximately 100-400 Hz.

3.3.4 Aerial Surveys of Boating

Results from all of the boat surveys by 5-minute survey block are summarized in Table 19 below. Data from the aerial survey shows that boating activity and recreational fishing effort occurs closer to shore than is depicted in the ODNR developed sport fishery maps shown in Figure 30. Each 5-minute survey block has an ID and the numeric part of the ID (911 and 912) corresponds to the 10-minute size survey blocks that are used by ODNR to conduct boating surveys in Lake Erie. On July 3, 2016 only 6 out of 188 boats (~3%) counted that day were in the 5-minute block covering the project area. Across all dates only 2% of the boats counted were found within the 5-minute block covering the project area. This data shows that boating activity and recreational fishing effort occurs closer to shore and well away from the project site.

Table 19. Summary of all offshore boat counts from 2016 plane flyovers.

Date	911-NW	911-NE	912-NW	912-NE	911-SW	911-SE	912-SW	Total
5/20/2016	1	0	0	0	2	2	1	6
5/22/2016	0	3	1	3	7	5	3	22
6/5/2016	0	19	16	15	32	16	14	112
6/6/2016	0	0	0	0	4	1	0	5
6/30/2016	3	0	6	17	13	12	13	64
7/3/2016	6	27	35	20	38	53	9	188
8/28/2016	3	1	4	9	37	50	12	116
8/29/2016	1	0	1	2	4	1	2	11
9/18/2016	1	1	6	5	14	2	13	42
9/21/2016	2	4	1	6	12	14	10	49
10/15/2016	1	1	33	44	64	23	68	234
10/24/2016	0	0	0	0	0	0	0	0
Total	18	56	103	121	227	179	145	849
% of Total	2	7	12	14	27	21	17	100

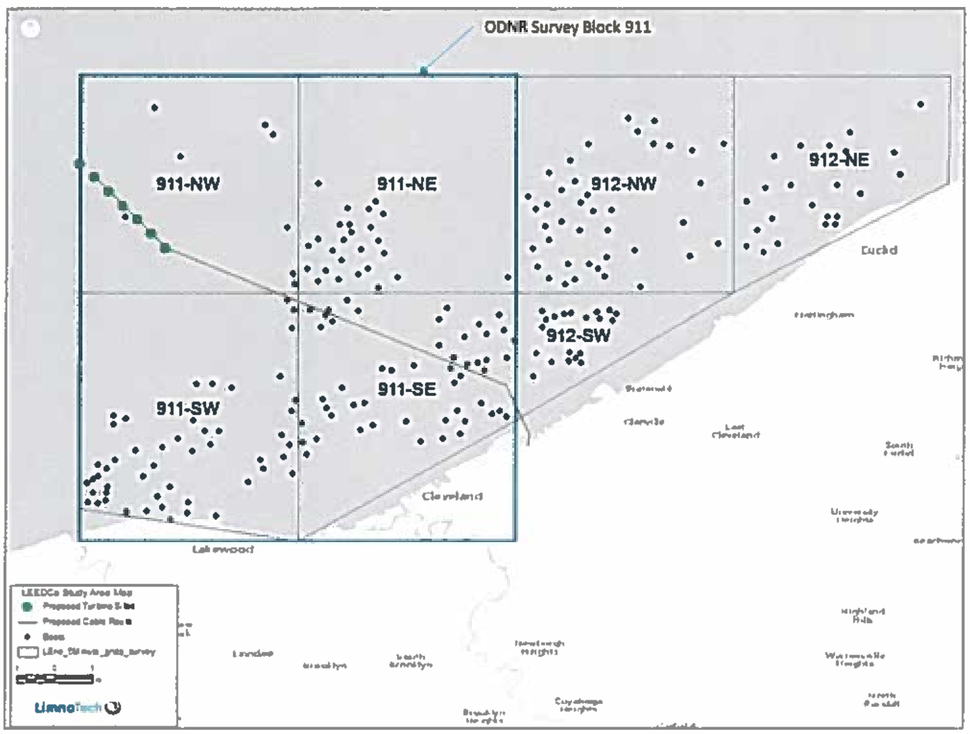

Figure 30. Map of recreational boats (dots) as counted by plane and turbine location (green dots) on July 3, 2016.

3.4 Other Activities

This section summarizes the results and conclusions from two memoranda that were created during the project as well as the outcome of a site characterization and impact assessment report.

3.4.1 Electromagnetic Field Review

The primary concern with submarine cables is the magnetic field that develops around the cable. A magnetic field cannot be contained by the cable shielding and can travel through sediment and water, to some degree. However, studies conducted on magnetic fields created by submarine transmission lines indicate that the magnetic fields are similar to background levels and decrease exponentially with distance from the transmission line. A comparison of EMF studies at existing buried cable installations found that the maximum magnetic field at the seabed was estimated to be 18 micro tesla units (μT). The average estimated magnetic field at the seabed for all 10 projects evaluated was found to be 7.8 μT, well below the level of the naturally occurring earth magnetic field, which is around 50 μT. Using available specifications for the cable and voltage for Icebreaker Wind, the estimated magnetic field at one meter from the cable is approximately 2 μT. The only known species that is sensitive to EMF is lake sturgeon, which has been shown to have a threshold effects level of 1000 μT. Figure 31 below shows the results of EMF projects, the estimate for the Icebreaker Wind project as well as background levels relative to the effects threshold.

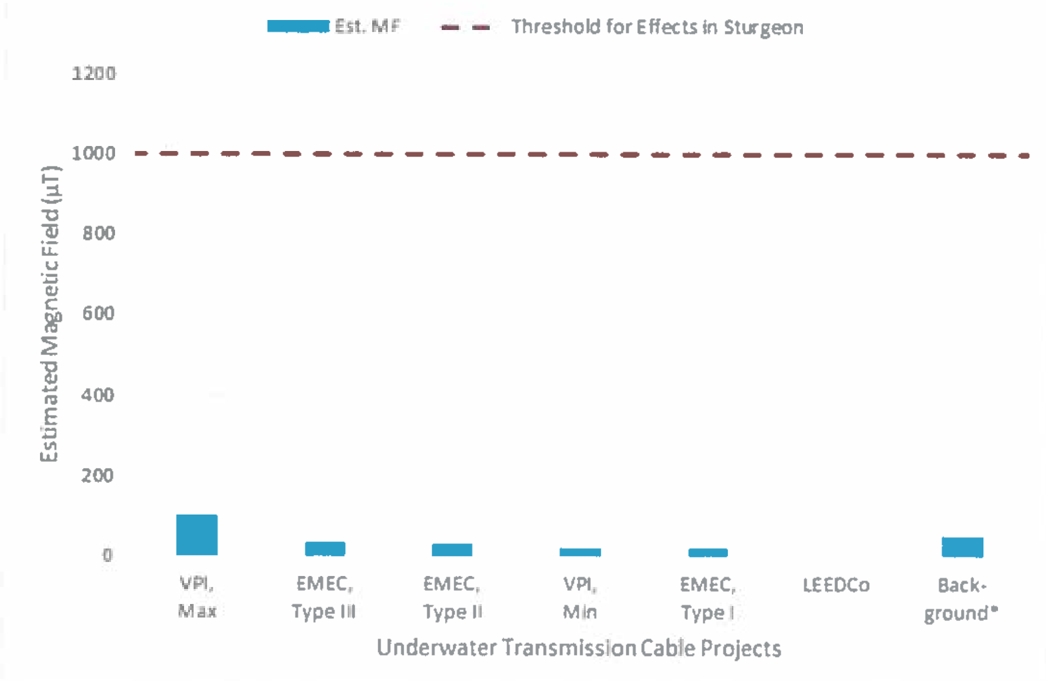

Figure 31. EMF levels (at 1 m above buried cables) for various transmission lines and LEEDCo estimate versus Sturgeon effects level.

California Power Cable Observation Study

A study released in June 2016 by the U.S. Department of the Interior, Bureau of Ocean Energy Management, summarized research from 2012 to 2014, which investigated the potential behavior and reaction of electromagnetic-sensitive species to energized and unenergized cables in a corridor on the seafloor in an offshore area of Southern California (Love et al., 2016). All of the cables in the Love et al. study are very similar to the Icebreaker Wind proposed cable (35kV AC cable with similar power loads) except the cables were not buried below the sediment surface (as will be the case for the Icebreaker Wind electric transmission cables). Over the course of the study, average EMF levels were between 73 μT and 91.4 μT, at the sediment surface which are significantly higher than the Icebreaker Wind estimated EMF levels (of no more than 2 μT one meter above the buried cable). The study did not find any biologically significant differences among fish and invertebrate communities between energized cables, pipe, and natural habitat. The authors noted there was not any compelling evidence that the EMF produced by the energized power cables in this study were either attracting or repelling fishes. The Love et al. study also corroborated the findings of previous studies which determined that EMF strength dissipates with distance from the transmission cable and approaches background levels at approximately one meter from the cable. Furthermore, Love et al. concluded that, "[i]n this and similar cases, cable burial at sufficient depth would be an adequate tool to prevent EMF emissions from being present at the seafloor." The Icebreaker Wind cables will be buried below the lakebed, more than enough to prevent EMF emissions from being present at the sediment water interface.

Lake Ontario Magnetic Field Study

A recent study conducted within the Great Lakes to monitor for the potential impacts of magnetic fields on fish, Dunlop (2016), concluded "...no detectable effects of the cable on the fish community were found. Local habitat variables, including substrate or depth, were more important in explaining variation in fish density than proximity to the cable". This project monitored the Wolfe Island wind power project which has a 7.8 km buried transmission line running from an island offshore to the mainland. The transmission line carries up to 200 MW of power at a maximum of 170kV, which is much larger than the Icebreaker Wind proposed transmission line voltage and power. The study involved nearshore electrofishing surveys and acoustic surveys paired with gill netting. Only minor differences between fish communities in transects near the cable and reference transects were detected by the survey. In the acoustic surveys, researchers did not see significant changes in fish density related to transmission cable proximity either.

Lake Erie Connector Project

The most relevant and nearby project is the ITC Lake Erie Connector project, which is a proposed 1,000 MW, 320 kV, DC transmission cable to link the Ontario Independent Electric System Operator (IESO) with the Pennsylvania PJM Interconnection (PJM). This cable would carry significantly more power compared with the Icebreaker Wind proposed transmission cable. More information on the project can be found at http://www.itclakeerieconnector.com/. Although this project does not enter Ohio waters, it is going through a similar permitting process with the Province of Ontario, State of Pennsylvania, US Department of Energy, Canada's National Energy Board, and US Army Corps of Engineers. The cable will span the entire width of Lake Erie and will cross both nearshore and offshore fish habitat areas. Based on personal conversations, we learned that to date, none of the relevant permitting agencies involved have focused on magnetic field concerns. ITC Holdings, LLC, the project owner, reviewed the relevant magnetic field concerns early on in the project and found no significant impacts were expected. Per conversations with project staff, impact concerns have centered on construction methods and shoreline directional drilling rather than magnetic field concerns. These concerns are being reviewed in Icebreaker Wind's permit applications to the Ohio Power Siting Board and U.S. Army Corps of Engineers, as well as in the Environmental Assessment being prepared for the U.S. Department of Energy's NEPA process.

Based on the expected low EMF levels to be generated by Icebreaker Wind and the current research regarding EMF impacts on fish behavior and habitat, including some studies that have been completed in the Great Lakes or on Great Lakes species of concern, it is our assessment that additional review or studies of potential EMF impacts from the planned electric cable are not necessary and will divert limited resources away from more productive areas of inquiry and research, as LimnoTech is confident that EMF generated by the electric transmission cable will not have an adverse impact on fish behavior and habitat.

3.4.2 Marina Boat Counts

A total of 6,057 boat slips were inventoried across the 16 marina areas. A summary of each of the 16 marina areas is shown in Data from this study helps to document the approximate pool of total boaters in this portion of Lake Erie and can be used to document any long term changes to boat ownership in the

Cleveland area. Data from the sailboat counts and mast height estimates can be used to support US Coast Guard and other related permits.

Table 20. A summary of boat lengths for all of the marina areas is shown in Table 21. For sail boats, an estimate of the mast height above the water was generated by looking up sail boat specifications common to sailboats in each sailboat range on http://sailboatdata.com. Catalina brand sailboats were used for lengths up to 36 feet and Oceanis brand sailboats were used for sailboats longer than 36 feet. Data from this study helps to document the approximate pool of total boaters in this portion of Lake Erie and can be used to document any long term changes to boat ownership in the Cleveland area. Data from the sailboat counts and mast height estimates can be used to support US Coast Guard and other related permits.

Table 20. Summary of boat slips and type by marina area.

Cty.	Marina	Empty	Powerboat	Sailboat	Total
Cuyahoga	Bicentennial Park	46	1	0	47
	East 55th ST	42	260	60	362
	Edgewater	133	235	254	622
	Euclid Creek	46	50	5	101
	Forest City YC	18	75	36	129
	Intercity YC	61	39	0	100
	Lakeside YC	67	127	42	236
	Northeast YC	50	85	17	152
	Olde River YC	82	170	3	255
	Rocky River	84	378	96	558
	Shoreby	50	59	6	115
	Whiskey Island	76	157	27	260
	Sub-Total	**755**	**1636**	**546**	**2937**
Lake	Fairport	270	449	92	811
	Mentor	277	448	52	777
	Sub-Total	**547**	**897**	**144**	**1588**
Lorain	Beaver Park	227	399	7	633
	Lorain	464	320	115	899
	Sub-Total	**691**	**719**	**122**	**1532**
	Total	**1993**	**3252**	**812**	**6057**

Table 21. Summary of boat lengths and estimated mast heights above water.

Percentile of boats counted	Power Boat Length (feet)	Sailboats		
		Length (feet)	# of boats > or =	Min. Mast Height (feet)
25%	23	26	586	41
50%	27	29	396	45
75%	31	33	191	48
90%	36	36	74	50
95%	39	38	47	54

97%	42	40	20	58
99%	48	45	8	65

3.4.3 Impact Assessment

A review of the available information from federal, state, universities, and site specific data collected as part of the project concludes that Icebreaker Wind poses minimal risk to the aquatic ecological resources of Lake Erie. This conclusion was based on the following major assessment outcomes:

Aquatic habitat alteration

- The chosen project site is far from ODNR identified fish spawning or larval nursery areas, reefs, or shoals that offer enhanced fish habitat. ODNR identifies the turbine area as very favorable for development based on aquatic habitat. Data collected in 2016 at the site verify this assessment.
- Dissolved oxygen (DO) data collected in 2016 show the proposed turbine sites were all within the Lake Erie Dead Zone and therefore offer poorer habitat for fish and macroinvertebrates.
- Fish trawl and acoustic sonar survey data from 2016 show the turbine area has significantly lower numbers of fish in the summer and early fall months compared with other months due to the presence of hypoxic waters.
- The area impacted by the 17 meter diameter turbine foundations is 0.05 acres per turbine and 0.3 acres total. Spacing between turbines is approximately 0.5 mi. Therefore the footprint of the foundations represents an insignificant loss of habitat.

Sediment disturbance

- Construction related sediment resuspension and enhanced turbidity near the turbines is mitigated by the chosen mono bucket foundation, which has minimal and only temporary impact on surrounding sediments during installation.
- In the case of the foundation, most of the sediment will settle on the bucket lid, which will be in the same vicinity it was prior to the installation. In the case of the cable it will settle back to its original location. In neither case will settling of the sediment result in an addition of material to the area of these activities, so it is not properly considered a discharge. Nor is there any purposeful relocation of the sediment. Its settlement back into the areas from which it originated is incidental to these activities.
- Degradation of habitat by sediment resuspension during electric cable installation is expected to only last several hours and have a limited spatial extend beyond the point of installation. This is based on a review of sediment transport results from a similar project in Lake Erie with similar sediment type and ambient lake velocity.

Noise

- Icebreaker Windpower has chosen a mono bucket foundation, which eliminates the need for pile driving and significantly reduces potential construction related noise at the site.
- Construction related impacts due to increased noise levels at the site are temporary and similar to noise levels experienced consistently in the region by up to 1,000 passing lake freighters going in and out of the Port of Cleveland on an annual basis. Low levels of noise emitted by the turbines during operation do not transmit any significant distance. In addition, there are often less receptors (fish) within the region due to the hypoxia mentioned earlier.

Fish movement/behavior

- As cited previously, Icebreaker Wind is sited in a location with poor fish habitat as identified by ODNR to minimize any existing fish behavior changes.
- The mono bucket foundations chosen for Icebreaker Wind minimize sediment disturbance during installation and cover a limited area as cited above.
- A review of electromagnetic field (EMF) impacts on fish found that expected EMF levels at the sediment surface for Icebreaker Wind are well below background levels and below all threshold impact levels from existing EMF studies. The project's electrical transmission cables will be buried below the sediment surface to minimize or eliminate any electromagnetic impacts on fish in the water column.
- In 2016 Icebreaker Windpower monitored the location of boats offshore of Cleveland to ensure the chosen project site was not a frequent fishing or boating destination. The study found that only 2% of the boats counted in all of the surveys were within three miles of the project site.

Physical lake conditions

- The project is utilizing a circular foundation base that minimizes potential impacts to currents and sediment scour. The circular shape of the foundation and monopole minimizes eddy formation and allows currents to easily travel past the turbines with minimal interruption and disturbance. Each turbine base has a foundation diameter of 17 meters and a combined footprint from all six turbines of 0.3 acres.
- Installation of the buried electric cables will follow a jet plow installation method, which represents the industry standard for minimal impact to the surrounding area during installation compared with open trench cable laying. As cited previously, suspended sediments are expected to follow a similar fate as those of the ITC Connector Lake Erie project, which were estimated to remain suspended for several hours and travel less than a few hundred meters.

4 Conclusion

The 2016 sampling program kicked off the first year of data collection to support the characterization of the aquatic and biological environment at the proposed site of the nation's first freshwater offshore wind farm near Cleveland, OH in Lake Erie. The first year of sampling did not reveal any unusual site conditions that differ significantly from pre-existing understanding of the aquatic and biological make-up of this portion of Lake Erie. Observed trends in lake currents, temperature, dissolved oxygen, nutrients, water clarity, water quality conditions, sediments, benthic macroinvertebrates, phytoplankton, zooplankton, and larval and juvenile fish were all within ranges observed by others for this area of Lake Erie. Seasonal patterns were evident in almost every physical and biological parameter measured during the 2016 field season. The data presented in this report do provide fine scale and exact specificity to the range of values observed at the project site in 2016. These data can serve to represent baseline conditions that existed at these sites prior to the initiation of any construction activities. Later comparisons can be made between the data collected in 2016 with data collected during and after installation of wind turbines.

2017 Sampling Recommendations

The current permitting/construction/sampling plan proposes that additional pre-construction sampling continue into 2017 to collect a second year of data prior to the proposed 2018 construction activities. At this time LimnoTech recommends that all of the current sampling methods continue into 2017. The scope and range of the 2016 field program captured the physical, chemical/nutrient, and biological components of the lake well. However, LimnoTech recommends a reduction in the frequency of monthly sampling for water quality, phytoplankton, zooplankton, and fixed and mobile acoustics. The 2016 sampling was conducted monthly in May, June, July, August, September, and October. Specifically, we recommend eliminating sampling for the previously mentioned parameters for the months of June and August. Data collected in these months add little value to the annual dataset and merely show the seasonal gradients between May and July and July and September. Continuous data will still be collected at the project site during every month.

5
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6 Appendices

Appendix A – Electronic Copy of Field Data

This appendix will be included on a thumb drive that will be delivered to ODNR and USFWS in March 2017. Additional copies can be obtained by emailing everhamme@limno.com directly.

Appendix B – Field Notes, Chain of Custodies, and Field Photos

This appendix will be transmitted to ODNR and USFWS separately in March 2017. Additional copies can be obtained by emailing everhamme@limno.com directly.

Appendix C – Noise Production Additional Figures

This appendix is included below.

Appendix D – Letter from ODNR to LimnoTech approving the sampling plan.

APPENDIX C

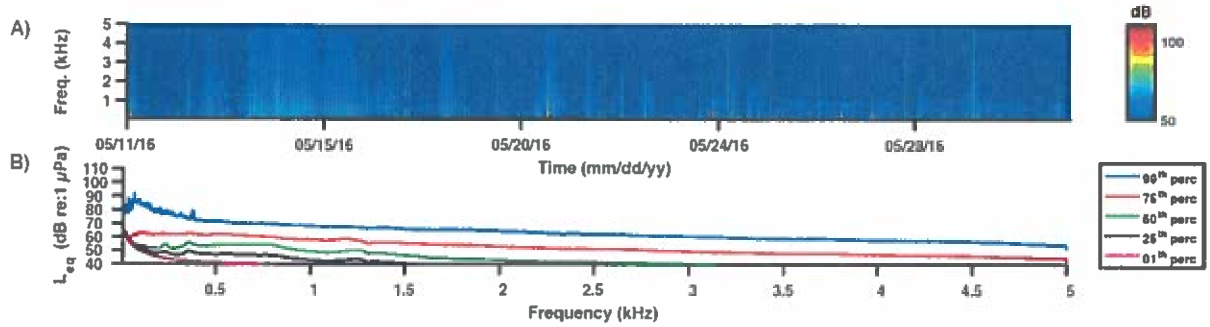

Figure 32: REF1 A) Long-term spectrogram and B) power spectrum from May 11-31, 2016.

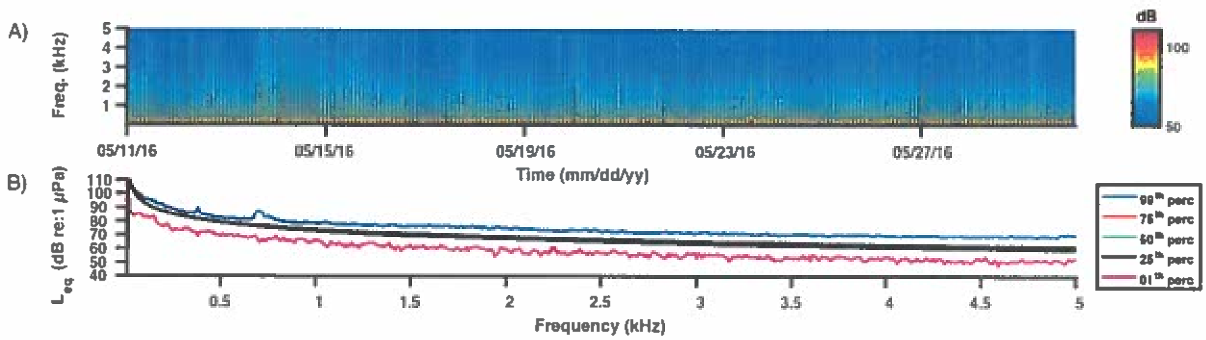

Figure 33: ICE4 A) Long-term spectrogram and B) power spectrum from May 11-31, 2016.

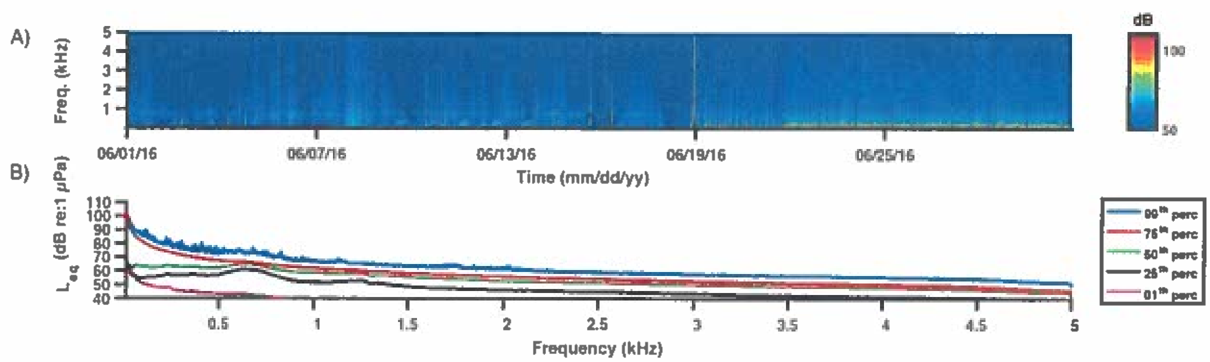

Figure 34: REF1 A) Long-term spectrogram and B) power spectrum from June 1-30, 2016. Spectrogram has 10 minute integration time.

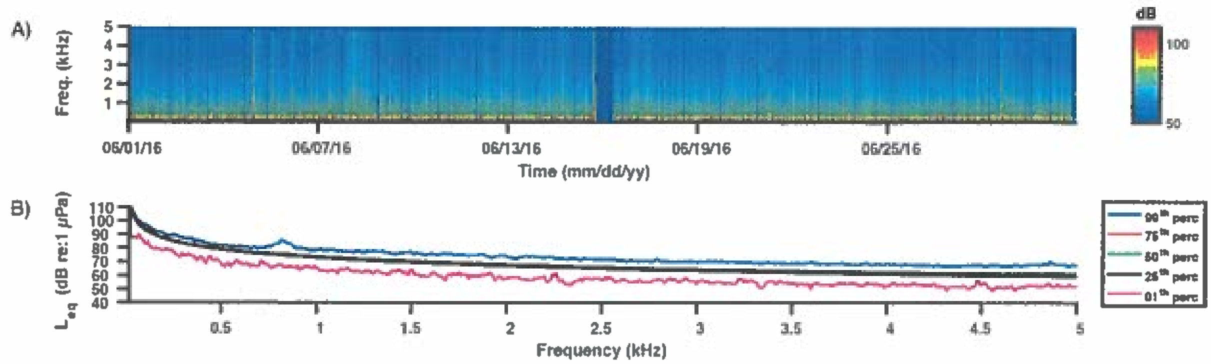

Figure 35: ICE4 A) Long-term spectrogram and B) power spectrum from June 1-30, 2016.

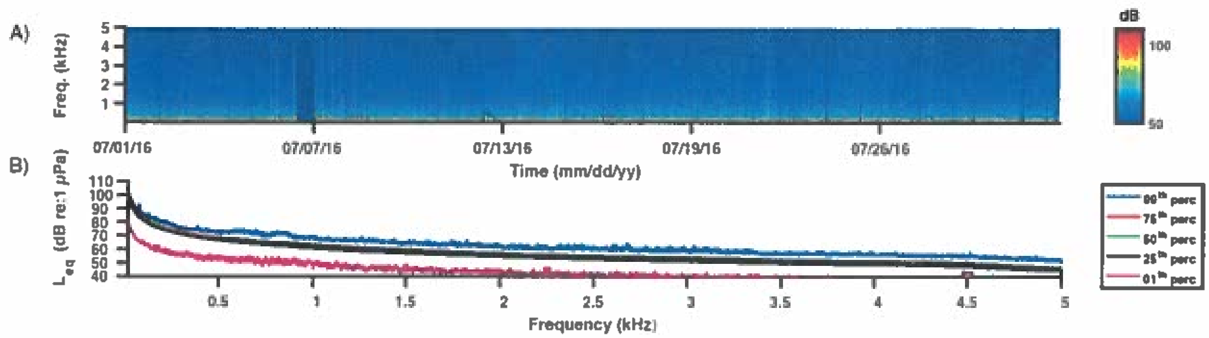

Figure 36: REF1 A) Long-term spectrogram and B) power spectrum from July 1-31, 2016.

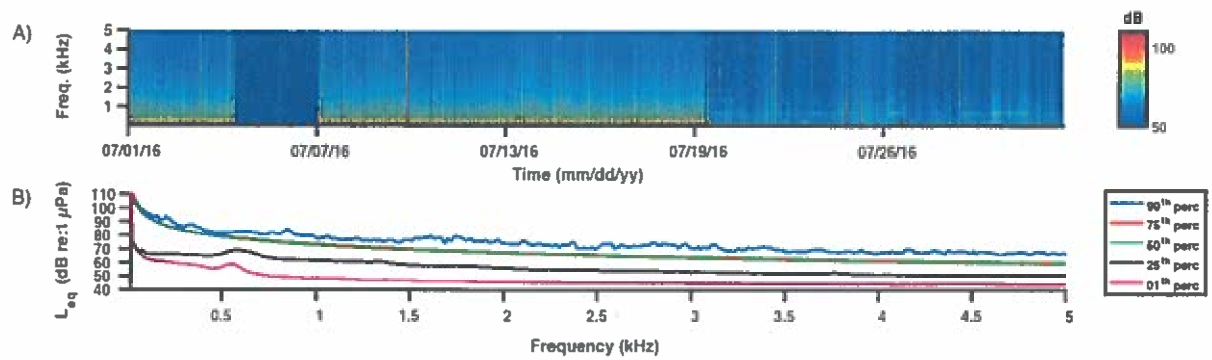

Figure 37: ICE4 A) Long-term spectrogram and B) power spectrum from July 1-31, 2016.

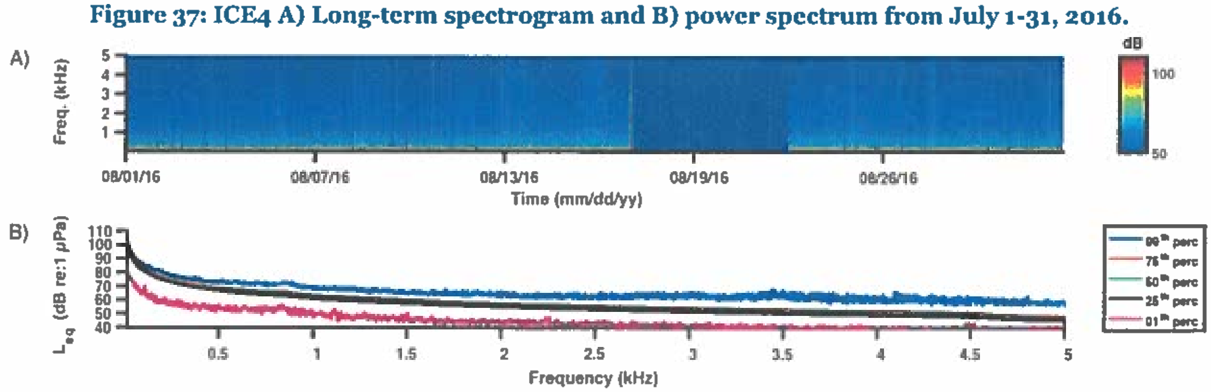

Figure 38: REF1 A) Long-term spectrogram and B) power spectrum from August 1-31, 2016.

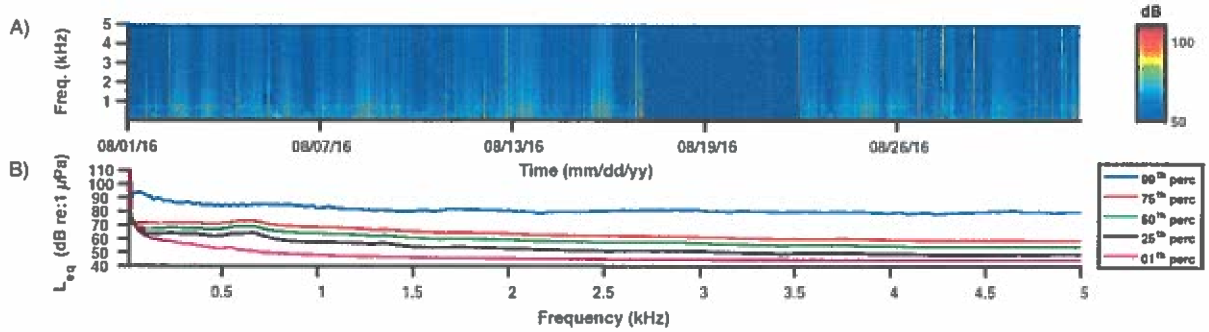

Figure 39: ICE4 A) Long-term spectrogram and B) power spectrum from August 1-31, 2016.

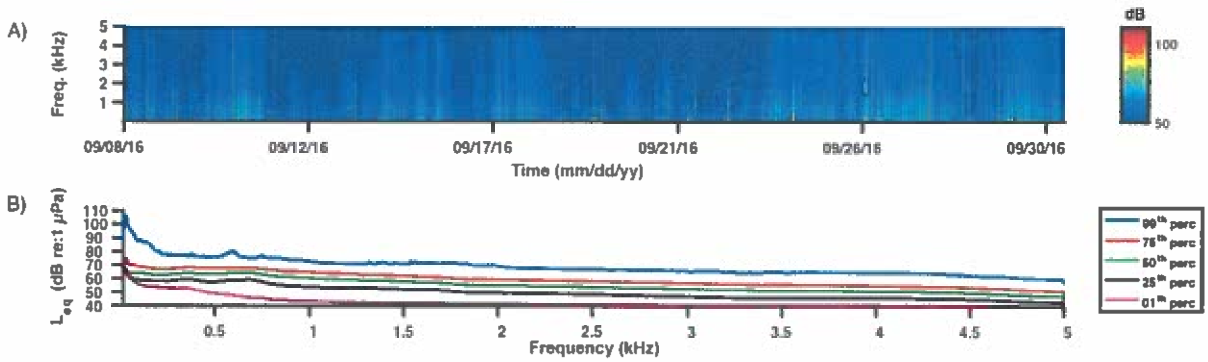

Figure 40: REF1 A) Long-term spectrogram and B) power spectrum from September 8-30, 2016.

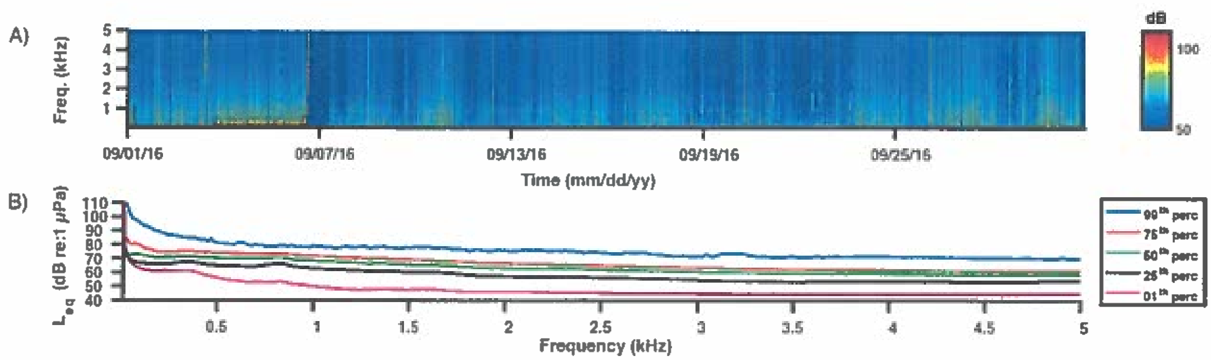

Figure 41: ICE4 A) Long-term spectrogram and B) power spectrum from September 1-30, 2016.

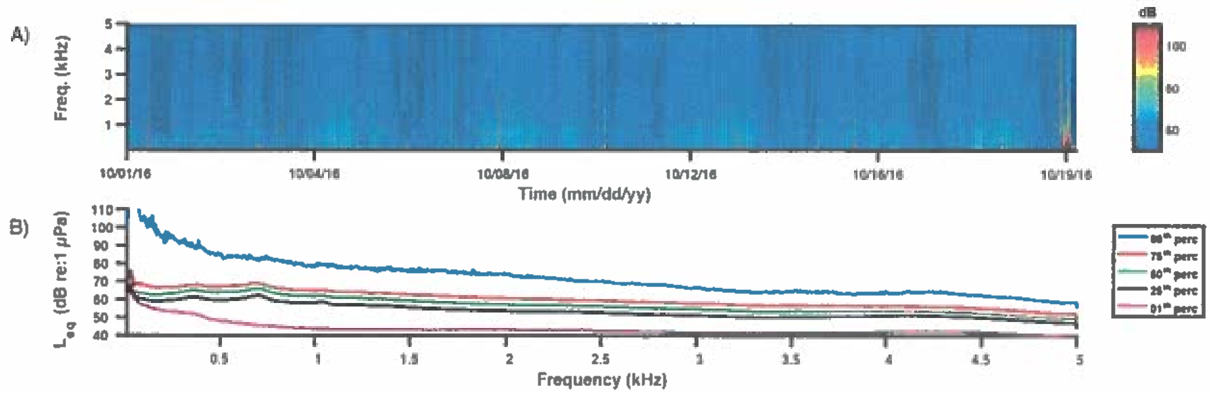

Figure 42: REF1 A) Long-term spectrogram and B) power spectrum from October 1-19, 2016.

APPENDIX D

Ohio Department of Natural Resources

JOHN R. KASICH, GOVERNOR JAMES ZEHRINGER, DIRECTOR

Ohio Division of Wildlife
Raymond W. Petering, Chief
2045 Morse Road, Bldg. G
Columbus, OH 43229-6693
Phone: (614) 265-6300

February 1, 2017

Mr. Edward Verhamme
Project Engineer
LimnoTech
501 Avis Drive
Ann Arbor, MI 48108

Re: <u>LimnoTech Lake Erie Monitoring Plan</u>

Dear Mr. Verhamme:

The purpose of this letter is to formally acknowledge that the January 25, 2017 version of the *LimnoTech Lake Erie Monitoring Plan for the Offshore Wind Project: Icebreaker Wind* received via email on January 25, 2017 meets the requirements of the Ohio Department of Natural Resources (ODNR) Division of Wildlife (Division) Fish Management & Research Group. All Division comments have been addressed in this version of the plan.

The Division will work to develop adaptive language in a forthcoming Memorandum of Understanding (MOU) between ODNR, the United States Fish & Wildlife Service (USFWS), LEEDCo, and LimnoTech that obligates LEEDCo and LimnoTech to fully implement the agreed-to monitoring plan. The MOU will include provisions for an annual performance review, a comprehensive analysis of data, and an option to adjust the monitoring plan based on changes in project design and/or results-driven knowledge gained from the monitoring work.

Please feel free to contact me by email at rich.carter@dnr.state.oh.us or phone at (614) 265-6345 if you have any questions.

Sincerely,

Rich Carter
Executive Administrator
Fish Management and Research
ODNR-Division of Wildlife

cc: Robert Boyles, Deputy Director – ODNR
Raymond Petering, Chief, Division of Wildlife – ODNR
Scott Hale, Assistant Chief, Division of Wildlife - ODNR
Dr. Scudder Mackey, Chief, Office of Coastal Management – ODNR
Dave Kohler, Wildlife Administrator, Division of Wildlife - ODNR
Travis Hartman, Division of Wildlife - ODNR
Dr. Janice Kerns, Division of Wildlife - ODNR
Megan Seymour, Wildlife Biologist - USFWS

Office of the Director • 2045 Morse Rd • Columbus, OH 43229-6693 • ohiodnr.gov

Attachment 4

February 28, 2017
United States Fish and Wildlife Letter

LeedCo Icebreaker Pre-construction and Post-construction Monitoring Survey Protocol

U.S. Fish and Wildlife Service and Ohio Department of Natural Resources Division of Wildlife

Comments

Feb. 28, 2017

The below comments represent U.S. Fish and Wildlife Service and Ohio Department of Natural Resources Division of Wildlife recommendations relative to the matrix of pre- and post-construction monitoring options provided by LeedCo via e-mail on January 5, 2017.

1. Bat acoustic monitoring
    a. Pre-construction
        i. On 10 mile large buoy—high (~50 m or as high as possible) and low (~water level) detectors. If the "high" and "low" detectors are separated by at least 40 m, add a "middle" (~30 m) detector too.
        ii. On 3 and 7 mile buoys—low detector
        iii. On Cleveland crib—high (~50 m) and low (close to water surface) detectors
        iv. Per ODNR protocol, use AnaBat detectors (either SD1 or those equipped with CF ZCAIMS), with sensitivity adjusted to detect a calibration tone3 at 20 meters.
        v. March 15-November 15, half hour before sunset until half hour after sunrise; all monitors running concurrently for the entire season.
    b. Post-construction
        i. On 3 turbines (at least one on an end)—high (nacelle), medium (~ 30 m), and low (~10 m)detectors
        ii. On crib—high, low detectors
        iii. On 10 mile buoy –high and low detectors
    c. Rationale
        i. Provides bat species composition at various altitudes, index of bat activity overall and at various heights, seasonal patterns of movements. Allows comparison between site-specific data and crib data, assuming that site-specific data may not be as high as can be obtained from crib.
    d. Successful performance criteria
        i. 80% of nights per detector recorded during active period (March 15-Nov 15)
2. Waterfowl aerial surveys—with observer
    a. Pre-construction, *see attached protocol*
        i. Focus on waterfowl (esp. red-breasted mergansers that are easily spooked), bald eagles, ice relative to location of birds
        ii. Survey transects should run parallel to the turbine string.
        iii. Dates: mid-October - end of May
        iv. Frequency: Every 2 weeks

v. Transect spacing: Transects should be close enough to the turbines to observe birds between the turbines, but need to be a safe distance from the blades.
vi. Flight heights: 76-100 m in order to detect small waterbirds.
vii. Flight speeds: 150-200 km/h (unless constrained by local flying restrictions)
viii. Weather conditions: 4 or below on the Beaufort scale, winds approximately 37 km/h or less. Minimum of 3.2 km of visibility (or pilot's discretion).
ix. GPS location for each bird or flock should be recorded.

b. Post-construction
  i. Similar transect protocol as pre-construction
  ii. Year 1 after construction, year 4 after construction

c. Rationale
  i. Species numbers, distribution, use of project area seasonal patterns; eagles; ice; avoidance/attraction/displacement

d. Successful performance criteria
  i. Bi-weekly surveys during designated timeframe in appropriate weather conditions.

3. Radar
  a. Boat based radar is not technologically there yet, nor cost advantageous, and it focuses on waterfowl, but we have other methods outlined to address waterfowl. NEXRAD data is not useful for assessing bird/bat behavior within rotor swept zone, which is the data we need. Thus we suggest these approaches should not be considered further.
  b. Pre-construction
    i. We strongly recommend S-band radar, *see attached protocol.*
    ii. Preferred is radar data from project area—FWS and ODNR have been requesting this information since 2008. We still advocate for a single radar, on its own platform, within project area for spring and fall season of pre-construction monitoring as the preferred option.
    iii. Our second choice is to install one or all turbine bases prior to fall (2017), put a radar on one of the turbine bases for fall 2017-spring 2018, then install turbines after spring 2018.
    iv. Our third choice is to install one or all turbine bases prior to fall. Once the first turbine base is installed at the furthest point from shore, place radar unit on it and begin collecting data on fall migration as other bases are being installed. Install towers, with radar on platform collecting data until last tower is erected. (Assumes data collected for 6-8 weeks over fall migration period, which is key focus). Additionally, install radar on Cleveland crib with elevated antenna for spring and fall.
      1. Limitations of this approach: We are only getting fall data (we believe that fall is the most important season due to high bat mortality in fall migration), no information on spring risk. We would use the comparison between crib data and onsite data in fall to extrapolate what may be occurring onsite in spring. This is not ideal, but we think it is workable.

Construction activities may cause "clutter" on the radar map and may alter bird activity within the project area.

v. Site specific radar data is critical to our analysis. If none of the above options can be implemented, we will work with the applicant to evaluate other methods of obtaining site specific radar data.

c. Post-construction

i. Preferred is single radar, on its own platform, within project area, in years 1, 3, and 5, from spring-fall.

ii. Our second choice is 2 radars mounted on turbine platforms, in years 1, 3, and 5, from spring-fall.

d. Rationale

i. Site specific data on night migration of birds and bats. Altitude data of bird and bat targets within rotor swept zone, counts of targets, peak dates of migration, seasonal patterns. Avoidance/attraction/displacement.

ii. Because this is a pilot project the intent is to study and understand the impact of the project on various resources. Without project-specific radar information we cannot get key information needed to understand that impact.

e. Successful performance criteria

i. Site-specific data; radars operating and collecting data over at least 80% of nights during spring/fall migration period.

4. Carcass monitoring

a. Pre-construction—proof of concept development

i. Bat nets—We believe this concept could have merit, but we would like to see a more fleshed-out conceptual proposal first. Please draft a detailed proposal and plans, and a land-based test concept and submit to FWS and ODNR for review. Be sure to consider carcass distribution of bats relative to distance from turbine. Net should be designed to collect at least 30% of bat carcasses and carcasses should be recoverable from the nets.

ii. "Thunk" detection—We believe this concept could have merit. We request follow-up with the technology developer to ensure the technology could be ready to deploy within the project timeframe (testing in year 1, deployment in 2018-2019, etc.). Please draft a detailed proposal and plans, and a land-based test concept and submit to FWS and ODNR for review.

iii. Identiflight—The original application for this technology (detecting golden eagles during daylight and shutting down turbines) is very different that the application needed for this project (detecting small nocturnal animals striking turbines). We think that the other options are more applicable and closer to being ready than this option. We suggest not using this option at this time.

b. Post-construction

i. Bat nets— If proof-of-concept test works, then install on 3 turbines during years 1, 3, and 5, and through the lifespan of the technology.

ii. "Thunk detection"—If proof-of-concept test works, then install on 3 turbines during years 1, 3, and 5, and beyond, through the lifespan of the technology.
iii. Live observers—do not recommend this for carcass monitoring, as most mortality is expected to occur at night and could not be observed. Do not recommend this for waterfowl displacement study because aerial flights and radar would be better to address displacement.

c. Rationale—to detect collisions of birds/bats, identify carcasses at least to guild
d. Successful performance criteria—ability to detect bird/bat collisions. Generate a reasonable estimate of collisions/MW/year. Set up an adaptive management program to address potential performance issues with new technology.

Attachment 5

March 6, 2017
Icebreaker Windpower Response to
United States Fish and Wildlife February 28, 2017 Letter

Icebreaker Wind Pre- and Post-Construction Monitoring Survey Protocol
Response to USFWS and ODNR Comments Dated February 28, 2017

March 6, 2017

On February 28, 2017 the U.S. Fish and Wildlife Service (USFWS) and Ohio Department of Natural Resources (ODNR) Division of Wildlife provided LEEDCo their recommendations regarding proposed pre- and post-construction bird and bat monitoring. The USFWS and ODNR recommendations were provided in response to an options matrix provided by LEEDCo to the agencies on January 5, 2017, and discussed at a meeting in Columbus and teleconference on January 6th. The following document summarizes LEEDCo's responses to the agencies' February 28 recommendations.

As a preliminary matter, we do believe that we are getting close to resolving the pre-construction baseline survey issues and look forward to continued discussions this week to finalize a plan. We also are getting closer to an agreement on the post-construction monitoring plan, and believe that those discussions can continue over the next couple of weeks to months.

1.Bat Acoustic Monitoring.

LEEDCo agrees with the agency recommendations to conduct acoustic monitoring for bats at both the proposed project site and the City of Cleveland's Water Intake Crib. Given the need to undertake pre-construction bat acoustic monitoring by March 15th, LEEDCo provided a response to the agencies by email dated March 2nd. LEEDCo stated that its pre-construction bat acoustic monitoring plan would include:

A. Placement of 4 units (type TBD, see D below) with 5 microphones at the following locations and heights:

1. 2 units (SM3, SM4 or Anabat) will be placed on a buoy at the project site. The maximum height that the units can be placed on the buoy is 10 feet off the water. Therefore, we suggest that the units be located between water level and 10 feet, instead of at the 50 meter height recommended by the agencies (see C below);

2. 1 unit (SM3, SM4 or Anabat) with 2 microphones on the Crib. One microphone will be placed on the center mast at a height of approximately 50 meters, the other will be placed on the Crib railing. We are retaining Aaron Goodwin to place the 50 m microphone on the mast, and are working with the City Water Department to secure permission;

3. 1 unit (SM3, SM4 or Anabat) on a buoy near the Crib. It will be located between water level and 10 feet.

(The mile 10 buoy suggested by the agencies is too small to support a recording device and does not have enough power to support its deployment)

B. Deployment of all of these units on March 13th, weather permitting. If the weather does not permit, LEEDCo will deploy the equipment as soon after 3/13 as possible.

C. In the event that, during discussions regarding pre-construction radar, LEEDCo and the agencies mutually agree to deploy a large 4 point anchor barge for the radar unit, the project site acoustic monitors could probably be moved to the barge. It is believed with a reasonable level of confidence the bat acoustic monitor can be placed higher than it will be on the buoy under this scenario.

D. LEEDCO's wildlife consultant (WEST) has discussed use of SM3 or SM4 units instead of the Anabat detectors with the USFWS. Both agencies have confirmed their acceptance of SM3 units, and LEEDCo is now waiting for approval to use the smaller and lighter SM4 units, at least on the buoy locations. Either could be used on the Crib. In any event, LEEDCo will use whatever monitoring technology is agreed upon.

With regard to post-construction monitors LEEDCo agrees with the agency recommendations to deploy multiple units on the installed turbines and on the Crib. LEEDCo's proposed deployment would be as follows:

A. Acoustic monitors can be placed on 3 turbines (at least one on an end) at the nacelle level and on the turbine platform or railing (approximately 12 m). It is not possible to place them on the tower itself at the medium (30 m) height as recommended by the agencies.

B. Monitors can be placed on the Crib at the high and low positions, as recommended by the agencies.

C. Monitors cannot be placed on the 10 mile buoy as recommended by the agencies (see above)

LEEDCo requests clarification on the number of years the agencies are asking for post-construction bat acoustic monitoring.

LEEDCo will strive to achieve the agencies' operational goal of 80% of nights per detector recorded during the active period goal. However, this rate cannot be guaranteed given the potential effect of weather and lake conditions.

2.Waterfowl aerial surveys – with observer

LEEDCo will implement waterfowl aerial surveys as recommended by the agencies.

3. Radar

With regard to pre-construction radar, LEEDCo agrees to deploy a radar unit at the project site, as recommended by the agencies. However, the agencies preferred means of deployment cannot be accommodated, as discussed below:

A. The agencies preferred approach is for a single radar, on its own platform, within the project area for the spring and fall migration seasons. One option to accomplish this would be to use a jack-up barge. However, the option of deploying the radar on a jack-up barge at the project site is not a viable option based on cost. Deployment of a radar unit on a jack-up barge for a spring and fall migration season is over a $3 million effort. This level of effort cannot be supported by the project.

B. The agencies' second choice is to install one or all turbine bases prior to fall, put a radar on one of the bases for fall and spring, and then install turbines after spring. This "double mobilization" option is also not viable from either an economic or logistic perspective. This "double deployment" option would be an approximate $6 million dollar effort, which level of effort cannot be supported by this project. In addition, the foundations will not be manufactured until the project has received all of its permits and approvals.

C. The agencies' third option of installing one or all turbine bases prior to fall and using the first base for the radar unit (the single deployment method) has been explored and discussed with Fred. Olsen Renewables, the company that will be constructing the project, and LEEDCo has determined that it is also not a viable option. There are several practical concerns with this option: 1) company safety regulations will not permit non-construction personnel to work on turbine platforms during construction; 2) the radar deployment and operations cannot interfere with the project construction schedule; 3) there is no guarantee that the turbine will be free for use by a radar unit for 6-8 weeks; and, perhaps most important, 4) it is *very unlikely* that the platform will be available during the spring or fall migration periods, as we are aiming for construction during the June-August timeframe.

D. This leaves us with the fourth option: work with the agencies to evaluate other methods of obtaining site specific radar data. LEEDCo continues to believe that it can gather the radar data sought by installing an S or X band radar unit on a large (over 100 foot) 4 point anchor barge at the project site. Discussions with companies in Germany, Denmark and the U.S. have led LEEDCo and WEST to believe that this is the only viable option to achieve the agencies' goals of gathering on-site pre-construction radar data, including targets within and immediately above and below the rotor swept zone, altitudinal distribution, passage rates, peak dates of migration, and seasonable patterns.

   Collecting radar from large vessels prior to construction is standard practice in Europe, where there is extensive offshore wind construction and operation (over 80 offshore wind farms). Many projects have used vessel-based radar. This practice has been written into the regulations as an alternative where stable platforms are not available. Moreover, much of this radar work is done in the North Sea, where wave heights are much greater than those in Lake Erie.

   Extensive discussions with consultants in the US, Denmark and Germany have given us a high level of confidence that we can collect the information sought by the agencies from a large barge secured with a 4 point anchor system at the project site.

The only other option is to deploy a radar unit on the Crib. However, this would not provide the site specific data that the agencies seem to believe is the highest priority.

With regard to post-construction radar monitoring, the agencies prefer a single radar on its own platform. This option is not economically viable, as it would be very costly to construct a turbine platform simply to house a radar unit.

The agencies' second choice is to install 2 radars mounted on the turbine platforms. LEEDCo needs to understand the need for 2 radar units, 1 on each of 2 of the turbine platforms.

The agencies also recommend post-construction radar in years 1, 3 and 5 from spring to fall. LEEDCo needs to better understand the need for 3 years of post-construction radar monitoring. LEEDCo suggests that, at a minimum, the need for year 5 radar data be made conditional based on the results from analyses done in years 1 and 3.

4.Carcass Monitoring

A. Bat nets. In order to collect at least 30% of the bat carcasses, as recommended by the agencies, WEST's statistician estimates that the nets would need to have a radius of at least 20 meters. Assuming this is the approximate radius needed, LEEDCo is willing to explore this option; however, before we can commit to it we must verify that the turbine manufacturer would allow attachment of a net of that size to the turbine. LEEDCo also needs to ascertain whether any of the owners of existing land-based wind turbines in the area would allow LEEDCo to attach a net to a turbine to test the concept, as requested by the agencies.

B. "Thunk." LEEDCo agrees with the agencies that automated collision monitors within the turbines ("Thunk") is a promising new technology. However, LEEDCo does not believe that it makes sense for a small demonstration project to bear the approximate $500,000 cost of the further testing needed for this technology. If other public or private funding sources become available to support the needed testing, and the technology is proven prior to construction of Icebreaker, LEEDCo will consider installing Thunk on 3 of its turbines.

C. Identiflight. As recommended by the agencies, LEEDCo will not pursue this option.

D. MUSE. LEEDCo recently learned that the Block Island Wind Farm will be testing a new combined radar/camera system this month, referred to as "MUSE." The system is designed to detect collisions, but LEEDCo has been told that the radar component of the system could also be used to collect the radar data sought by the agencies. LEEDCo will know more about the capabilities of MUSE in the coming months. If this technology does prove viable, then it could combine the benefits of post-construction radar, bat nets, Thunk, and Identiflight, and possibly replace some or all of these options.

E. Live observers. While the agencies are not recommending live observers for carcass monitoring, LEEDCo is leaning toward the use of some live observers as part of the post-construction monitoring effort. Observers would be used during the day from April 15 to November 15, primarily to document exposure of waterbirds and any actual evidence of avoidance/attraction. LEEDCo agrees with the agencies that live observers cannot be used for monitoring collisions of night migrants.

Attachment 6

March 10, 2017
Sediment Evaluation

TECHNICAL MEMORANDUM

LEEDCo Sediment Evaluation, Icebreaker Demonstration Wind Project, Lake Erie near Cleveland, Ohio

PREPARED FOR: Lake Erie Energy Development Corporation

PREPARED BY: CH2M HILL, Inc.

DATE: March 10, 2017

This technical memorandum summarizes the screening evaluation performed on sediment analytical data collected as part of the environmental baseline study for the Icebreaker Demonstration Wind Project proposed by Lake Erie Energy Development Corporation (LEEDCo). This evaluation was conducted to determine sediment quality within the project area, which is in Lake Erie near Cleveland, Ohio.

Project Background

The Icebreaker Demonstration Wind Project proposed by LEEDCo is the first offshore wind demonstration project within freshwater of the Great Lakes. The project location is 8 to 10 miles offshore from Cleveland, Ohio and will include six 3.45-megawatt wind turbine generators spaced approximately 756 meters apart.

A baseline environmental study was performed for this project and included collecting sediment samples within the project area to determine sediment quality. TDI Brooks International (TDI) conducted the field sampling from September 12 through October 10, 2016. The sampling report is included as Attachment 1. TDI collected three piston core composites and one box core composite for a total of four samples for analysis of grain size, total organic carbon, trace metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and organochlorine pesticides.

Sediment Quality Evaluation Approach

The sediment analytical results were evaluated to determine the existing sediment quality within the project area. The evaluation followed the Tier I screening outlined in *Guidance on Evaluating Sediment Contaminant Results* (Ohio Environmental Protection Agency 2010). The screening evaluation included comparisons to threshold effects concentrations (TECs) and probable effects concentrations (PECs) (MacDonald et al. 2000). Threshold effect levels such as TECs are conservative screening values that represent a level below which there would be a high confidence of no adverse effects, but above which unacceptable risk is uncertain. Constituent concentrations that exceeded TECs were then compared to PECs. The PECs represent a level above which there is a reasonable likelihood of adverse effects.

Subsequently, samples also were evaluated on a sample-by-sample basis to look at combined effects of chemical mixtures. Ingersoll et al. (2001) evaluated the ability of consensus-based sediment quality guidelines and compared approaches for evaluating the combined effects of chemical mixtures on the toxicity of field-collected sediment. Ingersoll et al. (2001) showed that because field-collected sediment contains chemical mixtures, the predictability of sediment assessments increases when sediment quality guidelines, such as PECs, are used in combination to classify toxicity.

Using this approach for each detected constituent, a probable effect concentration quotient (PEC-Q) was developed by dividing the concentration of each constituent by the PEC. A mean quotient was then calculated for each sample by summing the individual quotient for each constituent and dividing this sum by the number of PECs evaluated. Ingersoll et al. (2001) demonstrated that the incidence of toxicity increases with increasing mean PEC-Qs. For example, in the *Hyallela azteca* (amphipod) 28- to 40-day tests, the incidence of toxicity was 10 percent for samples with mean PEC-Qs less than 0.1; 31 percent for samples with mean PEC-Qs between 0.1 and 1; 96 percent for samples with mean PEC-Qs between 1 and 5; and 100 percent for samples with mean PEC-Qs greater than 5.

Similar increase in incidence of toxicity was encountered in *Chironomus dilutus* (midge) 10- to 14-day toxicity tests, where the incidence in toxicity was 20 percent for samples with mean PEC-Qs less than 0.1; 21 percent for mean PEC-Qs between 0.1 and 1; 43 percent for samples with mean PEC-Qs between 1 and 5; and 68 percent for samples with mean PEC-Qs greater than 5 (Ingersoll et al. 2001). Based on these results, the incidence of toxicity can be classified as minimal for PEC-Qs less than 0.1, low to moderate for mean PEC-Qs between 0.1 and 1, moderate to high for mean PEC-Qs between 1 and 5, and high for mean PEC-Qs greater than 5.

Sediment Quality Evaluation Results

TEC and PEC Screening Results

Tables 1, 2, and 3 summarize the screening evaluation for metals, PAHs, PCBs, and organochlorine pesticides. For metals, the TEC was exceeded in one or more samples for all metals with nickel exceeding the respective screening value in all four samples. Nickel was the only metal detected above the respective PEC screening value (Table 1).

PAHs were evaluated individually and based on a total PAH concentration (calculated using the high-priority 16 PAHs). The TEC for total PAHs was exceeded in three of the four composite samples; however, the PEC was not exceeded in any composite samples (Table 2).

Total PCBs were detected in two of the four composite samples above the TEC but did not exceed the PEC for any sample (Table 3).

Total dichlorodiphenyl trichloroethane (DDT) and sum dichlorodiphenyl dichloroethylene (DDE) (the summation of 2,4'-DDE and 4,4'-DDE) exceeded their respective TEC in one sample each; however, no constituent exceeded the respective PEC.

Mean PEC-Quotient Evaluation

Table 4 presents the mean PEC-Q results. The results indicate that no stations pose a moderate to high or high incidence of toxicity to aquatic organisms. Three stations had mean PEC-Qs between 0.1 and 1 (indication low to moderate incidence of toxicity), and one station had mean PEC-Q less than 0.1, indicating minimal incidence of toxicity. Overall, the incidence of toxicity for sediments within the project area would be considered low.

Summary

The sediment quality evaluation was performed on four composite samples collected from the proposed LEEDCo project area within Lake Erie. Only nickel exceeded its respective PEC in one composite sample. Overall, there is low potential for toxicity in the project area, based on the low frequency of PEC exceedance and the mean PEC-Q evaluation results. As a result, aquatic receptors will not likely be impacted by disturbed sediment during the construction activities within the project area.

References

Ingersoll, C.G., D.D. MacDonald, N. Wang, J.L. Crane, L.J. Field, P.S. Haverland, N.E. Kemble, R.A. Lindskoog, C.G. Severn, D.E. Smorong. 2001. Predictions of sediment toxicity using consensus-based freshwater sediment quality guidelines. *Arch Environ Contam Toxicol* 41:8-21.

MacDonald. D.D., C.G. Ingersoll, and T. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Arch Environ Contam Toxicol* 39:20-31.

Tables

Table 1. Comparison of Sediment Metals Results to Freshwater Sediment Quality Guidelines

LEEDCo Sediment Evaluation, Icebreaker Demonstration Wind Project, Lake Erie near Cleveland, Ohio

Laboratory ID Laboratory ID Sample ID(s) Sample Extraction Date	LED0043 XX-3122 PC01R, PC02, PC03 10/12/16	LED0044 XX-3123 PC04, PC05R1, PC06R2, PC07 10/12/16	LED0045 XX-3124 PC09, PC10 10/12/16	LED0046 XX-3125 BC01, BC02, BC03 10/12/16	Consensus Based TEC* (mg/kg DW)	Consensus Based PEC* (mg/kg DW)
Metals (mg/kg DW)						
Arsenic	**13.1**	**13.9**	**14.6**	8.21	9.79	33
Cadmium	0.17	0.24	0.51	**1.94**	0.99	4.98
Chromium	18.6	19	26.1	**53.1**	43.4	111
Copper	22.6	26.8	**42.4**	**47.7**	31.6	149
Lead	11.8	16	24	**44.9**	35.8	128
Mercury	0.0138	0.0173	0.0354	**0.335**	0.18	1.06
Nickel	**30.3**	**30.2**	**34.1**	**51.4**	22.7	48.6
Zinc	72.7	111	116	**204**	121	459

Notes:

* MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems. *Arch. Environ. Contam. Toxicol.* 39, 20-31.

Bolded values > TEC

Bolded and shaded values > PEC

TEC = threshold effects concentration

PEC = probable effects concentration

mg/kg DW = milligrams per kilogram, dry weight

Table 2. Comparison of Sediment PAH and PCB Results to Freshwater Sediment Quality Guidelines

LEEDCo Sediment Evaluation, Icebreaker Demonstration Wind Project, Lake Erie near Cleveland, Ohio

Laboratory ID Sample ID(s)	LED0037,D PC01R, PC02, PC03	LED0038 PC04, PC05R1, PC06R2, PC07	LED0039 PC09, PC10	LED0046 BC01, BC02, BC03	Consensus Based TEC* (µg/kg DW)	Consensus Based PEC* (µg/kg DW)
Polycyclic aromatic hydrocarbons (µg/kg DW)						
Sample Extraction Date	**11/7/16**	**11/7/16**	**11/7/16**	**11/7/16**		
Acenaphthylene[1]	1.22	**237**	**55.8**	**32.4**	5.87	NSV
Acenapthene[1]	2.03	**66.5**	**37.9**	**8.7**	6.71	NSV
Anthracene	0.546	**435**	**140**	49.4	57.2	845
Benz[a]anthracene	1.65	**1860**	**242**	**135**	108	1,050
Benzo[a]pyrene	2.64	**1807**	**187**	**154**	150	1,450
Benzo[b]fluoranthene[2]	10.3	**1264**	**254**	**214**	27.2	NSV
Benzo[k]fluoranthene[1]	0.9	**767**	150	177	240	NSV
Benzo[ghi]perylene[1]	10.5	**932**	108	128	170	NSV
Chrysene	63.9	**2243**	**333**	**208**	166	1,290
Dibenz[a,h]anthracene	1.16	**376**	**35.8**	**37.1**	33	140
Fluoranthene	6.94	**1838**	**514**	279	423	2,230
Fluorene	13	71.3	61.5	26.5	77.4	536
Indeno[1,2,3-cd]pyrene[1]	0.981	**629**	100	122	200	NSV
Naphthalene	4.47	84.9	66.8	50.2	176	561
Phenanthrene	82.4	**500**	**359**	122	204	1,170
Pyrene	8.51	**2,198**	**411**	**228**	195	1,520
Total PAHs[3]	211	**15,309**	**3056**	**1971**	1,610	22,800
Polychlorinated biphenyls (µg/kg DW)						
Sample Extraction Date	**11/9/16**	**11/9/16**	**11/9/16**	**11/9/16**		
Total PCBs	0.98 J	15.9	**401.17**	**77.05**	59.8	676

Notes:

* MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems.*Arch. Environ. Contam. Toxicol.* 39, 20-31.

Bolded values > TEC

Bolded and shaded values > PEC

[1] TEC Value selected from: U.S. EPA 2003. USEPA Region V Ecological Screeing Levels. August.

[2] TEC value selected from: U.S. Environmental Protection Agency. 2006. Region 3 BTAG Freshwater Sediment Screening Benchmarks.
http://www.epa.gov/reg3hwmd/risk/eco/index.htm. August.

[3] Total PAHs calculated uising the 16 PAHs

NSV = no screeing value

µg/kg DW = micrograms per kilogram, dry weight

Table 3. Comparison of Sediment Organochlorine Pesticide Results to Freshwater Sediment Quality Guidelines

LEEDCo Sediment Evaluation, Icebreaker Demonstration Wind Project, Lake Erie near Cleveland, Ohio

Laboratory ID Sample ID(s) Sample Extraction Date	LED0037 PC01R, PC02, PC03 11/9/16	LED0038 PC04, PC05R1, PC06R2, PC07 11/9/16	LED0039 PC09, PC10 11/9/16	LED0046 BC01, BC02, BC03 11/9/16	Consensus Based TEC* (µg/kg DW)	Consensus Based PEC* (µg/kg DW)
Organochlorine pesticides (µg/kg DW)						
Alpha- Chlordane [1]	0.02 J	0.32	<0.05 U	0.38	3.24	17.6
Dieldrin	<0.05 U	<0.05 U	<0.05 U	0.18	1.90	61.8
Sum DDD [2]	0.23	0.455	<0.05 U	0.635	4.88	28
Sum DDE [3]	0.035	0.21	2.13	3.92	3.16	31.3
Sum DDT [4]	0.12	0.05	0.05	0.12	4.16	62.9
Total DDTs [5]	0.385	0.715	2.23	4.67	5.28	572
Endrin	<0.06 U	<0.06 U	<0.06 U	<0.06 U	2.22	207
Heptachlor epoxide	<0.06 U	<0.06 U	<0.06 U	0.11	2.47	16
Gamma-HCH [6]	0.20	<0.04 U	<0.04 U	0.85	2.37	4.99

Notes:

* MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems *Arch. Environ. Contam. Toxicol.* 39, 20-31.

Bolded values > TEC

[1] Compared to screening guideline for chlordane

[2] Sum of 2,4'-DDD and 4,4'-DDD compared to Sum DDD screening value

[3] Sum of 2,4'-DDE and 4,4'-DDE compared to Sum DDE screening value

[4] Sum of 2,4'-DDT and 4,4'-DDT compared to Sum DDT screening value

[5] Sum of DDD, DDE, and DDT isomers compared to Total DDT screening value

[6] Compared to screening guideline for gamma-BHC (lindane)

µg/kg DW = micrograms per kilogram, dry weight

Table 4. Mean PEC-Q Evaluation

LEEDCo Sediment Evaluation, Icebreaker Demonstration Wind Project, Lake Erie near Cleveland, Ohio

Laboratory ID	LED0043		LED0044		LED0045		LED0046		Consensus
Laboratory ID	XX-3122		XX-3123		XX-3124		XX-3125		Based PEC*
Sample ID(s)	PC01R, PC02, PC03	PEC-Q	PC04, PC05R1, PC06R2, PC07	PEC-Q	PC09, PC10	PEC-Q	BC01, BC02, BC03	PEC-Q	(µg/kg DW)
Metals (mg/kg DW)									
Arsenic	13.1	0.397	13.9	0.42	14.6	0.442	8.21	0.249	33
Cadmium	0.17	0.034	0.24	0.05	0.51	0.102	1.94	0.390	4.98
Chromium	18.6	0.168	19	0.17	26.1	0.235	53.1	0.478	111
Copper	22.6	0.152	26.8	0.18	42.4	0.285	47.7	0.320	149
Lead	11.8	0.092	16	0.13	24	0.188	44.9	0.351	128
Mercury	0.0138	0.013	0.0173	0.02	0.0354	0.033	0.335	0.316	1.06
Nickel	30.3	0.623	30.2	0.62	34.1	0.702	51.4	1.058	48.6
Zinc	72.7	0.158	111	0.24	116	0.253	204	0.444	459
Polycyclic aromatic hydrocarbons (µg/kg DW)									
Total PAHs	211	0.009	15,309	0.67	3,056	0.134	1,971	0.086	22,800
Polychlorinated biphenyls (µg/kg DW)									
Total PCBs	0.98 J	0.001	15.9	0.02	401.17	0.593	77.05	0.114	676
Organochlorine pesticides (µg/kg DW)									
Alpha- Chlordane	0.02 J	0.001	0.32	0.02	<0.05 U	0.003	0.38	0.022	17.6
Dieldrin	<0.05 U	0.001	<0.05 U	0.00	<0.05 U	0.001	0.18	0.003	61.8
Sum DDD	0.23	0.008	0.455	0.02	<0.05 U	0.002	0.635	0.023	28
Sum DDE	0.035	0.001	0.21	0.01	2.13	0.068	3.92	0.125	31.3
Sum DDT	0.12	0.002	0.05	0.00	0.05	0.001	0.12	0.002	62.9
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Endrin	<0.06 U	0.000	<0.06 U	0.00	<0.06 U	0.000	<0.06 U	0.000	207
Heptachlor epoxide	<0.06 U	0.004	<0.06 U	0.00	<0.06 U	0.004	0.11	0.007	16
Gamma-HCH	0.20	0.040	<0.04 U	0.01	<0.04 U	0.008	0.85	0.170	4.99
Mean PEC-Q		0.09		0.14		0.16		0.22	

Notes:

* MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems. *Arch. Environ. Contam. Toxicol.* 39, 20-31.

For nondetected constituents, the detection limit was used.

PEC-Q = Probable effect concentration quotients

No Highlights = Mean PEC-Q < 0.1 = minimal incidence of toxicity

Highlighted Yellow = Mean PEC-Q between 0.1 and 1.0 = low to moderate toxicity

Mean PEC-Q between 1.0 and 5.0 = moderate to high incidence of toxicity (no samples identified in this category)

Mean PEC-Q greater than 5 = high incidence of toxicity (no samples identified in this category)

µg/kg DW = micrograms per kilogram, dry weight

mg/kg DW = milligrams per kilogram, dry weight

Attachment 1
Environmental Baseline Survey Data Report, January 2016

TDI Brooks
Scientific Services on a Global Basis
TDI-Brooks International, Inc.
14391 S. Dowling, College Station, TX 77845
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Environmental Baseline Survey
Data Report

Wind Turbine Generator Alignment
Icebreaker Wind Demonstration Project
Lake Erie

Technical Report 16-3634

Submitted by

TDI-Brooks International, Inc.
14391 South Dowling Rd
College Station, TX 77845
USA

LEEDCo
Lake Erie Energy Development Corporation

McNeilan & Associates

January 2016

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1 INTRODUCTION

This document presents the results from the environmental baseline study (EBS) completed by TDI-Brooks International (TDI) for the Lake Erie Energy Development Corporation (LEEDCo). The field operations were performed from 12 September through 10 October 2016. The EBS program consisted of the following samples/acquisitions:

- Three (3) piston core composites
  - PC01R, PC02, PC03
  - PC04, PC05R1, PC06R2, PC07
  - PC09, PC10
- One (1) box core composite
  - BC01, BC02, BC03

The EBS investigation was conducted from the **Salvage Chief**, mobilized and demobilized in Cleveland, Ohio. The field work was conducted in water depths ranging from 22 to 66 ft. TDI-Brooks mobilized and operated the sample collection equipment.

1.1 PROJECT BACKGROUND

The Icebreaker Demonstration Wind Project is proposed by Lake Erie Energy Development Company (LEEDCo) as the first offshore wind demonstration project in the freshwater Great Lakes. The Icebreaker project is located approximately 13.1 to 17.8 km offshore from Cleveland.

The project will include six, 3.6-MW wind turbine generators (WTGs) spaced about 750 meters apart and located along a north- northwest to south-southeast alignment.

The planned six WTG positions are designated as ICE1 through ICE6 (numbered from southeast to northwest) and one alternate position (to the northwest of ICE6) is designated as ICE7. Each of the WTGs will be supported by a mono-pole substructure founded on a suction bucket foundation (mono-bucket).

Energy generated from the WTGs will be transmitted through an export cable from the offshore project area to shore. The in-harbor portion of the export cable will be installed within a horizontally directional drilled (HDD) casing Water depths at test locations increase from southeast to northwest and vary from about 17.4 to 18.8 meters relative to IGLD85 low water datum (LWD). The surveyed area surrounding the seven investigated turbine locations is about 0.3 km wide by 6.5 km long.

1.2 SCOPE OF WORK

LEEDCo required environmental data collection, processing and reporting together with geotechnical exploration and interpretation **(Figure 1-1, Figure 1-2 and Figure 1-3)**.

1 INTRODUCTION

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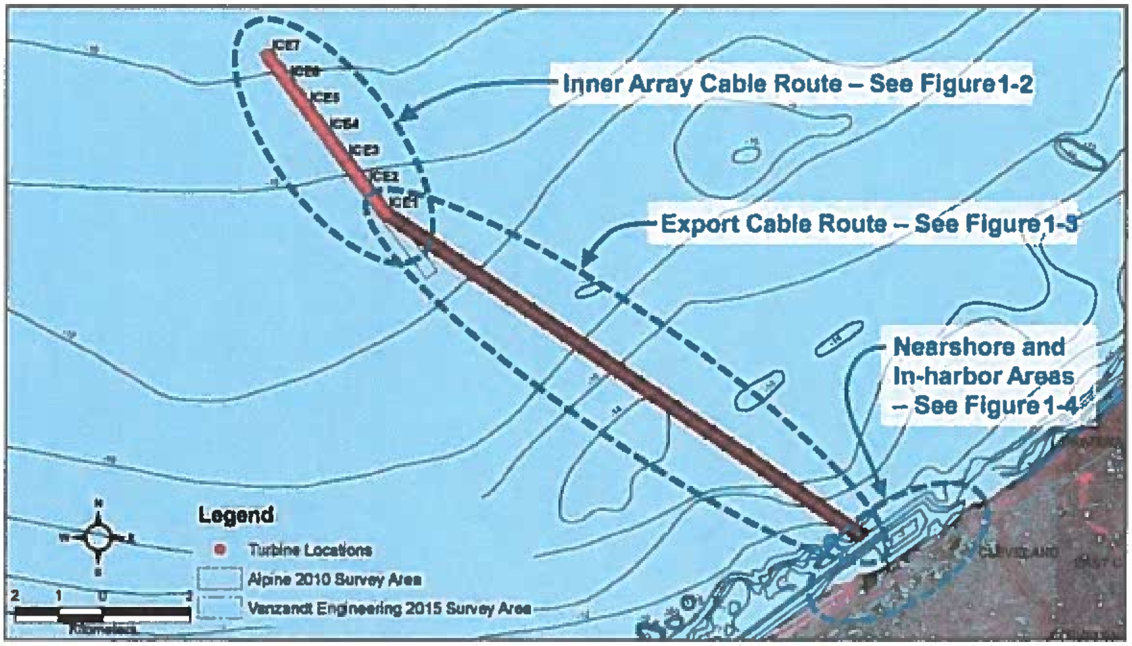


Figure 1-1. Project location.

The scope of work was intended to provide suitable lake-bottom and subsurface definition to finalize cable route alignments, design and plan for the cable route installation. In addition, the activities in the Cleveland Harbor and immediately to the north of the Cleveland Breakwater will be used for the evaluation, design and construction of the Horizontally Directionally Drilled (HDD) shore crossing.

This document provides the information on the collection of the data, the tools used, the procedures completed and the data results for the EBS investigation at this site.

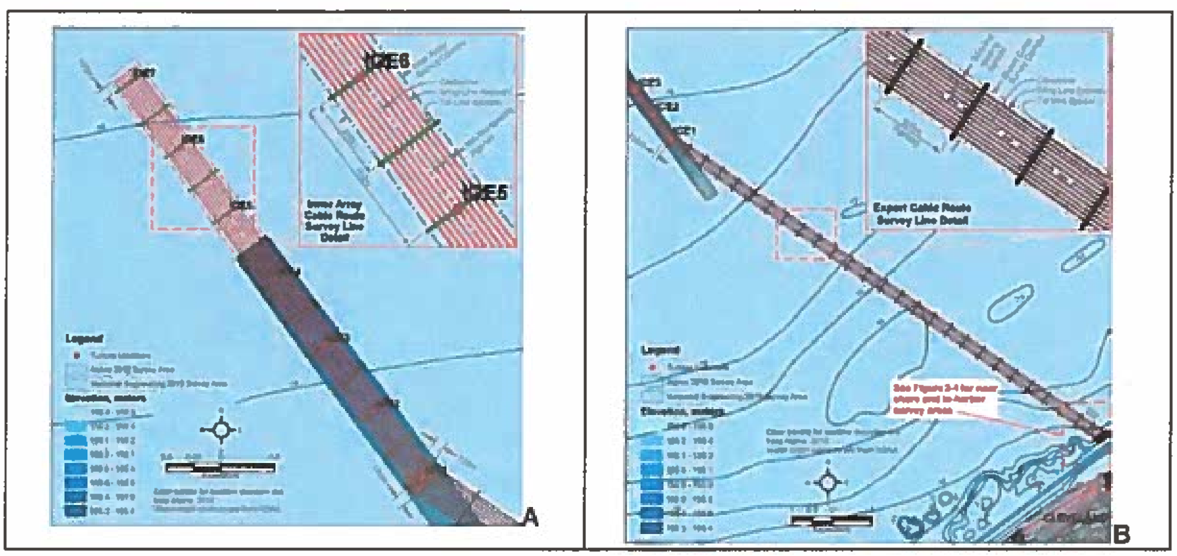


Figure 1-2. Inner array (A) and Export cable route (B).

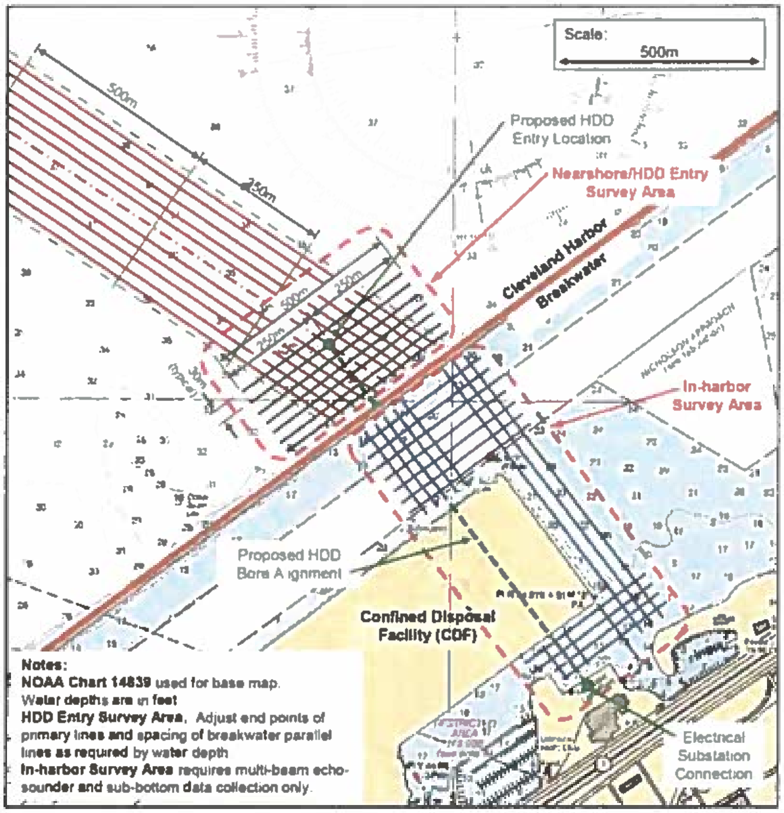


Figure 1-3. Inshore and In-Harbor.

1.3 SURVEY GEAR

The survey gear mobilized by TDI-Brooks for this EBS field campaign, together with the tool barrel lengths and sampling depths for the set of seabed sampling tools used for this project are presented in **Table 1-2**.

Table 1-1. Seabed Tool Sampling Dimensions.

TDI-Brooks Seabed Tool Name	Tool Acronym	Tool Length (ft)	Typical Depth Reached BML (ft)
Coring Tools			
Extended Box Core (1.6x1.6x3.3-ft)	XBC	Box: 3.3	3.0
Piston Core (3-in. dia.)	PC	20	18

These systems were mobilized with sufficient redundancy of components for replacement of damaged parts and/or for complete replacement of a tool. A minimum 50% redundancy of core barrel sections was onboard. Consumables sufficient for at least 120% of the samples proposed to be collected were also mobilized. Further details on the Survey Gear can be found in TDI's "*LEEDCo- Geotechnical Survey- Lake Erie- Technical Report 16-3585*".

1.4 FIELD PROGRAM

An overview of the seabed sampling locations for this program is presented in **Figure 1-4** and sediment characteristics at the sites in **Figure 1-5**

1.5 PROJECT DATUMS AND WTG LOCATIONS

The project datums are:

- Horizontal – WGS84, UTM Zone 17N, meters
- Vertical – International Great Lakes Datum (IGLD) 1985, LWD meters

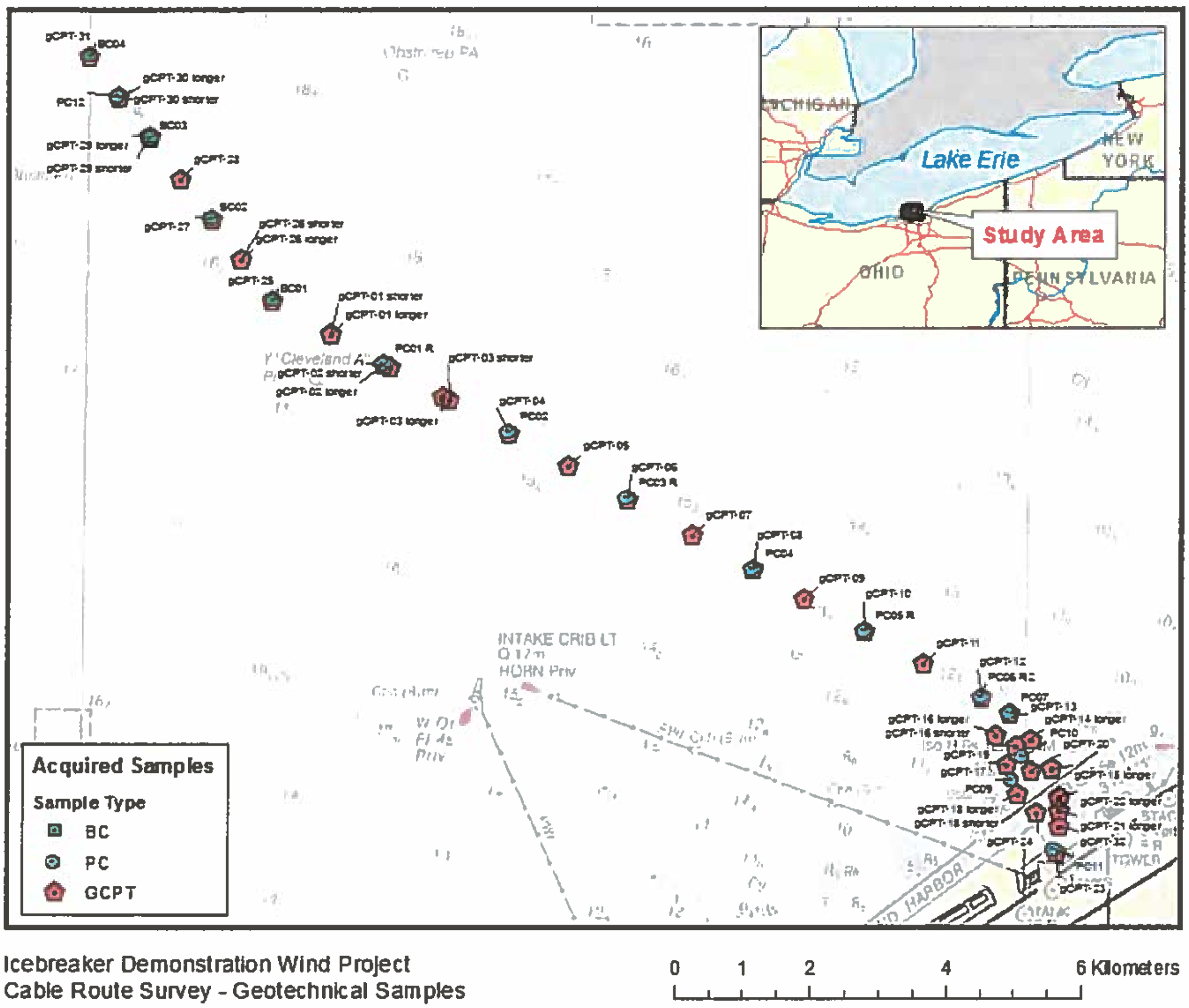


Figure 1-4. Sampling locations for the field effort.

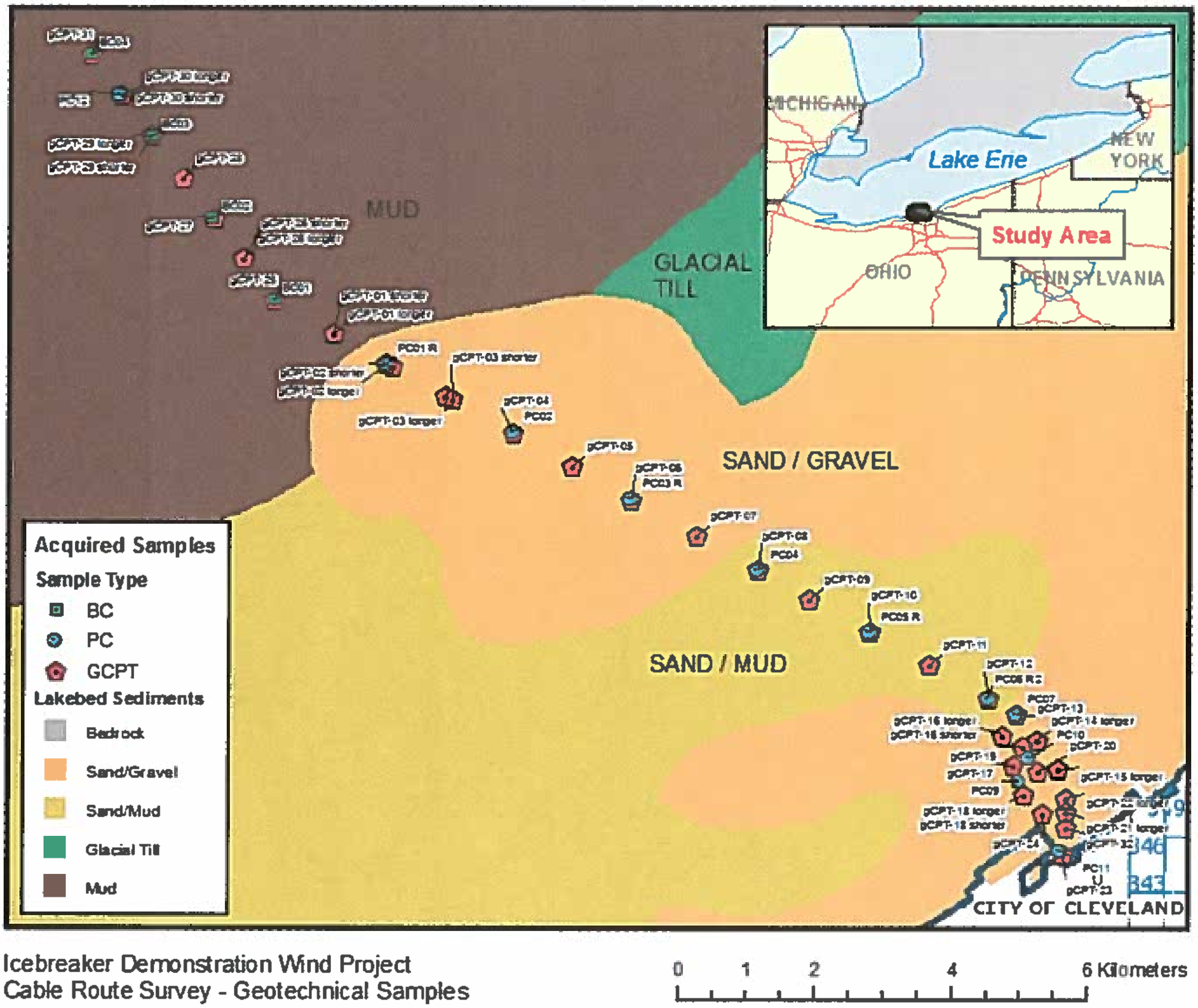
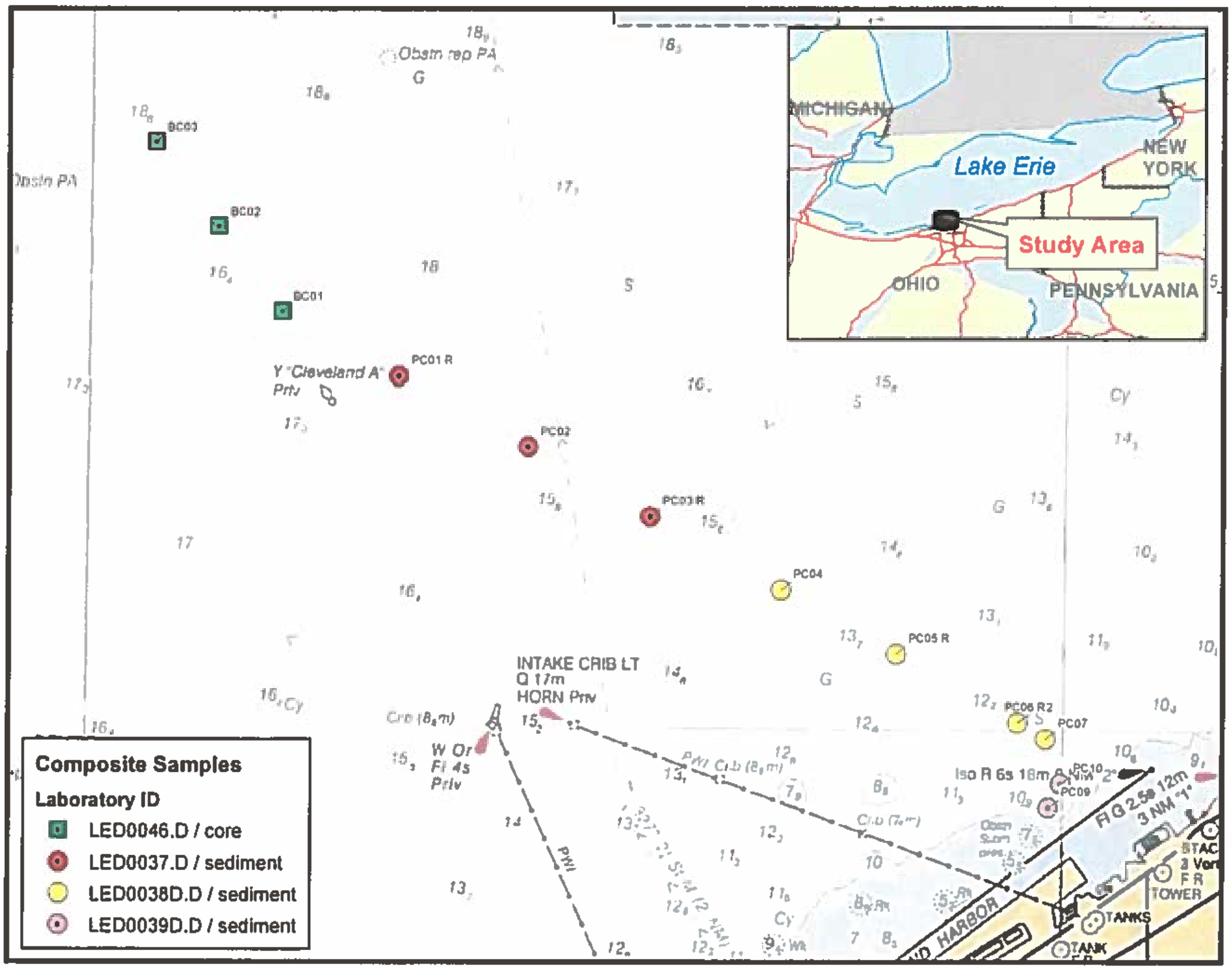


Figure 1-5. Sediment types at the sampling locations.

2 FIELD RESULTS

2.1 CORE LOCATIONS

Figure 2-1 displays the composite core collection locations. **Table 2-1** presents a listing of the collection information for each of the accepted composite core samples. The information is presented by the sample (core) ID. The table presents the client-specified information on the left (grey), and the as-built information on the right.



Icebreaker Demonstration Wind Project
Cable Route Survey - Composite Samples

0 1 2 4 6 Kilometers

Figure 2-1. Composite core collection locations.

Table 2-1. Collection Information for the Accepted Composite Core Samples.

			Acquired Sample Locations		Target Locations		
Target ID	Sample ID	Sample Type	E	N	E	N	Dist to Trgt (m)
PC1	PC1b	PC	434942.25	4604828.09	435031.01	4604784.41	98.9
PC2	PC2a	PC	436784.38	4603817.37	436777.67	4603802.64	16.2
PC3	PC3b	PC	438525.79	4602826.18	438523.81	4602824.58	2.5
PC4	PC4a	PC	440384.70	4601779.86	440387.00	4601780.31	2.3
PC5	PC5b	PC	442016.42	4600867.05	442018.41	4600866.46	2.1
PC6	PC6c	PC	443758.40	4599884.95	443756.89	4599888.81	4.1
PC7	PC7a	PC	444163.35	4599654.41	444167.04	4599653.44	3.8
PC9	PC9a	PC	444208.73	4598686.27	444210.73	4598684.88	2.4
PC10_2	PC10b	PC	444378.84	4599024.11	444382.80	4599023.05	4.1
BC1	BC1a	BC	433284.82	4605758.01	433287.22	4605755.68	3.3
BC2	BC2a	BC	432386.65	4606973.32	432386.11	4606970.91	2.5
BC3	BC3a	BC	431486.43	4608180.67	431485.31	4608186.54	6.0

All coordinates are in WGS84 UTM Zone 17 N

3 LABORATORY METHODS

3.1 SEDIMENT

3.1.1 Extraction

An automated extraction apparatus (Dionex ASE200 Accelerated Solvent Extractor) was used to extract various organics (PAH/TPH) from 1 to 15 g of a pre-dried, homogenous sample. All appropriate surrogates and spiking solutions were added. The extractions were performed using 100% dichloromethane inside stainless-steel extraction cells held at elevated temperature and solvent pressure. The extracted compounds dissolved in the hot solvent were collected in 60-mL glass vials.

The following ASE extraction conditions were used to extract the sediments:

Extraction solvent:	100% dichloromethane
Solvent pressure:	1,500 psi
Cell temperature:	100°C
Cell pre-heat time:	5 min (non-adjustable pre-set for 100°C)
Static pressure time:	2 min
Static cycles:	2 ea
Solvent flush:	60% of cell volume each cycle
Nitrogen purge time:	90 sec at end to dry cell
Method rinse:	ON (between samples)
Total extraction time:	approximately11 min/cell

The solvent in the glass vials was concentrated in a 55 - 60°C water bath until the solvent was reduced in volume to approximately 5-10 mL. The extract was transferred into a Kurderna-Danish (KD) concentrator tube. The sample volume was reduced to 0.5 mL in a 55 - 60°C water bath. The extract was then submitted for instrument analysis.

3.1.2 PAH

The quantitative method for the determination of polycyclic aromatic hydrocarbons (PAHs) and their alkylated homologues in extracts of sediment was performed by capillary gas chromatography/mass spectrometry (GC/MS) in selected ion monitoring mode (SIM). The gas chromatograph was temperature-programmed and operated in splitless mode. The capillary column was an Agilent Technologies HP-5MS (60 m long by 0.25 mm ID and 0.25 μm film thickness). Carrier flow was by electronic pressure control. The mass spectrometer scanned from 35 to 500 AMU every second or less and utilized 70 volts electron energy in electron impact ionization mode. The data acquisition system acquired and stored all data during analysis.

Calibration solutions were prepared at six concentrations ranging from 0.02 to 6 μg/mL by diluting a commercially available solution containing the analytes of interest. For each analyte of interest, a relative response factor (RRF) was determined for each calibration level. The 6 response factors were then averaged to produce a mean relative response factor for each analyte.

An analytical set contained standards, samples, and quality control samples. Each extraction batch was analyzed as an analytical set including samples and some or all of the following quality control samples: method-blank, duplicate, matrix-spike, matrix-spike duplicate, and standard reference material.

3.1.3 Aliphatic Hydrocarbon

The quantitative method for the determination of aliphatic hydrocarbons in extracts of sediment was performed by high resolution, capillary gas chromatography with flame ionization detection (GC/FID). Normal alkanes with 8 to 40 carbons (C_8 to C_{40}), and the isoprenoid series from i-C13 to i-C20 were determined with this procedure. The gas chromatograph was temperature-programmed and operated in split mode. The capillary column was a Restek Scientific RTX-1 (30 m long by 0.25 mm ID and 0.25 µm film thickness). Carrier flow was regulated by electronic pressure control. The autosampler was capable of making 1 to 5 ml injections. Dual columns and FIDs were used. The data acquisition system was by HP Chemstation software, capable of acquiring and processing GC data.

A calibration curve was established by analyzing each of 6 calibration standards (1.25, 10, 25, 40, 50 and 100 µg/ml), and fitting the data to a straight line using the least square technique. For each analyte of interest, a response factor (RF) was determined for each calibration level. All 6 response factors were then averaged to produce a mean relative response factor for each analyte. If an individual aliphatic hydrocarbon was not in the calibration solutions, a RF was estimated from the average RF of the hydrocarbon eluting immediately before the compound.

An analytical set consists of standards, samples, and quality control samples. Each extraction batch was analyzed as an analytical set including samples and some or all of the following quality control samples: method blank, duplicate, matrix spike, matrix spike duplicate and standard reference material.

3.1.4 Chlorinated Hydrocarbons

The quantitative method described in this document is for the determination of chlorinated hydrocarbons (PCBs and chlorinated pesticides) in extracts. Quantitation is performed by gas chromatography/electron capture detector (GC/ECD). The gas chromatograph is temperature-programmed and operated in splitless mode. The capillary column is a J&W DB-5® (30 m long by 0.25 mm ID and 0.25 µm film thickness). Carrier flow is by electronic pressure control. The autosampler is capable of making 1 to 5 µl injections. Dual columns and ECDs are used. The data acquisition system is by HP Chemstation software, capable of acquiring and processing GC data.

Calibration solutions are prepared at six concentrations ranging from 5 to 500 pg/µl by diluting a commercially available solution containing the analytes of interest. An Aroclor mixture consisting of Aroclor 1242, 1248, 1254 and 1260 is used as a retention time index solution for individual PCBs not found in the calibration solution. The individual PCB retention times are determined based on pattern recognition. A calibration curve is established by analyzing each of 6 calibration standards (5, 20, 40, 80, 200, and 500 pg/µl), and fitting the data to a quadratic equation.

An analytical set consists of standards, samples, and quality control samples. Each extraction batch is analyzed as an analytical set including samples and some or all of the following quality control samples: procedural blank, duplicate, matrix spike, matrix spike duplicate or blank spike, blank spike duplicate, and standard reference material.

3.1.5 Total Organic Carbon

Total organic carbon was determined in oven-dried, acid treated sediments using a LECO CR-412 Carbon Determinator. Samples were acid treated by adding 50% v/v of phosphoric acid to remove any inorganic carbon. Dried sediment was combusted at 1,350°C under an oxygen atmosphere and carbon present in the samples is oxidized to form CO_2 gas. This sample gas then flowed through two scrubber tubes. The first tube contained Anhydrone ($Mg(ClO_4)_2$), AR610 (halogen trap), and tin or copper granules to remove water and any chlorine gas, respectively. The second tube contained Anhydrone, which removes residual moisture. The sample gas then flowed through a nondispersive infrared (NDIR) detection cell.

In the NDIR detector cell, infrared energy is emitted from a nichrome wire heated to 850°C. Radiant energy enters the cell through a calcium fluoride window and projects through the cell chamber, which contains carrier or sample gas. Gases absorb infrared energy as they pass through the cell chamber. As energy exits the cell chamber through a second calcium fluoride window, a precise wavelength filter selectively blocks all wavelengths except that of CO_2 from passing into the detector. The detector responds to the energy changes between the carrier gas and sample gas and ultimately determines the concentration of the carbon contained in the sample.

Prior to analysis, the instrument establishes a baseline. As analysis proceeds, the integrated area under the signal detected is proportional to the amount of CO_2 passing through the NDIR cell. The computer reads the cell output nine times per second and provides a linearized output. The weight-corrected result is the total weight percent of carbon.

3.1.6 Grain Size

The large or coarse fraction was determined by sieving and the fine fraction was analyzed by hydrometer analysis, both according to ASTM D422. The coarse fraction is defined as sediment retained on the #200 sieve; the fine fraction is sediment passing the #200 sieve. Samples were prepared according to ASTM D421. Samples were dried in a 40°C oven in order to obtain the dry weight. Approximately 50 g of dry sample was obtained and grains were moderately disaggregated using a mortar and pestle. The sample was then soaked in 125 mL of 40 g/L sodium hexametaphosphate solution (dispersing agent) for more than 16 hours in a 1 L graduated cylinder, agitating occasionally, to complete the disaggregation process. Distilled water was then added to the solution until the total volume of the mixture (water, solution, and sample) was 1 L. The entire sample (coarse and fine fractions) was agitated in the graduated cylinder for 1 minute. Upon completion of the agitation, hydrometer readings were taken over a period of 24 hours.

Following hydrometer analysis, the samples were wet sieved. The solution was poured through a sieve set complying with ASTM D422, with the #200 sieve at the bottom of the stack. The sample was rinsed through the sieve to ensure all clay and silt particles were not retained by means of cohesion with larger grains. The sieves were placed in a 40°C oven, and the dry mass of sediment retained on each sieve in the set was obtained.

3.1.7 Trace Metal

Sediment samples were received and kept refrigerated until further processing. Sediment samples were homogenized and a representative, sub-aliquot was taken for leaching (digestion) processing. Each aliquot was freeze-dried and the percent moisture determined. Each aliquot was then manually ground to a homogeneous fine powder using a mortar and pestle. The finely ground sediment samples were then ready for further processing.

Approximately 0.2 g. of sample was placed in a clean ~ 70 mL polypropylene snap capped (perforated) container to which ~ 0.6 ml of concentrated, ultrapure HNO_3 and ~ 1.4 ml ultrapure HCl were added. Each container was closed and subjected to a heated, strong acid leach by placing in a block digester. The temperature of the hot plate was adjusted to 95 deg. C. The samples were allowed to reflux for 7-8 hours. The samples were cooled. Each digested sample was then transferred quantitatively to a 50 ml polypropylene tube using multiple deionized water rinses to achieve a final volume of ~ 20 ml (i.e. approximate dilution factor of 100. The leachate (digestate) was diluted another 10 fold (i.,e. approximate final, analytical dilution factor of 1,000) with deionized water to achieve an acid strength compatible with ICP-MS analysis. Iron was determined using an analytical dilution of ~ 400,000.

Metals concentrations were determined in the sediment leachate according to EPA** method 200.8 (ICP-MS). Reporting units are micrograms per gram (parts per million, ppm) on a dry weight basis. All metals were determined by standard mode ICP-MS except that chromium (Cr), iron (Fe), and vanadium (V) were determined by method 200.8 modified for dynamic reaction cell (DRC)-ICP-MS using ammonia as the cell gas. Arsenic (As) was determined by DRC-ICP-MS using oxygen as the cell gas. DRC-ICP-MS are interference control technologies that minimize the overestimation of trace metals levels associated with isobaric interferences that can occur with standard mode ICP-MS. Isobaric interferences are a significant concern especially for marine sediment samples with elevated levels of calcium, sodium and chloride.

The heated, strong acid leach digestion used for this study is not a total digestion (i.e. using hydrofluoric acid) quantifying all of a given element present in the sediment matrix. The percentage of metal leached into solution for analysis varies by element. For example, for the more refractory metals (e.g. Cr, V) only a relatively small percentage is leached into solution for analysis. For many other elements (including many pollutant metals) that are largely adsorbed onto the sediment particles, a much higher percentage is leached into solution for analysis. A marine sediment reference material was used to estimate the percentage of each element leached into solution for analysis. The percentage released is compared to an historical percentage that is typically observed for such a heated strong acid leach.

The same freeze-dried, finely powdered sediment samples were used for separate mercury (Hg) analysis. Mercury was determined according to EPA method 7473. EPA method 7473 is a direct analysis method involving thermal decomposition, amalgamation (on a gold trap) followed by and atomic absorption spectrophotometry. Approximately 0.05-0.06 g of dry sediment is placed in a ceramic boat and carried through a high temperature heating process that volatilizes all Hg in the sample. Reporting units are micrograms per gram (parts per million, ppm) on a dry weight basis. A marine sediment reference material is carried through the same analytical process as a check on volatilization efficiency and data accuracy. EPA method 7473 is considered a total Hg method that produces data representing the total Hg present in each sample.

*** All references in this report to EPA and EPA methods are referring to the USA government agency.*

4 RESULTS

4.1 SEDIMENT HYDROCARBONS

Oil is a complex mixture of > 75% petroleum hydrocarbons and other organic compounds (Laflamme & Hites, 1978). Petroleum hydrocarbons can be broadly classified according to their structure as saturates, olefins, aromatics, asphaltenes, polar compounds and resins. Two classes of organic chemicals, saturated hydrocarbons (SHC) and polycyclic aromatic hydrocarbons (PAH) were analyzed in this study since they are important indicators of the age and source of hydrocarbons. Saturated hydrocarbons (SHC) consist of normal alkanes and selected isoprenoids, ranging from nC_9 to nC_{40}. Total SHC, representing the sum of the resolved and unresolved compounds, is reported for a wide range of compounds, i.e., nC_9 to nC_{44}. Polycyclic aromatic hydrocarbons included 20 parent (un-alkylated) compounds and 23 alkylated compounds, consisting of two- to six-ring PAH compounds. The full laboratory results of the sediment PAH are shown in **Appendix A**. The full laboratory results of the sediment aliphatic hydrocarbons are presented in **Appendix B.**

4.2 SEDIMENT CHLORINATED HYDROCARBONS

An extensive congener specific list of PCBs and Chlorinated Pesticides from Chlordanes, DDTs, and isomers of Hexachlorohexanes were measured in the samples. Method Detection Limits using high resolution gas chromatography / electron capture detection (GC/ECD) are very low (< 0.2 ng/dry g for sediment). The full laboratory results of the sediment chlorinated hydrocarbons are presented in **Appendix C.**

4.3 SEDIMENT TOTAL ORGANIC CARBON

Total organic carbon measurements provide an indication of the amount of organic matter present in bottom sediments. The full laboratory results of the sediment TOC are shown in **Appendix D.**

4.4 GRAIN SIZE

Sediment particle size is important because it controls sedimentary community dynamics and it correlates well with biologically meaningful variables such as porosity, compaction, water content and retention of organic matter.

Sediment particle size is equally important in controlling the chemical composition due to the increase in adsorption with high surface area, fine-grained particles. Many contaminants are strongly bound to organic particles that are in turn readily adsorbed onto fine-grained sediment.

Sediment particle size is reported in four major classes: gravel, sand, silt and clay. This classification is based on the percent composition for each class. Gravel is >2 to 64 mm diameter, sand from >0.0625 to 2 mm, silt is >0.0039 to 0.0625 m and clay is less than 0.0039 mm diameter. Percent fines are the sum of silt and clay and represent the portion of particles with diameters less than 0.063 mm. The full laboratory results of the grain size analysis are presented in **Appendix E.**

4.5 SEDIMENT TRACE METALS

The complete sample results including all QA/QC results are presented in **Appendix F.**

Note: The appendices contain the results of the analyses followed by the QA/QC sample results.

- Total PAHs of the four (4) samples are shown on Page 14.
- Total Petroleum Hydrocarbons of the four (4) samples are shown on Page 26.
- Chlorinated Pesticides (as Totals of HCc, Chlordane, DDT and PCG) are shown on Page 31
- Total Carbon (TC), Total Organic Carbon (TOC) and Total Inorganic Carbon (TIC) are shown on Page 49
- Grain Size on Pages 52 to 55
- Trace Metals for individual elements are shown on as Pages 58 and 59

5 APPENDICES

5.1 APPENDIX A – POLYCYCLIC AROMATIC HYDROCARBON - PAH

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Client Submitted Samples

Laboratory ID	LED0037.D		LED0038D.D		LED0039D.D		LED0048.D	
Sample ID	PC01R, PC02, PC03		PC04, PC06R1, PC06R2, PC07		PC09, PC10		BC01, BC02, BC03	
Matrix	Sediment		Sediment		Sediment		Sediment	
Collection Date	NA		NA		NA		NA	
Received Date	10/12/16		09/21/16		10/12/16		10/12/16	
Extraction Date	11/07/16		11/07/16		11/07/16		11/07/16	
Extraction Batch	ENV3615		ENV3515		ENV3615		ENV3615	
Date Acquired	11/11/16 0.03		11/11/16 8.07		11/11/16 9.16		11/11/16 3.30	
Method	B&B SOP1006		B&B SOP1006		B&B SOP1006		B&B SOP1005	
Sample Dry Weight (g)	15.02		15.11		15.05		15.02	
% Dry	80		83		77		23	
% Moisture	20		17		23		77	
Dilution	1X		5X		2X		1X	
Target Compounds	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q
cis/trans Decalin	14.5		24.4		13.4		28.9	
C1-Decalins	21.0		34.3		27.7		26.5	
C2-Decalins	122		105.5		52.7		54.3	
C3-Decalins	286		341		145		82.3	
C4-Decalins	267		386		200		74.5	
Naphthalene	4.47		84.9		66.8		50.2	
C1-Naphthalenes	9.75		37.5		37.1		37.9	
C2-Naphthalenes	34.4		70.2		77.9		68.6	
C3-Naphthalenes	101		363		182		105	
C4-Naphthalenes	239		635		224		105	
Benzothiophene	1.40		4.12		3.94		2.19	
C1-Benzothiophenes	8.70		14.9		10.7		7.45	
C2-Benzothiophenes	6.08		15.9		9.1		7.43	
C3-Benzothiophenes	12.1		38.8		13.0		8.57	
C4-Benzothiophenes	7.08		31.0		11.9		8.75	
Biphenyl	6.72		10.4		11.8		10.1	
Acenaphthylene	1.22		237		55.8		32.4	
Acenaphthene	2.03		66.5		37.9		9.70	
Dibenzofuran	17.0		41.3		32.9		26.3	
Fluorene	13.0		71.3		61.5		26.5	
C1-Fluorenes	87.2		278		45.1		24.2	
C2-Fluorenes	176		573		106		48.3	
C3-Fluorenes	189		645		168		43.5	
Carbazole	3.07		23.5		12.5		13.4	
Anthracene	0.546		435		140		49.4	
Phenanthrene	82.4		500		359		122	
C1-Phenanthrenes/Anthracenes	264		1003		302		135	
C2-Phenanthrenes/Anthracenes	434		2184		494		176	
C3-Phenanthrenes/Anthracenes	424		1877		659		189	
C4-Phenanthrenes/Anthracenes	223		798		488		109	
Dibenzothiophene	18.4		72.1		30.7		17.9	
C1-Dibenzothiophenes	55.9		222		58.3		28.5	
C2-Dibenzothiophenes	88.7		489		141		50.2	
C3-Dibenzothiophenes	78.3		541		216		56.9	
C4-Dibenzothiophenes	22.9		242		112		27.5	
Fluoranthene	6.94		1838		514		279	
Pyrene	8.51		2198		411		228	
C1-Fluoranthenes/Pyrenes	31.0		2947		331		166	
C2-Fluoranthenes/Pyrenes	72.2		1929		183		89.6	
C3-Fluoranthenes/Pyrenes	79.2		1675		185		59.0	
C4-Fluoranthenes/Pyrenes	59.0		980		105		49.3	
Naphthobenzothiophene	34.8		893		105		70.0	
C1-Naphthobenzothiophenes	40.9		1615		121		78.1	
C2-Naphthobenzothiophenes	58.2		1392		156		76.0	
C3-Naphthobenzothiophenes	38.3		735		119		53.6	
C4-Naphthobenzothiophenes	12.1		254		40.6		26.7	
Benz(a)anthracene	1.65		1860		242		135	
Chrysene/Triphenylene	63.9		2243		333		209	
C1-Chrysenes	94.9		3943		237		124	
C2-Chrysenes	160		2788		271		119	
C3-Chrysenes	107		1384		172		76.2	
C4-Chrysenes	42.7		468		66.6		38.7	
Benzo(b)fluoranthene	10.3		1284		254		214	
Benzo(k.j)fluoranthene	0.90		787		150		177	
Benzo(a)fluoranthene	<0.1	U	242		40.9		30.4	
Benzo(e)pyrene	24.4		1797		165		167	
Benzo(a)pyrene	2.64		1807		157		154	
Perylene	11.1		252		59.0		153	
Indeno(1.2.3-c.d)pyrene	0.981		629		100		122	
Dibenzo(a.h)anthracene	1.16		376		35.8		37.1	
Benzo(g.h.i)perylene	10.6		932		103		128	
Total PAHs	4272		48708		9303		4919	

B&B Laboratories
Project J16222
Report 16-3589

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Client Submitted Samples

Laboratory ID	LED0037.D	LED0038D.D	LED0039D.D	LED0046.D
Sample ID	PC01R, PC02, PC03	PC04, PC05R1, PC06R2, PC07	PC09, PC10	BC01, BC02, BC03
Matrix	Sediment	Sediment	Sediment	Sediment
Collection Date	NA	NA	NA	NA
Received Date	10/12/16	09/21/16	10/12/16	10/12/16
Extraction Date	11/07/16	11/07/16	11/07/16	11/07/16
Extraction Batch	ENV3615	ENV3615	ENV3615	ENV3615
Date Acquired	11/11/16 0:03	11/11/16 9:07	11/11/16 9:16	11/11/16 3:30
Method	B&B SOP1006	B&B SOP1006	B&B SOP1006	B&B SOP1006
Sample Dry Weight (g)	15.02	15.11	15.05	15.02
% Dry	80	83	77	23
% Moisture	20	17	23	77
Dilution	1X	5X	2X	1X

Target Compounds	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q
Individual Alkyl Isomers and Hopanes								
2-Methylnaphthalene	6.83		36.1		34.7		34.0	
1-Methylnaphthalene	8.19		20.9		21.6		23.8	
2,6-Dimethylnaphthalene	5.26		13.47		16.8		16.2	
1,6,7-Trimethylnaphthalene	10.7		42.8		21.1		11.6	
1-Methylfluorene	41.4		151		24.5		12.6	
4-Methyldibenzothiophene	43.2		173		36.9		17.5	
2/3-Methyldibenzothiophene	16.8		90.1		27.1		11.5	
1-Methyldibenzothiophene	14.6		32.5		11.3		9.06	
3-Methylphenanthrene	60.8		357		83.5		38.0	
2-Methylphenanthrene	68.5		252		109		44.9	
2-Methylanthracene	3.54		178		38.8		15.6	
4/9-Methylphenanthrene	137		288		95.5		47.8	
1-Methylphenanthrene	74.2		233		68.6		29.2	
3,6-Dimethylphenanthrene	19.4		273		33.4		10.8	
Retene	4.10		48.6		29.1		10.4	
2-Methylfluoranthene	2.11		343		52.4		25.1	
Benzo(b)fluorene	2.99		672		113		48.2	
C29-Hopane	12.5		27.8		225		246	
18a-Oleanane	<0.6	U	<2.9	U	35.4		42.6	
C30-Hopane	27.6		51.4		346		317	
C20-TAS	47.1		67		67.0		24.2	
C21-TAS	26.3		52.4		40.2		16.2	
C26(20S)-TAS	38.3		32.9		50.4		38.6	
C26(20R)/C27(20S)-TAS	64.2		74.4		137		108	
C28(20S)-TAS	145		119		164		135	
C27(20R)-TAS	47.2		39.9		76.4		68.7	
C28(20R)-TAS	113		92.1		126		98.9	

Surrogate Recovery

Naphthalene-d8	70		84	D	79	D	66	
Acenaphthene-d10	88		93	D	91	D	85	
Phenanthrene-d10	90		93	D	95	D	86	
Chrysene-d12	93		104	D	104	D	92	
Perylene-d12	84		99	D	95	D	80	

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Method Blank Report

Laboratory ID	ENV3615A.D
Sample ID	Method Blank
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/07/16
Extraction Batch	ENV3615
Date Acquired	11/10/16 17:09
Method	B&B SOP1006
Sample Dry Weight (g)	15.0
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su Corrected Conc (ng/dry g)	Q	3X MDL	Actual MDL
cis/trans Decalin	<0.1	U	0.396	0.132
C1-Decalins	<0.3	U	0.789	0.263
C2-Decalins	<0.3	U	0.789	0.263
C3-Decalins	<0.3	U	0.789	0.263
C4-Decalins	<0.3	U	0.789	0.263
Naphthalene	0.122	J	1.03	0.342
C1-Naphthalenes	<1	U	3.09	1.03
C2-Naphthalenes	<0.7	U	2.05	0.684
C3-Naphthalenes	<0.7	U	2.05	0.684
C4-Naphthalenes	<0.7	U	2.05	0.684
Benzothiophene	<0.1	U	0.270	0.090
C1-Benzothiophenes	<0.2	U	0.540	0.180
C2-Benzothiophenes	<0.2	U	0.540	0.180
C3-Benzothiophenes	<0.2	U	0.540	0.180
C4-Benzothiophenes	<0.2	U	0.540	0.180
Biphenyl	0.130	J	0.882	0.294
Acenaphthylene	0.067		0.123	0.041
Acenaphthene	<0.1	U	0.309	0.103
Dibenzofuran	<0.2	U	0.612	0.204
Fluorene	<0.2	U	0.549	0.183
C1-Fluorenes	<0.4	U	1.10	0.367
C2-Fluorenes	<0.4	U	1.10	0.367
C3-Fluorenes	<0.4	U	1.10	0.367
Carbazole	<0.1	U	0.450	0.150
Anthracene	<0.1	U	0.345	0.115
Phenanthrene	0.139	J	0.624	0.208
C1-Phenanthrenes/Anthracenes	<0.1	U	0.231	0.077
C2-Phenanthrenes/Anthracenes	<0.3	U	0.855	0.285
C3-Phenanthrenes/Anthracenes	<0.3	U	0.855	0.285
C4-Phenanthrenes/Anthracenes	<0.3	U	0.855	0.285
Dibenzothiophene	<0.1	U	0.348	0.116
C1-Dibenzothiophenes	<0.1	U	0.192	0.064
C2-Dibenzothiophenes	<0.2	U	0.696	0.232
C3-Dibenzothiophenes	<0.2	U	0.696	0.232
C4-Dibenzothiophenes	<0.2	U	0.696	0.232
Fluoranthene	<0.3	U	0.999	0.333
Pyrene	<0.1	U	0.408	0.136
C1-Fluoranthenes/Pyrenes	<0.5	U	1.41	0.469
C2-Fluoranthenes/Pyrenes	<0.5	U	1.41	0.469
C3-Fluoranthenes/Pyrenes	<0.5	U	1.41	0.469
C4-Fluoranthenes/Pyrenes	<0.5	U	1.41	0.469
Naphthobenzothiophene	<0.1	U	0.384	0.128
C1-Naphthobenzothiophenes	<0.3	U	0.768	0.256
C2-Naphthobenzothiophenes	<0.3	U	0.768	0.256
C3-Naphthobenzothiophenes	<0.3	U	0.768	0.256
C4-Naphthobenzothiophenes	<0.3	U	0.768	0.256
Benz(a)anthracene	<0.2	U	0.576	0.192
Chrysene/Triphenylene	<0.1	U	0.348	0.116
C1-Chrysenes	<0.2	U	0.696	0.232
C2-Chrysenes	<0.2	U	0.696	0.232
C3-Chrysenes	<0.2	U	0.696	0.232
C4-Chrysenes	<0.2	U	0.696	0.232
Benzo(b)fluoranthene	<0.2	U	0.609	0.203
Benzo(k,j)fluoranthene	<0.1	U	0.294	0.098
Benzo(a)fluoranthene	<0.1	U	0.294	0.098
Benzo(e)pyrene	<0.2	U	0.531	0.177
Benzo(a)pyrene	<0.1	U	0.303	0.101
Perylene	<1.3	U	3.80	1.27
Indeno(1,2,3-c,d)pyrene	<0.1	U	0.150	0.050
Dibenzo(a,h)anthracene	<0.1	U	0.192	0.064
Benzo(g,h,i)perylene	<0.1	U	0.264	0.088
Total PAHs	0.458			

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Method Blank Report

Laboratory ID	ENV3615A.D
Sample ID	Method Blank
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/07/16
Extraction Batch	ENV3615
Date Acquired	11/10/16 17:09
Method	B&B SOP1006
Sample Dry Weight (g)	15.0
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su. Corrected Conc. (ng/dry g)	Q	3X MDL	Actual MDL
Individual Alkyl Isomers and Hopanes				
2-Methylnaphthalene	<1.3	U	3.89	1.30
1-Methylnaphthalene	<0.5	U	1.64	0.546
2,6-Dimethylnaphthalene	<0.3	U	0.783	0.261
1,6,7-Trimethylnaphthalene	<0.1	U	0.381	0.127
1-Methylfluorene	<0.2	U	0.573	0.191
4-Methyldibenzothiophene	<0.1	U	0.273	0.091
2/3-Methyldibenzothiophene	<0.1	U	0.273	0.091
1-Methyldibenzothiophene	<0.1	U	0.273	0.091
3-Methylphenanthrene	<0.1	U	0.291	0.097
2-Methylphenanthrene	<0.1	U	0.291	0.097
2-Methylanthracene	<0.1	U	0.291	0.097
4/9-Methylphenanthrene	<0.1	U	0.291	0.097
1-Methylphenanthrene	<0.1	U	0.291	0.097
3,6-Dimethylphenanthrene	<0.1	U	0.330	0.110
Retene	<0.2	U	0.693	0.231
2-Methylfluoranthene	<0.2	U	0.669	0.223
Benzo(b)fluorene	<0.1	U	0.375	0.125
C29-Hopane	<0.6	U	1.73	0.58
18a-Oleanane	<0.6	U	1.73	0.58
C30-Hopane	<0.6	U	1.73	0.58
C20-TAS	<0.6	U	1.73	0.58
C21-TAS	<0.6	U	1.73	0.58
C26(20S)-TAS	<0.6	U	1.73	0.58
C26(20R)/C27(20S)-TAS	<0.6	U	1.73	0.58
C28(20S)-TAS	<0.6	U	1.73	0.58
C27(20R)-TAS	<0.6	U	1.73	0.58
C28(20R)-TAS	<0.6	U	1.73	0.58

Surrogate Recovery	
Naphthalene-d8	76
Acenaphthene-d10	81
Phenanthrene-d10	87
Chrysene-d12	88
Perylene-d12	90

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Blank Spike Report

Laboratory ID	ENV3615B D
Sample ID	Blank Spike
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/07/16
Extraction Batch	ENV3615
Date Acquired	11/10/16 18:18
Method	B&B SOP1006
Sample Dry Weight (g)	1.00
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su Corrected Amount (ng)	Q	Recovery (%)	Q	Spike amount (ng)
cis/trans Decalin	106		106		100
C1-Decalins	NA				
C2-Decalins	NA				
C3-Decalins	NA				
C4-Decalins	NA				
Naphthalene	95.9		96		100
C1-Naphthalenes	NA				
C2-Naphthalenes	NA				
C3-Naphthalenes	NA				
C4-Naphthalenes	NA				
Benzothiophene	93.7		93		100
C1-Benzothiophenes	NA				
C2-Benzothiophenes	NA				
C3-Benzothiophenes	NA				
C4-Benzothiophenes	NA				
Biphenyl	133		133		100
Acenaphthylene	95.6		96		100
Acenaphthene	101		100		100
Dibenzofuran	104		104		100
Fluorene	103		103		100
C1-Fluorenes	NA				
C2-Fluorenes	NA				
C3-Fluorenes	NA				
Carbazole	103		103		100
Anthracene	101		101		100
Phenanthrene	105		105		100
C1-Phenanthrenes/Anthracenes	NA				
C2-Phenanthrenes/Anthracenes	NA				
C3-Phenanthrenes/Anthracenes	NA				
C4-Phenanthrenes/Anthracenes	NA				
Dibenzothiophene	98.1		98		100
C1-Dibenzothiophenes	NA				
C2-Dibenzothiophenes	NA				
C3-Dibenzothiophenes	NA				
C4-Dibenzothiophenes	NA				
Fluoranthene	108		107		100
Pyrene	105		105		100
C1-Fluoranthenes/Pyrenes	NA				
C2-Fluoranthenes/Pyrenes	NA				
C3-Fluoranthenes/Pyrenes	NA				
C4-Fluoranthenes/Pyrenes	NA				
Naphthobenzothiophene	103		103		100
C1-Naphthobenzothiophenes	NA				
C2-Naphthobenzothiophenes	NA				
C3-Naphthobenzothiophenes	NA				
C4-Naphthobenzothiophenes	NA				
Benz(a)anthracene	105		104		100
Chrysene/Triphenylene	104		104		100
C1-Chrysenes	NA				
C2-Chrysenes	NA				
C3-Chrysenes	NA				
C4-Chrysenes	NA				
Benzo(b)fluoranthene	108		108		100
Benzo(k,j)fluoranthene	105		105		100
Benzo(a)fluoranthene	NA				
Benzo(e)pyrene	106		106		100
Benzo(a)pyrene	106		105		100
Perylene	100		100		100
Indeno(1,2,3-c,d)pyrene	100		100		100
Dibenzo(a,h)anthracene	104		104		100
Benzo(g,h,i)perylene	90.9		91		100
Average % Recovery			103		

B&B Laboratories
Project J16222
Report 16-3589

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Blank Spike Report

Laboratory ID	ENV3615B.D
Sample ID	Blank Spike
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/07/16
Extraction Batch	ENV3615
Date Acquired	11/10/16 18:18
Method	B&B SOP1006
Sample Dry Weight (g)	1.00
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su. Corrected Amount (ng)	Q	Recovery (%)	Q	Spike amount (ng)
Individual Alkyl Isomers and Hopanes					
2-Methylnaphthalene	99.0		99		100
1-Methylnaphthalene	97.0		97		100
2,6-Dimethylnaphthalene	97.4		97		100
1,6,7-Trimethylnaphthalene	101		101		100
1-Methylfluorene	102		102		100
4-Methyldibenzothiophene	103		102		101
2/3-Methyldibenzothiophene	NA				
1-Methyldibenzothiophene	NA				
3-Methylphenanthrene	NA				
2-Methylphenanthrene	NA				
2-Methylanthracene	NA				
4/9-Methylphenanthrene	NA				
1-Methylphenanthrene	106		106		100
3,6-Dimethylphenanthrene	104		104		100
Retene	101		100		100
2-Methylfluoranthene	102		102		100
Benzo(b)fluorene	108		107		100
C29-Hopane	NA				
18a-Oleanane	NA				
C30-Hopane	104		104		100
C20-TAS	NA				
C21-TAS	NA				
C26(20S)-TAS	NA				
C26(20R)/C27(20S)-TAS	NA				
C28(20S)-TAS	NA				
C27(20R)-TAS	NA				
C28(20R)-TAS	NA				

Surrogate Recovery	
Naphthalene-d8	81
Acenaphthene-d10	87
Phenanthrene-d10	91
Chrysene-d12	91
Perylene-d12	90

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Laboratory Duplicate Report

Laboratory ID	LED0039D D	ENV3615E D
Sample ID	PC09, PC10	Dupl. (PC09, PC10)
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	10/12/16	10/12/16
Extraction Date	11/07/16	11/07/16
Extraction Batch	ENV3615	ENV3615
Date Acquired	11/11/16 9:16	11/11/16 10:25
Method	B&B SOP1006	B&B SOP1006
Sample Dry Weight (g)	15.05	15.07
% Dry	77	77
% Moisture	23	23
Dilution	2X	2X

Target Compounds	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q	RPD %	Q Q1	3X MDL	MDL
cis/trans Decalin	13.4		13.0		2		0.786	0.262
C1-Decalins	27.7		27.9		0		1.58	0.525
C2-Decalins	52.7		52.5		0		1.58	0.525
C3-Decalins	145		147		2		1.58	0.525
C4-Decalins	200		199		0		1.58	0.525
Naphthalene	66.8		67.1		0		2.05	0.682
C1-Naphthalenes	37.1		37.2		1		6.16	2.05
C2-Naphthalenes	77.9		78.6		1		4.09	1.36
C3-Naphthalenes	182		186		2		4.09	1.36
C4-Naphthalenes	224		230		3		4.09	1.36
Benzothiophene	3.94		3.96		0		0.540	0.180
C1-Benzothiophenes	10.7		10.2		5		1.08	0.359
C2-Benzothiophenes	9.10		9.50		4		1.08	0.359
C3-Benzothiophenes	13.0		12.8		2		1.08	0.359
C4-Benzothiophenes	11.9		12.4		4		1.08	0.359
Biphenyl	11.8		11.8		0		1.76	0.585
Acenaphthylene	55.8		56.0		0		0.243	0.081
Acenaphthene	37.9		38.3		1		0.615	0.205
Dibenzofuran	32.9		33.2		1		1.221	0.407
Fluorene	61.5		62.3		1		1.10	0.365
C1-Fluorenes	45.1		46.2		2		2.19	0.731
C2-Fluorenes	106.4		108		1		2.19	0.731
C3-Fluorenes	168		179		7		2.19	0.731
Carbazole	12.5		12.5		0		0.894	0.298
Anthracene	140		140		0		0.690	0.230
Phenanthrene	359		358		0		1.24	0.414
C1-Phenanthrenes/Anthracenes	302		304		1		0.462	0.154
C2-Phenanthrenes/Anthracenes	494		500		1		1.70	0.568
C3-Phenanthrenes/Anthracenes	659		680		3		1.70	0.568
C4-Phenanthrenes/Anthracenes	486		457		6		1.70	0.568
Dibenzothiophene	30.7		30.7		0		0.693	0.231
C1-Dibenzothiophenes	56.3		56.3		0		0.381	0.127
C2-Dibenzothiophenes	141		142		1		1.39	0.462
C3-Dibenzothiophenes	216		223		3		1.39	0.462
C4-Dibenzothiophenes	112		113		2		1.39	0.462
Fluoranthene	514		510		1		1.99	0.663
Pyrene	411		409		1		0.813	0.271
C1-Fluoranthenes/Pyrenes	331		345		4		2.80	0.934
C2-Fluoranthenes/Pyrenes	183		185		1		2.80	0.934
C3-Fluoranthenes/Pyrenes	185		192		4		2.80	0.934
C4-Fluoranthenes/Pyrenes	105		100		5		2.80	0.934
Naphthobenzothiophene	105		109		5		0.765	0.255
C1-Naphthobenzothiophenes	121		127		5		1.53	0.510
C2-Naphthobenzothiophenes	166		171		3		1.53	0.510
C3-Naphthobenzothiophenes	119		117		2		1.53	0.510
C4-Naphthobenzothiophenes	40.6		42.0		3		1.53	0.510
Benz(a)anthracene	242		251		4		1.15	0.383
Chrysene/Triphenylene	333		327		2		0.693	0.231
C1-Chrysenes	237		237		0		1.39	0.462
C2-Chrysenes	271		264		2		1.39	0.462
C3-Chrysenes	172		174		1		1.39	0.462
C4-Chrysenes	66.8		63.4		5		1.39	0.462
Benzo(b)fluoranthene	254		250		1		1.21	0.404
Benzo(k,j)fluoranthene	150		152		2		0.585	0.195
Benzo(a)fluoranthene	40.9		42.1		3		0.585	0.195
Benzo(e)pyrene	165		166		1		1.06	0.352
Benzo(a)pyrene	187		195		4		0.606	0.202
Perylene	59.0		59.6		1		7.58	2.53
Indeno(1,2,3-c,d)pyrene	100		101		0		0.300	0.100
Dibenzo(a,h)anthracene	35.8		36.4		2		0.384	0.128
Benzo(g,h,i)perylene	108		108		1		0.525	0.175
Total PAHs	9303		9375		1			

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Laboratory Duplicate Report

Laboratory ID	LED0039D.D	ENV3615E.D
Sample ID	PC09, PC10	Dupl. (PC09, PC10)
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	10/12/16	10/12/16
Extraction Date	11/07/16	11/07/16
Extraction Batch	ENV3615	ENV3615
Date Acquired	11/11/16 9:16	11/11/16 10:25
Method	B&B SOP1006	B&B SOP1006
Sample Dry Weight (g)	15.05	15.07
% Dry	77	77
% Moisture	23	23
Dilution	2X	2X

Target Compounds	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q	RPD %	Q Q1	3X MDL	MDL
Individual Alkyl Isomers and Hopanes								
2-Methylnaphthalene	34.7		34.9		1		7.75	2.58
1-Methylnaphthalene	21.6		21.7		0		3.27	1.09
2,6-Dimethylnaphthalene	16.8		16.6		1		1.56	0.519
1,6,7-Trimethylnaphthalene	21.1		21.4		1		0.762	0.254
1-Methylfluorene	24.5		25.0		2		1.14	0.381
4-Methyldibenzothiophene	36.8		36.7		0		0.546	0.182
2/3-Methyldibenzothiophene	27.1		27.2		0		0.546	0.182
1-Methyldibenzothiophene	11.3		11.2		0		0.546	0.182
3-Methylphenanthrene	83.5		83.4		0		0.582	0.194
2-Methylphenanthrene	109		108		1		0.582	0.194
2-Methylanthracene	38.8		38.5		1		0.582	0.194
4/9-Methylphenanthrene	95.5		95.7		0		0.582	0.194
1-Methylphenanthrene	66.6		70.2		5		0.582	0.194
3,6-Dimethylphenanthrene	33.4		32.2		4		0.657	0.219
Retene	29.1		27.9		4		1.38	0.461
2-Methylfluoranthene	52.4		51.1		2		1.33	0.444
Benzo(b)fluorene	113		114		0		0.747	0.249
C29-Hopane	225		234		4		3.44	1.15
18a-Oleanane	35.4		33.7		5		3.44	1.15
C30-Hopane	346		349		1		3.44	1.15
C20-TAS	67.0		72.6		8		3.44	1.15
C21-TAS	40.2		41.5		3		3.44	1.15
C26(20S)-TAS	50.4		49.8		1		3.44	1.15
C26(20R)/C27(20S)-TAS	137		136		0		3.44	1.15
C28(20S)-TAS	164		166		1		3.44	1.15
C27(20R)-TAS	76.4		76.2		0		3.44	1.15
C28(20R)-TAS	126		127		1		3.44	1.15

Surrogate Recovery				
Naphthalene-d8	79	D	78	D
Acenaphthene-d10	91	D	91	D
Phenanthrene-d10	95	D	94	D
Chrysene-d12	104	D	103	D
Perylene-d12	95	D	96	D

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Matrix Spike Report

Laboratory ID	LED0037.D	ENV3615D.D
Sample ID	PC01R, PC02, PC03	MS (PC01R, PC02, PC03)
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	10/12/16	10/12/16
Extraction Date	11/07/16	11/07/16
Extraction Batch	ENV3615	ENV3615
Date Acquired	11/11/16 0:03	11/10/16 20:36
Method	B&B SOP1006	B&B SOP1006
Sample Dry Weight (g)	15.02	15.00
% Dry	80	80
% Moisture	20	20
Dilution	1X	1X

Target Compounds	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q	Recovery (%)	Q	Q1	Spike Amount (ng)
cis/trans Decalin	14.5		19.5		74		Y	100
C1-Decalins	21.0		NA					
C2-Decalins	122		NA					
C3-Decalins	266		NA					
C4-Decalins	267		NA					
Naphthalene	4.47		10.5		90			100
C1-Naphthalenes	9.75		NA					
C2-Naphthalenes	34.4		NA					
C3-Naphthalenes	101		NA					
C4-Naphthalenes	239		NA					
Benzothiophene	1.40		7.17		86			100
C1-Benzothiophenes	8.70		NA					
C2-Benzothiophenes	6.08		NA					
C3-Benzothiophenes	12.1		NA					
C4-Benzothiophenes	7.08		NA					
Biphenyl	6.72		11.4		70			100
Acenaphthylene	1.22		7.76		98			100
Acenaphthene	2.03		8.51		97			100
Dibenzofuran	17.0		24.1		105		Y	100
Fluorene	13.0		20.3		108			100
C1-Fluorenes	87.2		NA					
C2-Fluorenes	176		NA					
C3-Fluorenes	189		NA					
Carbazole	3.07		9.84		101			100
Anthracene	0.546		6.56		90			100
Phenanthrene	82.4		88.0		83		Y	100
C1-Phenanthrenes/Anthracenes	264		NA					
C2-Phenanthrenes/Anthracenes	434		NA					
C3-Phenanthrenes/Anthracenes	424		NA					
C4-Phenanthrenes/Anthracenes	223		NA					
Dibenzothiophene	18.4		26.4		118		Y	100
C1-Dibenzothiophenes	55.9		NA					
C2-Dibenzothiophenes	88.7		NA					
C3-Dibenzothiophenes	76.3		NA					
C4-Dibenzothiophenes	22.9		NA					
Fluoranthene	6.94		14.0		106			100
Pyrene	8.51		15.4		103			100
C1-Fluoranthenes/Pyrenes	31.0		NA					
C2-Fluoranthenes/Pyrenes	72.2		NA					
C3-Fluoranthenes/Pyrenes	79.2		NA					
C4-Fluoranthenes/Pyrenes	59.0		NA					
Naphthobenzothiophene	34.8		NA					
C1-Naphthobenzothiophenes	40.9		NA					
C2-Naphthobenzothiophenes	58.2		NA					
C3-Naphthobenzothiophenes	38.3		NA					
C4-Naphthobenzothiophenes	12.1		NA					
Benz(a)anthracene	1.65		9.16		113			100
Chrysene/Triphenylene	63.9		73.9		148		Y	100
C1-Chrysenes	94.9		NA					
C2-Chrysenes	160		NA					
C3-Chrysenes	107		NA					
C4-Chrysenes	42.7		NA					
Benzo(b)fluoranthene	10.3		14.8		67			100
Benzo(k,j)fluoranthene	0.899		8.66		116			100
Benzo(a)fluoranthene	<0.1	U	NA					
Benzo(e)pyrene	24.4		34.0		143		Y	100
Benzo(a)pyrene	2.64		10.2		114			100
Perylene	11.1		18.5		110			100
Indeno(1,2,3-c,d)pyrene	0.981		8.82		118			100
Dibenzo(a,h)anthracene	1.16		8.95		117			100
Benzo(g,h,i)perylene	10.5		17.2		101			100
Average % Recovery					102			

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Matrix Spike Report

Laboratory ID	LED0037.D	ENV3615D.D
Sample ID	PC01R, PC02, PC03	MS (PC01R, PC02, PC03)
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	10/12/16	10/12/16
Extraction Date	11/07/16	11/07/16
Extraction Batch	ENV3615	ENV3615
Date Acquired	11/11/16 0:03	11/10/16 20:36
Method	B&B SOP1006	B&B SOP1006
Sample Dry Weight (g)	15.02	15.00
% Dry	80	80
% Moisture	20	20
Dilution	1X	1X

Target Compounds	Su. Corrected Conc. (ng/dry g)	Q	Su. Corrected Conc. (ng/dry g)	Q	Recovery (%)	Q	Q1	Spike Amount (ng)
Individual Alkyl Isomers and Hopanes								
2-Methylnaphthalene	6.83		14.3		111			100
1-Methylnaphthalene	8.19		14.6		96			100
2,6-Dimethylnaphthalene	5.26		11.3		90			100
1,6,7-Trimethylnaphthalene	10.7		14.9		64			100
1-Methylfluorene	41.4		48.6		105		Y	100
4-Methyldibenzothiophene	43.2		49.0		85		Y	101
2/3-Methyldibenzothiophene	16.8		NA					
1-Methyldibenzothiophene	14.6		NA					
3-Methylphenanthrene	60.8		NA					
2-Methylphenanthrene	68.5		NA					
2-Methylanthracene	3.54		NA					
4/9-Methylphenanthrene	137		NA					
1-Methylphenanthrene	74.2		80.4		90		Y	100
3,6-Dimethylphenanthrene	19.4		29.3		147		Y	100
Retene	4.10		9.1		74			100
2-Methylfluoranthene	2.11		9.6		112			100
Benzo(b)fluorene	2.99		10.1		106			100
C29-Hopane	12.5		NA					
18a-Oleanane	<0.6	U	NA					
C30-Hopane	27.8		NA					
C20-TAS	47.1		NA					
C21-TAS	26.3		NA					
C26(20S)-TAS	38.3		NA					
C26(20R)/C27(20S)-TAS	84.2		NA					
C28(20S)-TAS	145		NA					
C27(20R)-TAS	47.2		NA					
C28(20R)-TAS	113		NA					

Surrogate Recovery		
Naphthalene-d8	70	71
Acenaphthene-d10	88	89
Phenanthrene-d10	90	86
Chrysene-d12	93	89
Perylene-d12	84	87

B&B Laboratories
Project J16222
Report 16-3589

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Standard Reference Material Report

Laboratory ID	ENV3615C D
Sample ID	SRM1941b
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/07/16
Extraction Batch	ENV3615
Date Acquired	11/10/16 19:27
Method	B&B SOP1006
Sample Dry Weight (g)	4.05
% Dry	98
% Moisture	2
Dilution	1X

Target Compounds	Su. Corrected Conc. (ng/dry g)	Q	RPD (%)	SRM 1941b Certified Conc. (ng/dry g)	-30% Certified Conc. (ng/dry g)	+30% Certified Conc. (ng/dry g)
cis/trans Decalin	31.9					
C1-Decalins	15.5					
C2-Decalins	12.6					
C3-Decalins	24.4					
C4-Decalins	49.7					
Naphthalene	645		27	848 ± 95	527	1226
C1-Naphthalenes	203					
C2-Naphthalenes	197					
C3-Naphthalenes	164					
C4-Naphthalenes	83.3					
Benzothiophene	27.5					
C1-Benzothiophenes	31.2					
C2-Benzothiophenes	20.6					
C3-Benzothiophenes	18.0					
C4-Benzothiophenes	9.70					
Biphenyl	64.5					
Acenaphthylene	76.3					
Acenaphthene	24.0					
Dibenzofuran	81.9					
Fluorene	49.8		52	85 ± 15	49.0	130
C1-Fluorenes	50.2					
C2-Fluorenes	75.1					
C3-Fluorenes	81.1					
Carbazole	19.3					
Anthracene	183		0	184 ± 18	116	263
Phenanthrene	396		3	406 ± 44	253	585
C1-Phenanthrenes/Anthracenes	295					
C2-Phenanthrenes/Anthracenes	300					
C3-Phenanthrenes/Anthracenes	194					
C4-Phenanthrenes/Anthracenes	130					
Dibenzothiophene	50.9					
C1-Dibenzothiophenes	64.2					
C2-Dibenzothiophenes	100					
C3-Dibenzothiophenes	94.3					
C4-Dibenzothiophenes	31.5					
Fluoranthene	629		3	651 ± 50	421	911
Pyrene	474		20	581 ± 39	379	806
C1-Fluoranthenes/Pyrenes	305					
C2-Fluoranthenes/Pyrenes	242					
C3-Fluoranthenes/Pyrenes	125					
C4-Fluoranthenes/Pyrenes	68					
Naphthobenzothiophene	152					
C1-Naphthobenzothiophenes	126					
C2-Naphthobenzothiophenes	121					
C3-Naphthobenzothiophenes	68.0					
C4-Naphthobenzothiophenes	29.6					
Benz(a)anthracene	289		15	335 ± 25	217	468
Chrysene/Triphenylene	389		2	399 ± 36	254	566
C1-Chrysenes	231					
C2-Chrysenes	149					
C3-Chrysenes	80.9					
C4-Chrysenes	52.2					
Benzo(b)fluoranthene	421		7	453 ± 21	302	616
Benzo(k,j)fluoranthene	439		1	442 ± 23	293	605
Benzo(a)fluoranthene	67.5					
Benzo(e)pyrene	328		1	325 ± 25	210	455
Benzo(a)pyrene	251		35	358 ± 17	239	488
Perylene	322		21	397 ± 45	246	575
Indeno(1,2,3-c,d)pyrene	248		32	341 ± 57	199	517
Dibenzo(a,h)anthracene	79.8		40	53 ± 10	30.1	81.9
Benzo(g,h,i)perylene	240		25	307 ± 45	183	458
Total PAHs	9841					

B&B Laboratories
Project J16222
Report 16-3589

LEED Co - Lake Erie
Polycyclic Aromatic Hydrocarbon Data
Standard Reference Material Report

Laboratory ID	ENV3615C.D
Sample ID	SRM1941b
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/07/16
Extraction Batch	ENV3615
Date Acquired	11/10/16 19:27
Method	B&B SOP1006
Sample Dry Weight (g)	4.05
% Dry	98
% Moisture	2
Dilution	1X

Target Compounds	Su. Corrected Conc. (ng/dry g)	Q	RPD (%)	SRM 1941b Certified Conc. (ng/dry g)	-30% Certified Conc. (ng/dry g)	+30% Certified Conc. (ng/dry g)
Individual Alkyl Isomers and Hopanes						
2-Methylnaphthalene	206					
1-Methylnaphthalene	102					
2,6-Dimethylnaphthalene	39.1					
1,6,7-Trimethylnaphthalene	21.0					
1-Methylfluorene	26.9					
4-Methyldibenzothiophene	43.7					
2/3-Methyldibenzothiophene	29.2					
1-Methyldibenzothiophene	12.7					
3-Methylphenanthrene	88.8		17	105 ± 13	64.4	153
2-Methylphenanthrene	105					
2-Methylanthracene	62.6					
4/9-Methylphenanthrene	67.4					
1-Methylphenanthrene	60.9		18	73.2 ± 5.9	47.1	103
3,6-Dimethylphenanthrene	26.5					
Retene	29.3					
2-Methylfluoranthene	73.0					
Benzo(b)fluorene	70.8					
C29-Hopane	195					
18a-Oleanane	34.9					
C30-Hopane	283					
C20-TAS	44.7					
C21-TAS	6.25					
C26(20S)-TAS	9.00					
C26(20R)/C27(20S)-TAS	44.7					
C28(20S)-TAS	26.9					
C27(20R)-TAS	25.5					
C28(20R)-TAS	23.8					

Surrogate Recovery

Naphthalene-d8	63
Acenaphthene-d10	76
Phenanthrene-d10	80
Chrysene-d12	80
Perylene-d12	73

5.2 Appendix B - Aliphatic Hydrocarbons

B&B Laboratories
Project J16222
Report 16-3589

LEED Co. - Lake Erie
Aliphatic Hydrocarbon and Total Petroleum Hydrocarbon Data
Client Submitted Samples

Laboratory ID	LED0037.D	LED0038.D	LED0039.D	LED0046.D
Sample ID	PC01R, PC02, PC03	PC04, PC05R1, PC06R2, PC07	PC09, PC10	BC01, BC02, BC03
Matrix	Sediment	Sediment	Sediment	Sediment
Collection Date	NA	NA	NA	NA
Received Date	10/12/16	09/21/16	10/12/16	10/12/16
Extraction Date	11/07/16	11/07/16	11/07/16	11/07/16
Extraction Batch	ENV3615	ENV3615	ENV3615	ENV3615
Date Acquired	16-Nov-2016, 05:54	16-Nov-2016, 07:04	16-Nov-2016, 08:15	16-Nov-2016, 09:26
Method	B&B SOP1016	B&B SOP1016	B&B SOP1016	B&B SOP1016
Sample Dry Weight (g)	15.02	15.11	15.05	15.02
Sample Wet Weight (g)	18.69	18.18	19.61	65.26
% Dry	80	83	77	23
% Moisture	20	17	23	77
Dilution	1X	1X	1X	1X

Target Compounds	Su. Corrected Conc. (µg/dry g)	Q	Su. Corrected Conc. (µg/dry g)	Q	Su. Corrected Conc. (µg/dry g)	Q	Su. Corrected Conc. (µg/dry g)	Q
n-C9	0.120		0.113		0.089		0.095	
n-C10	0.048		0.077		0.065		0.071	
n-C11	0.099		0.172		0.109		0.114	
n-C12	0.321		0.275		0.141		0.175	
n-C13	0.961		0.682		0.349		0.325	
i-C15	0.395		0.709		0.346		0.204	
n-C14	1.305		1.259		0.624		0.393	
i-C16	0.815		1.333		0.758		0.302	
n-C15	1.297		1.813		1.105		0.542	
n-C16	1.302		1.550		1.083		0.422	
i-C18	0.624		1.226		0.751		0.222	
n-C17	1.214		1.722		1.137		1.467	
Pristane	1.127		1.701		1.384		0.339	
n-C18	1.222		1.286		1.041		0.990	
Phytane	0.634		1.465		0.993		0.299	
n-C19	1.244		1.576		1.137		0.643	
n-C20	0.979		1.443		1.025		0.348	
n-C21	0.894		1.248		0.881		1.672	
n-C22	0.820		1.465		0.773		0.392	
n-C23	0.707		1.274		0.675		0.698	
n-C24	0.567		0.636		0.518		0.350	
n-C25	0.513		0.922		0.568		0.849	
n-C26	0.432		0.658		0.385		0.352	
n-C27	0.415		0.900		0.395		1.264	
n-C28	0.376		0.317		0.612		0.641	
n-C29	0.379		0.812		0.420		1.880	
n-C30	0.229		0.313		0.192		0.398	
n-C31	0.253		0.407		0.465		2.344	
n-C32	0.143		0.155		0.247		0.395	
n-C33	0.154		0.410		0.216		1.721	
n-C34	0.094		0.117		0.186		0.282	
n-C35	0.092		0.109		0.184		1.503	
n-C36	0.040		0.105		<0.016	U	0.139	
n-C37	0.033		0.093		<0.017	U	0.214	
n-C38	0.033		0.062		<0.019	U	0.130	
n-C39	<0.019	U	0.042		<0.019	U	0.092	
n-C40	0.083		0.047		<0.019	U	0.124	
Total Alkanes	20.0		28.5		18.9		22.4	
Total Petroleum Hydrocarbons	201		822		770		606	
Total Resolved Hydrocarbons	45		141		59		160	
Unresolved Complex Mixture	156		682		711		446	
EOM (µg/dry g)	427		1159		1050		1530	

Surrogate (Su)	Su Recovery (%)	Su Recovery (%)	Su Recovery (%)	Su Recovery (%)
n-dodecane-d26	80	81	86	81
n-eicosane-d42	99	90	87	94
n-triacontane-d62	94	113	104	106

LEED Co. - Lake Erie
Aliphatic Hydrocarbon and Total Petroleum Hydrocarbon Data
Method Blank Report

Laboratory ID	ENV3615A.D
Sample ID	Method Blank
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/07/16
Extraction Batch	ENV3615
Date Acquired	15-Nov-2016, 22:49
Method	B&B SOP1016
Sample Dry Weight (g)	15.00
Sample Wet Weight (g)	NA
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su. Corrected Conc. (µg/dry g)	Q	Q	3X MDL Conc. (µg/dry g)	Actual MDL Conc. (µg/dry g)
n-C9	<0.012	U		0.037	0.012
n-C10	<0.021	U		0.064	0.021
n-C11	<0.016	U		0.049	0.016
n-C12	<0.019	U		0.056	0.019
n-C13	<0.045	U		0.134	0.045
i-C15	<0.016	U		0.049	0.016
n-C14	<0.013	U		0.039	0.013
i-C16	<0.004	U		0.013	0.004
n-C15	<0.016	U		0.049	0.016
n-C16	<0.004	U		0.013	0.004
i-C18	<0.004	U		0.011	0.004
n-C17	<0.003	U		0.010	0.003
Pristane	<0.003	U		0.008	0.003
n-C18	<0.004	U		0.011	0.004
Phytane	<0.006	U		0.018	0.006
n-C19	<0.005	U		0.015	0.005
n-C20	<0.012	U		0.037	0.012
n-C21	<0.004	U		0.012	0.004
n-C22	<0.003	U		0.010	0.003
n-C23	<0.008	U		0.024	0.008
n-C24	<0.005	U		0.016	0.005
n-C25	<0.007	U		0.021	0.007
n-C26	<0.008	U		0.023	0.008
n-C27	<0.011	U		0.032	0.011
n-C28	<0.011	U		0.033	0.011
n-C29	<0.021	U		0.064	0.021
n-C30	<0.013	U		0.038	0.013
n-C31	<0.015	U		0.044	0.015
n-C32	<0.012	U		0.035	0.012
n-C33	<0.021	U		0.064	0.021
n-C34	<0.016	U		0.049	0.016
n-C35	<0.015	U		0.044	0.015
n-C36	<0.016	U		0.047	0.016
n-C37	<0.017	U		0.052	0.017
n-C38	<0.019	U		0.057	0.019
n-C39	<0.019	U		0.056	0.019
n-C40	<0.019	U		0.056	0.019
Total Alkanes			U		
Total Petroleum Hydrocarbons	<1.4	U		4.20	1.40
Total Resolved Hydrocarbons	<1.4	U		4.20	1.40
Unresolved Complex Mixture	<1.4	U		4.20	1.40
EOM (µg/dry g)	<100			300	100

Surrogate (Su)	Su Recovery (%)
n-dodecane-d26	81
n-eicosane-d42	95
n-triacontane-d62	93

LEED Co. - Lake Erie
Aliphatic Hydrocarbon and Total Petroleum Hydrocarbon Data
Blank Spike Report

Laboratory ID	ENV3615B
Sample ID	Blank Spike
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/07/16
Extraction Batch	ENV3615
Date Acquired	16-Nov-2016, 00:00
Method	B&B SOP1016
Sample Dry Weight (g)	1.00
Sample Wet Weight (g)	NA
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su. Corrected Conc. (µg/dry g)	Recovery (%)	Q	Spike Amount (µg)
n-C9	9.86	98		10.0
n-C10	9.68	97		10.0
n-C11	10.0	100		10.0
n-C12	10.2	101		10.0
n-C13	9.73	96		10.1
n-C14	9.93	99		10.0
n-C15	10.0	100		10.0
n-C16	10.1	101		10.0
n-C17	10.1	101		10.0
Pristane	10.2	103		9.92
n-C18	10.2	102		10.1
Phytane	9.51	95		10.0
n-C19	10.2	103		10.0
n-C20	10.2	103		10.0
n-C21	10.2	102		10.1
n-C22	10.2	103		9.95
n-C23	10.3	104		9.89
n-C24	10.0	101		9.93
n-C25	10.2	102		10.0
n-C26	10.0	99		10.1
n-C27	10.2	102		10.0
n-C28	10.1	100		10.1
n-C29	10.0	101		9.93
n-C30	10.0	100		10.0
n-C31	10.0	99		10.1
n-C32	9.85	100		9.87
n-C33	10.1	101		10.0
n-C34	9.94	99		10.0
n-C35	9.84	99		10.0
n-C36	9.77	97		10.0
n-C37	9.94	99		10.1
n-C38	9.60	96		10.0
n-C39	9.44	94		10.0
n-C40	9.61	96		10.0
Average %Recovery		100		

Surrogate (Su)	Su Recovery (%)
n-dodecane-d26	91
n-eicosane-d42	96
n-triacontane-d62	94

LEED Co. - Lake Erie
Aliphatic Hydrocarbon and Total Petroleum Hydrocarbon Data
Laboratory Duplicate Report

Laboratory ID	LED0039.D	ENV3615E.D
Sample ID	PC09, PC10	PC09, PC10
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	10/12/16	10/12/16
Extraction Date	11/07/16	11/07/16
Extraction Batch	ENV3615	ENV3615
Date Acquired	16-Nov-2016, 08:15	16-Nov-2016, 04:43
Method	B&B SOP1016	B&B SOP1016
Sample Dry Weight (g)	15.05	15.07
Sample Wet Weight (g)	19.61	19.63
% Dry	77	77
% Moisture	23	23
Dilution	1X	1X

Target Compounds	Su. Corrected Conc. (µg/dry g)	Q	Su. Corrected Conc. (µg/dry g)	Q	RPD (%)	Q Q	MDL (µg/dry g)	3X MDL (µg/dry g)
n-C9	0.089		0.096		8		0.012	0.037
n-C10	0.065		0.055		17		0.021	0.064
n-C11	0.109		0.114		4		0.016	0.049
n-C12	0.141		0.152		8		0.019	0.056
n-C13	0.349		0.371		6		0.045	0.134
i-C15	0.346		0.347		0		0.016	0.049
n-C14	0.624		0.626		0		0.013	0.039
i-C16	0.758		0.772		2		0.004	0.013
n-C15	1.105		1.028		7		0.016	0.049
n-C16	1.083		1.029		5		0.004	0.013
i-C18	0.751		0.759		1		0.004	0.011
n-C17	1.137		1.199		5		0.003	0.010
Pristane	1.384		1.444		4		0.003	0.008
n-C18	1.041		1.045		0		0.004	0.011
Phytane	0.993		0.949		5		0.006	0.018
n-C19	1.137		1.090		4		0.005	0.015
n-C20	1.025		1.065		4		0.012	0.037
n-C21	0.881		0.876		1		0.004	0.012
n-C22	0.773		0.799		3		0.003	0.010
n-C23	0.675		0.678		0		0.008	0.024
n-C24	0.518		0.545		5		0.005	0.016
n-C25	0.568		0.527		7		0.007	0.021
n-C26	0.385		0.421		9		0.008	0.023
n-C27	0.395		0.388		2		0.011	0.032
n-C28	0.612		0.645		5		0.011	0.033
n-C29	0.420		0.416		1		0.021	0.064
n-C30	0.192		0.207		8		0.013	0.038
n-C31	0.465		0.461		1		0.015	0.044
n-C32	0.247		0.239		3		0.012	0.035
n-C33	0.216		0.225		4		0.021	0.064
n-C34	0.186		0.184		1		0.016	0.049
n-C35	0.184		0.171		7		0.015	0.044
n-C36	<0.016	U	<0.016	U	0		0.016	0.047
n-C37	<0.017	U	<0.017	U	0		0.017	0.052
n-C38	<0.019	U	<0.019	U	0		0.019	0.057
n-C39	<0.019	U	<0.019	U	0		0.019	0.056
n-C40	<0.019	U	<0.019	U	0		0.019	0.056
Total Alkanes	18.9		18.9		0			
Total Petroleum Hydrocarbons	770		772		0		1.40	4.20
Total Resolved Hydrocarbons	59		59		0		1.40	4.20
Unresolved Complex Mixture	711		713		0		1.40	4.20
EOM (µg/dry g)	1050		1105		5			

Surrogate (Su)	Su Recovery (%)	Su Recovery (%)
n-dodecane-d26	86	86
n-eicosane-d42	87	92
n-triacontane-d62	104	108

LEED Co. - Lake Erie
Aliphatic Hydrocarbon and Total Petroleum Hydrocarbon Data
Matrix Spike Report

Laboratory ID	LED0037.D	ENV3615D D
Sample ID	PC01R, PC02, PC03	PC01R, PC02, PC03
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	10/12/16	10/12/16
Extraction Date	11/07/16	11/07/16
Extraction Batch	ENV3615	ENV3615
Date Acquired	16-Nov-2016, 05:54	16-Nov-2016, 02 21
Method	B&B SOP1016	B&B SOP1016
Sample Dry Weight (g)	15.02	15.00
Sample Wet Weight (g)	18.69	18.66
% Dry	80	80
% Moisture	20	20
Dilution	1X	1X

Target Compounds	Su. Corrected Conc. (µg/dry g)	Q	Su. Corrected Conc. (µg/dry g)	Q	Recovery (%)	Q	Q	Spike Amount (µg)
n-C9	0.120		0.695		86			10.0
n-C10	0.048		0.656		91			10.0
n-C11	0.099		0.764		100			10.0
n-C12	0.321		1.052		109			10.0
n-C13	0.961		1.672		106			10.1
i-C15	0.395		NA					
n-C14	1.305		2.082		116			10.0
i-C16	0.815		NA					
n-C15	1.297		2.002		105			10.0
n-C16	1.302		1.962		99			10.0
i-C18	0.624		NA					
n-C17	1.214		1.980		114			10.0
Pristane	1.127		1.859		110			9.92
n-C18	1.222		1.994		115			10.1
Phytane	0.634		1.365		109			10.0
n-C19	1.244		1.924		102			10.0
n-C20	0.979		1.718		111			10.0
n-C21	0.894		1.629		110			10.1
n-C22	0.820		1.543		109			9.95
n-C23	0.707		1.446		112			9.89
n-C24	0.567		1.293		110			9.93
n-C25	0.513		1.230		108			10.0
n-C26	0.432		1.140		105			10.1
n-C27	0.415		1.153		110			10.0
n-C28	0.376		1.116		110			10.1
n-C29	0.379		1.097		108			9.93
n-C30	0.229		0.937		106			10.0
n-C31	0.253		0.979		108			10.1
n-C32	0.143		0.829		104			9.87
n-C33	0.154		0.872		108			10.0
n-C34	0.094		0.807		107			10.0
n-C35	0.092		0.806		107			10.0
n-C36	0.040		0.739		104			10.0
n-C37	0.033		0.736		105			10.1
n-C38	0.033		0.711		102			10.0
n-C39	<0.019	U	0.714		107			10.0
n-C40	0.083		0.767		103			10.0
Average %Recovery					106			

Surrogate (Su)	Su Recovery (%)	Su Recovery (%)
n-dodecane-d26	80	84
n-eicosane-d42	99	86
n-triacontane-d62	94	87

5.3 Appendix C - Chlorinated Hydrocarbons

B&B Laboratories
Project J16222
Report 16-3589

LEED Co - Lake Erie
Organochlorine Data
Client Submitted Samples

Lab ID	LED0037		LED0038		LED0039		LED0046	
Sample ID	PC01R, PC02, PC03		PC04, PC05R1, PC06R2, PC07		PC09, PC10		BC01, BC02, BC03	
Matrix	Sediment		Sediment		Sediment		Sediment	
Collection Date	NA		NA		NA		NA	
Received Date	10/12/16		09/21/16		10/12/16		10/12/16	
Extraction Date	11/09/16		11/09/16		11/09/16		11/09/16	
Extraction Batch	ENV3617		ENV3617		ENV3617		ENV3617	
Date Acquired	15-Nov-2016, 22:55		16-Nov-2016, 04:34		16-Nov-2016, 06:27		16-Nov-2016, 08:20	
Method	ECD1DUAL.M		ECD1DUAL.M		ECD1DUAL.M		ECD1DUAL.M	
Sample Dry Weight (g)	15.01		15.06		15.00		15.03	
Sample Wet Weight (g)	18.67		18.12		19.54		65.30	
% Dry	80		83		77		23	
% Moisture	20		17		23		77	
Dilution	1X		1X		1X		1X	
Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q
Aldrin	<0.06	U	<0.06	U	<0.06	U	<0.06	U
Dieldrin	<0.05	U	<0.05	U	<0.05	U	0.18	
Endrin	<0.06	U	<0.06	U	<0.06	U	<0.06	U
Heptachlor	0.02	J	<0.04	U	<0.04	U	0.27	
Heptachlor-Epoxide	<0.06	U	<0.06	U	<0.06	U	0.11	
Oxychlordane	0.06	J	<0.06	U	<0.06	U	0.06	J
Alpha-Chlordane	0.02	J	0.32		<0.05	U	0.38	
Gamma-Chlordane	<0.06	U	<0.05	U	<0.06	U	0.13	
Trans-Nonachlor	<0.05	U	0.04	J	<0.05	U	0.10	
Cis-Nonachlor	0.01	J	0.07		0.68		0.21	
Alpha-HCH	<0.08	U	<0.08	U	<0.08	U	<0.08	U
Beta-HCH	0.04	J	<0.05	U	<0.05	U	0.05	J
Delta-HCH	0.03	J	<0.05	U	0.03	J	0.14	
Gamma-HCH	0.20		<0.04	U	<0.04	U	0.85	
DDMU	<0.07	U	<0.07	U	<0.07	U	1.65	
2,4'-DDD	0.21		0.43		<0.05	U	0.61	
4,4'-DDD	0.02	J	<0.05	U	<0.05	U	<0.05	U
2,4'-DDE	0.01	J	<0.06	U	0.16		<0.06	U
4,4'-DDE	<0.05	U	0.18		1.97		3.89	
2,4'-DDT	0.01	J	<0.05	U	<0.05	U	<0.05	
4,4'-DDT	0.11		<0.05	U	<0.05	U	0.09	
1,2,3,4-Tetrachlorobenzene	<0.07	U	<0.07	U	<0.07	U	<0.07	U
1,2,4,5-Tetrachlorobenzene	<0.08	U	<0.08	U	<0.08	U	<0.08	U
Hexachlorobenzene	0.03	J	<0.05	U	0.12		1.48	
Pentachloroanisole	<0.05	U	<0.05	U	<0.05	U	<0.05	U
Pentachlorobenzene	<0.07	U	<0.07	U	<0.07	U	<0.07	U
Endosulfan II	<0.04	U	<0.04	U	2.15		<0.04	U
Endosulfan I	<0.04	U	<0.04	U	<0.04	U	<0.04	U
Endosulfan Sulfate	<0.04	U	<0.04	U	<0.04	U	<0.04	U
Mirex	<0.06	U	<0.06	U	0.14		0.03	J
Chlorpyrifos	<0.06	U	<0.06	U	<0.06	U	<0.06	U

LEED Co - Lake Erie
Organochlorine Data
Client Submitted Samples

Lab ID	LED0037	LED0038	LED0039	LED0046
Sample ID	PC01R, PC02, PC03	PC04, PC05R1, PC06R2, PC07	PC09, PC10	BC01, BC02, BC03
Matrix	Sediment	Sediment	Sediment	Sediment
Collection Date	NA	NA	NA	NA
Received Date	10/12/16	09/21/16	10/12/16	10/12/16
Extraction Date	11/09/16	11/09/16	11/09/16	11/09/16
Extraction Batch	ENV3617	ENV3617	ENV3617	ENV3617
Date Acquired	15-Nov-2016, 22:55	16-Nov-2016, 04:34	16-Nov-2016, 06:27	16-Nov-2016, 08:20
Method	ECD1DUAL.M	ECD1DUAL.M	ECD1DUAL.M	ECD1DUAL.M
Sample Dry Weight (g)	15.01	15.06	15.00	15.03
Sample Wet Weight (g)	18.67	18.12	19.54	65.30
% Dry	80	83	77	23
% Moisture	20	17	23	77
Dilution	1X	1X	1X	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q
PCB1	<0.08	U	<0.08	U	<0.08	U	<0.08	U
PCB7/9	<0.08	U	<0.08	U	<0.08	U	<0.08	U
PCB8/5	0.04	J	<0.08	U	3.40		<0.08	U
PCB15	<0.08	U	<0.08	U	4.56		0.35	
PCB16/32	<0.04	U	<0.04	U	4.98		1.13	
PCB18	0.03	J	<0.04	U	10.92		0.33	
PCB22/51	<0.04	U	0.58		11.45		1.05	
PCB24/27	0.03	J	<0.04	U	1.39		0.06	
PCB25	<0.04	U	0.67		2.41		0.61	
PCB26	<0.04	U	<0.04	U	4.26		0.24	
PCB28	0.03	J	0.06	J	15.19		1.78	
PCB29	<0.06	U	<0.06	U	0.03	J	0.30	
PCB31	<0.04	U	<0.04	U	18.95		1.69	
PCB33/53/20	<0.04	U	1.08		13.71		0.94	
PCB40	<0.07	U	<0.07	U	4.53		0.31	
PCB41/64	<0.07	U	<0.07	U	<0.07	U	<0.07	U
PCB42/59/37	<0.07	U	<0.07	U	9.78		0.62	
PCB43	0.07	J	0.45		0.64		1.25	
PCB44	<0.07	U	<0.07	U	14.79		0.98	
PCB45	0.03	J	0.04	J	3.03		0.14	
PCB46	0.06	J	0.03	J	1.41		0.19	
PCB47/48/75	<0.07	U	0.22		3.73		1.93	
PCB49	0.02	J	0.24		11.34		1.15	
PCB52	0.12		0.17		17.77		3.00	
PCB56/60	<0.07	U	<0.07	U	20.84		1.43	
PCB66	0.02	J	0.39		17.54		1.93	
PCB70	0.09		<0.07	U	23.80		2.98	
PCB74/61	0.06	J	<0.07	U	12.50		1.90	
PCB81	<0.07	U	<0.07	U	<0.07	U	<0.07	U
PCB82	<0.04	U	<0.04	U	4.14		0.93	
PCB83	<0.04	U	0.04	J	1.21		0.24	
PCB84	0.01	J	<0.04	U	3.91		0.78	
PCB85	<0.04	U	0.05		4.31		0.98	
PCB86	0.05		0.06		<0.04	U	<0.04	U
PCB87/115	<0.05	U	<0.05	U	8.08		1.75	
PCB88	0.01	J	<0.04	U	<0.04	U	<0.04	U
PCB92	<0.04	U	<0.04	U	3.90		<0.04	U
PCB95	0.01	J	0.25		3.98		1.46	
PCB97	<0.04	U	0.05		6.22		0.74	
PCB99	0.01	J	0.04	J	7.86		1.25	
PCB101/90	0.02	J	0.19		16.79		3.14	
PCB105	<0.04	U	<0.04	U	6.40		1.43	
PCB107	<0.04	U	<0.04	U	2.78		1.16	
PCB110/77	0.07		<0.05	U	17.68		5.35	
PCB114/131/122	<0.04	U	<0.04	U	0.26		<0.04	U
PCB118	0.01	J	0.55		12.32		3.24	
PCB128	<0.07	U	0.05	J	2.20		0.94	
PCB129/126	<0.1	U	0.29		0.46		0.11	
PCB136	<0.1	U	<0.1	U	2.12		<0.1	U
PCB138/160	<0.1	U	0.38		12.53		3.14	
PCB141/179	<0.1	U	<0.1	U	3.64		0.73	
PCB146	<0.1	U	<0.1	U	1.42		0.70	

B&B Laboratories
Project J16222
Report 16-3589

LEED Co - Lake Erie
Organochlorine Data
Client Submitted Samples

Lab ID	LED0037		LED0038		LED0039		LED0046	
Sample ID	PC01R, PC02, PC03		PC04, PC05R1, PC06R2, PC07		PC09, PC10		BC01, BC02, BC03	
Matrix	Sediment		Sediment		Sediment		Sediment	
Collection Date	NA		NA		NA		NA	
Received Date	10/12/16		09/21/16		10/12/16		10/12/16	
Extraction Date	11/09/16		11/09/16		11/09/16		11/09/16	
Extraction Batch	ENV3617		ENV3617		ENV3617		ENV3617	
Date Acquired	15-Nov-2016, 22:55		16-Nov-2016, 04:34		16-Nov-2016, 06:27		16-Nov-2016, 08:20	
Method	ECD1DUAL.M		ECD1DUAL.M		ECD1DUAL.M		ECD1DUAL.M	
Sample Dry Weight (g)	15.01		15.06		15.00		15.03	
Sample Wet Weight (g)	18.67		18.12		19.54		65.30	
% Dry	80		83		77		23	
% Moisture	20		17		23		77	
Dilution	1X		1X		1X		1X	
Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q
PCB149/123	0.02	J	<0.1	U	6.71		2.17	
PCB151	<0.1	U	<0.1	U	2.43		0.60	
PCB153/132	0.01	J	0.65		15.25		5.63	
PCB156/171/202	<0.1	U	0.82		0.76		0.61	
PCB158	<0.1	U	0.28		1.33		0.17	
PCB166	<0.1	U	<0.1	U	<0.1	U	0.12	
PCB167	<0.1	U	<0.1	U	<0.1	U	0.08	J
PCB169	<0.1	U	<0.1	U	<0.1	U	<0.1	U
PCB170/190	<0.09	U	0.17		0.85		1.93	
PCB172	0.15		0.08		0.06		0.37	
PCB174	<0.05	U	<0.05	U	2.43		1.07	
PCB176/137	<0.05	U	2.06		1.06		0.12	
PCB177	<0.05	U	0.80		1.21		0.52	
PCB178	<0.05	U	0.24		0.50		0.16	
PCB180	<0.05	U	0.33		5.28		1.50	
PCB183	0.01	J	<0.05	U	0.99		0.44	
PCB185	<0.05	U	0.52		0.49		0.52	
PCB187	<0.05	U	0.76		0.87		1.81	
PCB189	<0.05	U	0.19		0.05		0.04	J
PCB191	<0.05	U	<0.05	U	0.52		0.20	
PCB194	<0.04	U	1.65		0.99		0.37	
PCB195/208	<0.04	U	0.10		0.37		0.17	
PCB196/203	<0.04	U	0.19		1.29		0.78	
PCB199	<0.08	U	<0.08	U	1.37		1.00	
PCB200	<0.04	U	<0.04	U	0.11		0.01	J
PCB201/157/173	<0.04	U	1.10		0.40		0.22	
PCB205	<0.04	U	0.10		0.21		1.06	
PCB206	<0.05	U	<0.05	U	0.37		0.22	
PCB209	<0.05	U	<0.05	U	0.17		0.49	
Total HCH	0.28		0.00	U	0.03	J	1.04	
Total Chlordane	0.11	J	0.43		0.68		1.26	
Total DDT	0.37		0.60		2.13		6.23	
Total PCB	0.98	J	15.90		401.17		77.05	
Surrogate (Su)	Su Recovery (%)		Su Recovery (%)		Su Recovery (%)		Su Recovery (%)	
DBOFB	84		84		77		80	
PCB 103	74		83		75		78	
PCB 198	83		90		81		80	

Lab ID	ENV3617A
Sample ID	Method Blank
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/09/16
Extraction Batch	ENV3617
Date Acquired	15-Nov-2016, 06:01
Method	ECD1DUAL.M
Sample Dry Weight (g)	15.07
Sample Wet Weight (g)	NA
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Q	3X MDL	Actual MDL
Aldrin	<0.06	U		0.17	0.06
Dieldrin	<0.05	U		0.15	0.05
Endrin	<0.06	U		0.17	0.06
Heptachlor	<0.04	U		0.12	0.04
Heptachlor-Epoxide	<0.06	U		0.18	0.06
Oxychlordane	<0.06	U		0.19	0.06
Alpha-Chlordane	<0.05	U		0.14	0.05
Gamma-Chlordane	<0.05	U		0.16	0.05
Trans-Nonachlor	<0.05	U		0.15	0.05
Cis-Nonachlor	<0.04	U		0.13	0.04
Alpha-HCH	<0.08	U		0.23	0.08
Beta-HCH	<0.05	U		0.15	0.05
Delta-HCH	<0.05	U		0.14	0.05
Gamma-HCH	<0.04	U		0.11	0.04
DDMU	<0.07	U		0.20	0.07
2,4'-DDD	<0.05	U		0.14	0.05
4,4'-DDD	<0.05	U		0.16	0.05
2,4'-DDE	<0.06	U		0.17	0.06
4,4'-DDE	<0.05	U		0.14	0.05
2,4'-DDT	<0.05	U		0.14	0.05
4,4'-DDT	<0.05	U		0.14	0.05
1,2,3,4-Tetrachlorobenzene	<0.07	U		0.20	0.07
1,2,4,5-Tetrachlorobenzene	<0.08	U		0.24	0.08
Hexachlorobenzene	<0.05	U		0.16	0.05
Pentachloroanisole	<0.05	U		0.14	0.05
Pentachlorobenzene	<0.07	U		0.20	0.07
Endosulfan II	<0.04	U		0.12	0.04
Endosulfan I	<0.04	U		0.12	0.04
Endosulfan Sulfate	<0.04	U		0.13	0.04
Mirex	<0.06	U		0.17	0.06
Chlorpyrifos	<0.06	U		0.17	0.06

Lab ID	ENV3617A
Sample ID	Method Blank
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/09/16
Extraction Batch	ENV3617
Date Acquired	15-Nov-2016, 06 01
Method	ECD1DUAL.M
Sample Dry Weight (g)	15.07
Sample Wet Weight (g)	NA
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Q	3X MDL	Actual MDL
PCB1	<0.08	U		0.24	0.08
PCB7/9	<0.08	U		0.24	0.08
PCB8/5	<0.08	U		0.24	0.08
PCB15	<0.08	U		0.24	0.08
PCB16/32	<0.04	U		0.13	0.04
PCB18	<0.04	U		0.13	0.04
PCB22/51	<0.04	U		0.13	0.04
PCB24/27	<0.04	U		0.13	0.04
PCB25	<0.04	U		0.13	0.04
PCB26	<0.04	U		0.13	0.04
PCB28	<0.06	U		0.18	0.06
PCB29	<0.06	U		0.19	0.06
PCB31	<0.04	U		0.13	0.04
PCB33/53/20	<0.04	U		0.13	0.04
PCB40	<0.07	U		0.21	0.07
PCB41/64	<0.07	U		0.21	0.07
PCB42/59/37	<0.07	U		0.21	0.07
PCB43	<0.07	U		0.21	0.07
PCB44	<0.07	U		0.21	0.07
PCB45	<0.07	U		0.21	0.07
PCB46	<0.07	U		0.21	0.07
PCB47/48/75	<0.07	U		0.21	0.07
PCB49	<0.07	U		0.21	0.07
PCB52	<0.07	U		0.21	0.07
PCB56/60	<0.07	U		0.21	0.07
PCB66	<0.06	U		0.17	0.06
PCB70	<0.07	U		0.21	0.07
PCB74/61	<0.07	U		0.21	0.07
PCB81	<0.07	U		0.21	0.07
PCB82	<0.04	U		0.13	0.04
PCB83	<0.04	U		0.13	0.04
PCB84	<0.04	U		0.13	0.04
PCB85	<0.04	U		0.13	0.04
PCB86	<0.04	U		0.13	0.04
PCB87/115	<0.05	U		0.16	0.05
PCB88	<0.04	U		0.13	0.04
PCB92	<0.04	U		0.13	0.04
PCB95	<0.04	U		0.13	0.04
PCB97	<0.04	U		0.13	0.04
PCB99	<0.04	U		0.13	0.04
PCB101/90	<0.04	U		0.13	0.04
PCB105	<0.04	U		0.13	0.04
PCB107	<0.04	U		0.13	0.04
PCB110/77	<0.05	U		0.15	0.05
PCB114/131/122	<0.04	U		0.13	0.04
PCB118	<0.05	U		0.16	0.05
PCB128	<0.07	U		0.20	0.07
PCB129/126	<0.1	U		0.29	0.10
PCB136	<0.1	U		0.29	0.10
PCB138/160	<0.1	U		0.29	0.10
PCB141/179	<0.1	U		0.29	0.10
PCB146	<0.1	U		0.29	0.10

B&B Laboratories
Project J16222
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LEED Co - Lake Erie
Organochlorine Data
Method Blank Report

Lab ID	ENV3617A
Sample ID	Method Blank
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/09/16
Extraction Batch	ENV3617
Date Acquired	15-Nov-2016, 06:01
Method	ECD1DUAL.M
Sample Dry Weight (g)	15.07
Sample Wet Weight (g)	NA
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Q	3X MDL	Actual MDL
PCB149/123	<0.1	U		0.29	0.10
PCB151	<0.1	U		0.29	0.10
PCB153/132	<0.04	U		0.11	0.04
PCB156/171/202	<0.1	U		0.29	0.10
PCB158	<0.1	U		0.29	0.10
PCB166	<0.1	U		0.29	0.10
PCB167	<0.1	U		0.29	0.10
PCB169	<0.1	U		0.29	0.10
PCB170/190	<0.09	U		0.28	0.09
PCB172	<0.05	U		0.14	0.05
PCB174	<0.05	U		0.14	0.05
PCB176/137	<0.05	U		0.14	0.05
PCB177	<0.05	U		0.14	0.05
PCB178	<0.05	U		0.14	0.05
PCB180	<0.05	U		0.14	0.05
PCB183	<0.05	U		0.14	0.05
PCB185	<0.05	U		0.14	0.05
PCB187	<0.05	U		0.15	0.05
PCB189	<0.05	U		0.14	0.05
PCB191	<0.05	U		0.14	0.05
PCB194	<0.04	U		0.12	0.04
PCB195/208	<0.04	U		0.12	0.04
PCB196/203	<0.04	U		0.12	0.04
PCB199	<0.08	U		0.24	0.08
PCB200	<0.04	U		0.12	0.04
PCB201/157/173	<0.04	U		0.12	0.04
PCB205	<0.04	U		0.12	0.04
PCB206	<0.05	U		0.15	0.05
PCB209	<0.05	U		0.16	0.05
Total HCH	<0.1		U	0.29	0.10
Total Chlordane	<0.18		U	0.54	0.18
Total DDT	<0.15		U	0.45	0.15
Total PCB	<1.25		U	3.76	1.25

Surrogate (Su)	Su Recovery (%)
DBOFB	90
PCB 103	95
PCB 198	100

Lab ID	ENV3617B
Sample ID	Blank Spike
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/09/16
Extraction Batch	ENV3617
Date Acquired	15-Nov-2016, 07:54
Method	ECD1DUAL.M
Sample Dry Weight (g)	1.00
Sample Wet Weight (g)	NA
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Recovery (%)	Q	Spike Amount (ng)
Aldrin	34.02		85		40
Dieldrin	30.86		77		40
Endrin	34.01		85		40
Heptachlor	44.33		111		40
Heptachlor-Epoxide	36.93		92		40
Oxychlordane	34.06		85		40
Alpha-Chlordane	36.65		92		40
Gamma-Chlordane	35.13		87		40
Trans-Nonachlor	36.54		91		40
Cis-Nonachlor	37.25		93		40
Alpha-HCH	34.37		86		40
Beta-HCH	35.20		88		40
Delta-HCH	30.84		77		40
Gamma-HCH	33.06		83		40
DDMU	40.76		102		40
2,4'-DDD	36.67		92		40
4,4'-DDD	35.74		89		40
2,4'-DDE	37.44		94		40
4,4'-DDE	34.57		87		40
2,4'-DDT	39.49		99		40
4,4'-DDT	39.15		98		40
1,2,3,4-Tetrachlorobenzene	38.81		97		40
1,2,4,5-Tetrachlorobenzene	39.87		100		40
Hexachlorobenzene	38.63		97		40
Pentachloroanisole	41.07		103		40
Pentachlorobenzene	35.74		89		40
Endosulfan II	19.04		48		40
Endosulfan I	NA				
Endosulfan Sulfate	36.06		90		40
Mirex	42.36		106		40
Chlorpyrifos	36.98		92		40

Lab ID	ENV3617B
Sample ID	Blank Spike
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/09/16
Extraction Batch	ENV3617
Date Acquired	15-Nov-2016, 07:54
Method	ECD1DUAL.M
Sample Dry Weight (g)	1.00
Sample Wet Weight (g)	NA
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Recovery (%)	Q	Spike Amount (ng)
PCB1	NA				
PCB7/9	NA				
PCB8/5	33.07		83		40
PCB15	NA				
PCB16/32	NA				
PCB18	41.12		103		40
PCB22/51	NA				
PCB24/27	NA				
PCB25	NA				
PCB26	NA				
PCB28	40.98		102		40
PCB29	41.62		104		40
PCB31	NA				
PCB33/53/20	NA				
PCB40	NA				
PCB41/64	NA				
PCB42/59/37	NA				
PCB43	NA				
PCB44	41.02		103		40
PCB45	NA				
PCB46	NA				
PCB47/48/75	NA				
PCB49	NA				
PCB52	40.90		102		40
PCB56/60	NA				
PCB66	40.61		102		40
PCB70	NA				
PCB74/61	NA				
PCB81	NA				
PCB82	NA				
PCB83	NA				
PCB84	NA				
PCB85	NA				
PCB86	NA				
PCB87/115	39.95		100		40
PCB88	NA				
PCB92	NA				
PCB95	NA				
PCB97	NA				
PCB99	NA				
PCB101/90	41.45		104		40
PCB105	36.83		92		40
PCB107	NA				
PCB110/77	40.92		102		40
PCB114/131/122	NA				
PCB118	40.32		101		40
PCB128	42.00		105		40
PCB129/126	NA				
PCB136	NA				
PCB138/160	41.55		104		40
PCB141/179	NA				
PCB146	NA				

Lab ID	ENV3617B
Sample ID	Blank Spike
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/09/16
Extraction Batch	ENV3617
Date Acquired	15-Nov-2016, 07:54
Method	ECD1DUAL.M
Sample Dry Weight (g)	1.00
Sample Wet Weight (g)	NA
% Dry	NA
% Moisture	NA
Dilution	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Recovery (%)	Q	Spike Amount (ng)
PCB149/123	NA				
PCB151	NA				
PCB153/132	42.06		105		40
PCB156/171/202	NA				
PCB158	NA				
PCB166	NA				
PCB167	NA				
PCB169	NA				
PCB170/190	42.49		106		40
PCB172	NA				
PCB174	NA				
PCB176/137	NA				
PCB177	NA				
PCB178	NA				
PCB180	41.53		104		40
PCB183	NA				
PCB185	NA				
PCB187	41.91		105		40
PCB189	NA				
PCB191	NA				
PCB194	NA				
PCB195/208	44.31		111		40
PCB196/203	NA				
PCB199	43.62		109		40
PCB200	NA				
PCB201/157/173	NA				
PCB205	NA				
PCB206	44.76		112		40
PCB209	46.20		116		40
	Average % Recovery		96		

Surrogate (Su)	Su Recovery (%)
DBOFB	90
PCB 103	94
PCB 198	104

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Lab ID	LED0037	ENV3617E
Sample ID	PC01R, PC02, PC03	PC01R, PC02, PC03
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	10/12/16	10/12/16
Extraction Date	11/09/16	11/09/16
Extraction Batch	ENV3617	ENV3617
Date Acquired	15-Nov-2016, 22:55	15-Nov-2016, 21:03
Method	ECD1DUAL.M	ECD1DUAL.M
Sample Dry Weight (g)	15.01	15.03
Sample Wet Weight (g)	18.67	18.70
% Dry	80	80
% Moisture	20	20
Dilution	1X	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	RPD (%)	Q	3X MDL	MDL
Aldrin	<0.06	U	<0.06	U			0.166	0.06
Dieldrin	<0.05	U	<0.05	U			0.147	0.05
Endrin	<0.06	U	<0.06	U			0.167	0.06
Heptachlor	0.02	J	0.02	J	0		0.124	0.04
Heptachlor-Epoxide	<0.06	U	<0.06	U			0.179	0.06
Oxychlordane	0.06	J	0.06	J	0		0.188	0.06
Alpha-Chlordane	0.02	J	0.02	J	0		0.138	0.05
Gamma-Chlordane	<0.06	U	<0.06	U			0.165	0.06
Trans-Nonachlor	<0.05	U	<0.05	U			0.148	0.05
Cis-Nonachlor	0.01	J	0.02	J	67		0.132	0.04
Alpha-HCH	<0.08	U	<0.08	U			0.229	0.08
Beta-HCH	0.04	J	0.04	J	0		0.151	0.05
Delta-HCH	0.03	J	0.03	J	0		0.139	0.05
Gamma-HCH	0.20		0.21		5		0.110	0.04
DDMU	<0.07	U	<0.07	U			0.204	0.07
2,4'-DDD	0.21		0.22		5		0.137	0.05
4,4'-DDD	0.02	J	0.03	J	40		0.159	0.05
2,4'-DDE	0.01	J	0.01	J	0		0.170	0.06
4,4'-DDE	<0.05	U	<0.05	U			0.141	0.05
2,4'-DDT	0.01	J	0.01	J	0		0.138	0.05
4,4'-DDT	0.11		0.12		9		0.140	0.05
1,2,3,4-Tetrachlorobenzene	<0.07	U	<0.07	U			0.199	0.07
1,2,4,5-Tetrachlorobenzene	<0.08	U	<0.08	U			0.240	0.08
Hexachlorobenzene	0.03	J	0.03	J	0		0.163	0.05
Pentachloroanisole	<0.05	U	<0.05	U			0.137	0.05
Pentachlorobenzene	<0.07	U	<0.07	U			0.201	0.07
Endosulfan II	<0.04	U	<0.04	U			0.117	0.04
Endosulfan I	<0.04	U	<0.04	U			0.120	0.04
Endosulfan Sulfate	<0.04	U	<0.04	U			0.127	0.04
Mirex	<0.06	U	<0.06	U			0.173	0.06
Chlorpyrifos	<0.06	U	<0.06	U			0.173	0.06

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Lab ID	LED0037	ENV3617E
Sample ID	PC01R, PC02, PC03	PC01R, PC02, PC03
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	10/12/16	10/12/16
Extraction Date	11/09/16	11/09/16
Extraction Batch	ENV3617	ENV3617
Date Acquired	15-Nov-2016, 22:55	15-Nov-2016, 21:03
Method	ECD1DUAL.M	ECD1DUAL.M
Sample Dry Weight (g)	15.01	15.03
Sample Wet Weight (g)	18.67	18.70
% Dry	80	80
% Moisture	20	20
Dilution	1X	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	RPD (%)	Q	3X MDL	MDL
PCB1	<0.08	U	<0.08	U			0.245	0.08
PCB7/9	<0.08	U	<0.08	U			0.245	0.08
PCB8/5	0.04	J	0.03	J	29		0.245	0.08
PCB15	<0.08	U	<0.08	U			0.245	0.08
PCB16/32	<0.04	U	<0.04	U			0.134	0.04
PCB18	0.03	J	0.03	J	0		0.134	0.04
PCB22/51	<0.04	U	<0.04	U			0.134	0.04
PCB24/27	0.03	J	0.02	J	40		0.134	0.04
PCB25	<0.04	U	<0.04	U			0.134	0.04
PCB26	<0.04	U	<0.04	U			0.134	0.04
PCB28	0.03	J	0.03	J	0		0.181	0.06
PCB29	<0.06	U	<0.06	U			0.192	0.06
PCB31	<0.04	U	<0.04	U			0.134	0.04
PCB33/53/20	<0.04	U	<0.04	U			0.134	0.04
PCB40	<0.07	U	<0.07	U			0.215	0.07
PCB41/64	<0.07	U	<0.07	U			0.215	0.07
PCB42/59/37	<0.07	U	<0.07	U			0.215	0.07
PCB43	0.07	J	0.07	J	0		0.215	0.07
PCB44	<0.07	U	<0.07	U			0.215	0.07
PCB45	0.03	J	0.02	J	40		0.215	0.07
PCB46	0.06	J	0.07	J	15		0.215	0.07
PCB47/48/75	<0.07	U	<0.07	U			0.215	0.07
PCB49	0.02	J	0.02	J	0		0.215	0.07
PCB52	0.12		0.12		0		0.215	0.07
PCB56/60	<0.07	U	<0.07	U			0.215	0.07
PCB66	0.02	J	0.02	J	0		0.167	0.06
PCB70	0.09		0.09		0		0.215	0.07
PCB74/61	0.06	J	0.06	J	0		0.215	0.07
PCB81	<0.07	U	<0.07	U			0.215	0.07
PCB82	<0.04	U	<0.04	U			0.132	0.04
PCB83	<0.04	U	<0.04	U			0.132	0.04
PCB84	0.01	J	0.01	J	0		0.132	0.04
PCB85	<0.04	U	<0.04	U			0.132	0.04
PCB86	0.05		0.05		0		0.132	0.04
PCB87/115	<0.05	U	<0.05	U			0.158	0.05
PCB88	0.01	J	0.01	J	0		0.132	0.04
PCB92	<0.04	U	<0.04	U			0.132	0.04
PCB95	0.01	J	0.01	J	0		0.132	0.04
PCB97	<0.04	U	<0.04	U			0.132	0.04
PCB99	0.01	J	0.02	J	67		0.132	0.04
PCB101/90	0.02	J	0.03	J	40		0.132	0.04
PCB105	<0.04	U	<0.04	U			0.128	0.04
PCB107	<0.04	U	<0.04	U			0.132	0.04
PCB110/77	0.07		0.08		13		0.150	0.05
PCB114/131/122	<0.04	U	<0.04	U			0.132	0.04
PCB118	0.01	J	0.01	J	0		0.159	0.05
PCB128	<0.07	U	<0.07	U			0.196	0.07
PCB129/126	<0.1	U	<0.1	U			0.287	0.10
PCB136	<0.1	U	<0.1	U			0.287	0.10
PCB138/160	<0.1	U	<0.1	U			0.287	0.10
PCB141/179	<0.1	U	<0.1	U			0.287	0.10
PCB146	<0.1	U	<0.1	U			0.287	0.10

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Organochlorine Data
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Lab ID	LED0037	ENV3617E
Sample ID	PC01R, PC02, PC03	PC01R, PC02, PC03
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	10/12/16	10/12/16
Extraction Date	11/09/16	11/09/16
Extraction Batch	ENV3617	ENV3617
Date Acquired	15-Nov-2016, 22:55	15-Nov-2016, 21:03
Method	ECD1DUAL.M	ECD1DUAL.M
Sample Dry Weight (g)	15.01	15.03
Sample Wet Weight (g)	18.67	18.70
% Dry	80	80
% Moisture	20	20
Dilution	1X	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	RPD (%)	Q	3X MDL	MDL
PCB149/123	0.02	J	0.02	J	0		0.287	0.10
PCB151	<0.1	U	<0.1	U			0.287	0.10
PCB153/132	0.01	J	0.01	J	0		0.111	0.04
PCB156/171/202	<0.1	U	<0.1	U			0.287	0.10
PCB158	<0.1	U	<0.1	U			0.287	0.10
PCB166	<0.1	U	<0.1	U			0.287	0.10
PCB167	<0.1	U	<0.1	U			0.287	0.10
PCB169	<0.1	U	<0.1	U			0.287	0.10
PCB170/190	<0.09	U	<0.09	U			0.278	0.09
PCB172	0.15		0.16		6		0.143	0.05
PCB174	<0.05	U	<0.05	U			0.143	0.05
PCB176/137	<0.05	U	<0.05	U			0.143	0.05
PCB177	<0.05	U	<0.05	U			0.143	0.05
PCB178	<0.05	U	<0.05	U			0.143	0.05
PCB180	<0.05	U	<0.05	U			0.143	0.05
PCB183	0.01	J	0.01	J	0		0.143	0.05
PCB185	<0.05	U	<0.05	U			0.143	0.05
PCB187	<0.05	U	<0.05	U			0.150	0.05
PCB189	<0.05	U	<0.05	U			0.143	0.05
PCB191	<0.05	U	<0.05	U			0.143	0.05
PCB194	<0.04	U	<0.04	U			0.119	0.04
PCB195/208	<0.04	U	<0.04	U			0.119	0.04
PCB196/203	<0.04	U	<0.04	U			0.119	0.04
PCB199	<0.08	U	<0.08	U			0.243	0.08
PCB200	<0.04	U	<0.04	U			0.119	0.04
PCB201/157/173	<0.04	U	<0.04	U			0.119	0.04
PCB205	<0.04	U	<0.04	U			0.119	0.04
PCB206	<0.05	U	<0.05	U			0.155	0.05
PCB209	<0.05	U	<0.05	U			0.160	0.05
Total HCH	0.28		0.28		0		0.295	0.10
Total Chlordane	0.11	J	0.13	J	17		0.546	0.18
Total DDT	0.37		0.40		8		0.454	0.15
Total PCB	0.98	J	1.01	J	3		3.769	1.26

Surrogate (Su)	Su Recovery (%)	Su Recovery (%)
DBOFB	84	82
PCB 103	74	71
PCB 198	83	85

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LEED Co - Lake Erie
Organochlorine Data
Matrix Spike Report

Lab ID	LED0038	ENV3617D
Sample ID	PC04, PC05R1, PC06R2, PC07	PC04, PC05R1, PC06R2, PC07
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	09/21/16	09/21/16
Extraction Date	11/09/16	11/09/16
Extraction Batch	ENV3617	ENV3617
Date Acquired	16-Nov-2016, 04:34	15-Nov-2016, 15:25
Method	ECD1DUAL.M	ECD1DUAL.M
Sample Dry Weight (g)	15.06	15.06
Sample Wet Weight (g)	18.12	18.12
% Dry	83	83
% Moisture	17	17
Dilution	1X	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	Recovery (%)	Q	Q	Spike Amount (ng)
Aldrin	<0.06	U	2.62		99			40
Dieldrin	<0.05	U	2.33		88			40
Endrin	<0.06	U	2.33		87			40
Heptachlor	<0.04	U	2.32		87			40
Heptachlor-Epoxide	<0.06	U	2.33		88			40
Oxychlordane	<0.06	U	2.74		103			40
Alpha-Chlordane	0.32		2.34		76			40
Gamma-Chlordane	<0.05	U	2.39		90			40
Trans-Nonachlor	0.04	J	2.46		91			40
Cis-Nonachlor	0.07		2.43		89			40
Alpha-HCH	<0.08	U	2.32		87			40
Beta-HCH	<0.05	U	2.43		91			40
Delta-HCH	<0.05	U	1.86		70			40
Gamma-HCH	<0.04	U	2.38		90			40
DDMU	<0.07	U	2.60		98			40
2,4'-DDD	0.43		3.47		114			40
4,4'-DDD	<0.05	U	2.74		103			40
2,4'-DDE	<0.06	U	2.32		87			40
4,4'-DDE	0.18		2.03		70			40
2,4'-DDT	<0.05	U	2.37		89			40
4,4'-DDT	<0.05	U	1.97		74			40
1,2,3,4-Tetrachlorobenzene	<0.07	U	2.65		100			40
1,2,4,5-Tetrachlorobenzene	<0.08	U	2.22		84			40
Hexachlorobenzene	<0.05	U	2.76		104			40
Pentachloroanisole	<0.05	U	3.10		117			40
Pentachlorobenzene	<0.07	U	2.55		96			40
Endosulfan II	<0.04	U	1.96		74			40
Endosulfan I	<0.04	U	NA					
Endosulfan Sulfate	<0.04	U	2.78		104			40
Mirex	<0.06	U	2.46		93			40
Chlorpyrifos	<0.06	U	<0.06	U	0	I		40

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Organochlorine Data
Matrix Spike Report

Lab ID	LED0038	ENV3617D
Sample ID	PC04, PC05R1, PC06R2, PC07	PC04, PC05R1, PC06R2, PC07
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	09/21/16	09/21/16
Extraction Date	11/09/16	11/09/16
Extraction Batch	ENV3617	ENV3617
Date Acquired	16-Nov-2016, 04:34	15-Nov-2016, 15:25
Method	ECD1DUAL.M	ECD1DUAL.M
Sample Dry Weight (g)	15.06	15.06
Sample Wet Weight (g)	18.12	18.12
% Dry	83	83
% Moisture	17	17
Dilution	1X	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	Recovery (%)	Q	Q	Spike Amount (ng)
PCB1	<0.08	U	NA					
PCB7/9	<0.08	U	NA					
PCB8/5	<0.08	U	2.75		103			40
PCB15	<0.08	U	NA					
PCB16/32	<0.04	U	NA					
PCB18	<0.04	U	2.12		80			40
PCB22/51	0.58		NA					
PCB24/27	<0.04	U	NA					
PCB25	0.67		NA					
PCB26	<0.04	U	NA					
PCB28	0.06	J	1.86		68			40
PCB29	<0.06	U	2.27		85			40
PCB31	<0.04	U	NA					
PCB33/53/20	1.08		NA					
PCB40	<0.07	U	NA					
PCB41/64	<0.07	U	NA					
PCB42/59/37	<0.07	U	NA					
PCB43	0.45		NA					
PCB44	<0.07	U	2.13		80			40
PCB45	0.04	J	NA					
PCB46	0.03	J	NA					
PCB47/48/75	0.22		NA					
PCB49	0.24		NA					
PCB52	0.17		2.14		74			40
PCB56/60	<0.07	U	NA					
PCB66	0.39		2.84		92			40
PCB70	<0.07	U	NA					
PCB74/61	<0.07	U	NA					
PCB81	<0.07	U	NA					
PCB82	<0.04	U	NA					
PCB83	0.04	J	NA					
PCB84	<0.04	U	NA					
PCB85	0.05		NA					
PCB86	0.06		NA					
PCB87/115	<0.05	U	2.55		96			40
PCB88	<0.04	U	NA					
PCB92	<0.04	U	NA					
PCB95	0.25		NA					
PCB97	0.05		NA					
PCB99	0.04	J	NA					
PCB101/90	0.19		2.69		94			40
PCB105	<0.04	U	2.73		103			40
PCB107	<0.04	U	NA					
PCB110/77	<0.05	U	2.84		107			40
PCB114/131/122	<0.04	U	NA					
PCB118	0.55		3.09		96			40
PCB128	0.05	J	2.92		108			40
PCB129/126	0.29		NA					
PCB136	<0.1	U	NA					
PCB138/160	0.38		2.88		94			40
PCB141/179	<0.1	U	NA					
PCB146	<0.1	U	NA					

B&B Laboratories
Project J16222
Report 16-3589

LEED Co - Lake Erie
Organochlorine Data
Matrix Spike Report

Lab ID	LED0038	ENV3617D
Sample ID	PC04, PC05R1, PC06R2, PC07	PC04, PC05R1, PC06R2, PC07
Matrix	Sediment	Sediment
Collection Date	NA	NA
Received Date	09/21/16	09/21/16
Extraction Date	11/09/16	11/09/16
Extraction Batch	ENV3617	ENV3617
Date Acquired	16-Nov-2016, 04:34	15-Nov-2016, 15:25
Method	ECD1DUAL.M	ECD1DUAL.M
Sample Dry Weight (g)	15.06	15.06
Sample Wet Weight (g)	18.12	18.12
% Dry	83	83
% Moisture	17	17
Dilution	1X	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Su Corrected Conc. (ng/dry g)	Q	Recovery (%)	Q	Q	Spike Amount (ng)
PCB149/123	<0.1	U	NA					
PCB151	<0.1	U	NA					
PCB153/132	0.65		2.95		87			40
PCB156/171/202	0.82		NA					
PCB158	0.28		NA					
PCB166	<0.1	U	NA					
PCB167	<0.1	U	NA					
PCB169	<0.1	U	NA					
PCB170/190	0.17		2.79		99			40
PCB172	0.08		NA					
PCB174	<0.05	U	NA					
PCB176/137	2.06		NA					
PCB177	0.80		NA					
PCB178	0.24		NA					
PCB180	0.33		2.57		84			40
PCB183	<0.05	U	NA					
PCB185	0.52		NA					
PCB187	0.76		2.62		70			40
PCB189	0.19		NA					
PCB191	<0.05	U	NA					
PCB194	1.65		NA					
PCB195/208	0.10		2.38		86			40
PCB196/203	0.19		NA					
PCB199	<0.08	U	1.82		69			40
PCB200	<0.04	U	NA					
PCB201/157/173	1.10		NA					
PCB205	0.10		NA					
PCB206	<0.05	U	3.14		118			40
PCB209	<0.05	U	2.08		78			40
Average % Recovery					89			

Surrogate (Su)	Su Recovery (%)	Su Recovery (%)
DBOFB	84	87
PCB 103	83	81
PCB 198	90	98

B&B Laboratories
Project J16222
Report 16-3589

LEED Co - Lake Erie
Organochlorine Data
Standard Reference Material Report

Lab ID	ENV3617C
Sample ID	SRM 1941b
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/09/16
Extraction Batch	ENV3617
Date Acquired	15-Nov-2016, 13:32
Method	ECD1DUAL.M
Sample Dry Weight (g)	4.00
Sample Wet Weight (g)	4.10
% Dry	98
% Moisture	2
Dilution	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Q	SRM 1941b Certified Conc. Conc. (ng/dry g)	-30% Conc. Conc. (ng/dry g)	+30% Conc. Conc. (ng/dry g)
Aldrin	1.10					
Dieldrin	0.19					
Endrin	<0.21					
Heptachlor	<0.16					
Heptachlor-Epoxide	0.10	J				
Oxychlordane	<0.24					
Alpha-Chlordane	0.57			0.85	0.52	1.25
Gamma-Chlordane	0.33			0.57	0.33	0.86
Trans-Nonachlor	0.37			0.44	0.26	0.66
Cis-Nonachlor	0.25			0.38	0.23	0.56
Alpha-HCH	<0.29					
Beta-HCH	0.06	J				
Delta-HCH	0.12	J				
Gamma-HCH	<0.14					
DDMU	<0.26					
2,4'-DDD	1.14					
4,4'-DDD	3.37			4.66	2.94	6.66
2,4'-DDE	<0.21					
4,4'-DDE	3.12			3.22	2.06	4.55
2,4'-DDT	<0.17					
4,4'-DDT	0.81					
1,2,3,4-Tetrachlorobenzene	<0.25					
1,2,4,5-Tetrachlorobenzene	<0.3					
Hexachlorobenzene	7.77			5.83	3.82	8.07
Pentachloroanisole	<0.17					
Pentachlorobenzene	<0.25					
Endosulfan II	<0.15					
Endosulfan I	<0.15					
Endosulfan Sulfate	0.35					
Mirex	<0.22					
Chlorpyrifos	<0.22					

B&B Laboratories
Project J16222
Report 16-3589

LEED Co - Lake Erie
Organochlorine Data
Standard Reference Material Report

Lab ID	ENV3617C
Sample ID	SRM 1941b
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/09/16
Extraction Batch	ENV3617
Date Acquired	15-Nov-2016, 13:32
Method	ECD1DUAL.M
Sample Dry Weight (g)	4.00
Sample Wet Weight (g)	4.10
% Dry	98
% Moisture	2
Dilution	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Q	SRM 1941b Certified Conc. Conc. (ng/dry g)	-30% Conc. Conc. (ng/dry g)	+30% Conc. Conc. (ng/dry g)
PCB1	<0.31					
PCB7/9	<0.31					
PCB8/5	1.64			1.65	1.02	2.39
PCB15	1.47					
PCB16/32	1.58					
PCB18	2.04			2.39	1.47	3.48
PCB22/51	2.03					
PCB24/27	0.87					
PCB25	1.01					
PCB26	0.99					
PCB28	3.99			4.52	2.77	6.62
PCB29	0.07	J				
PCB31	3.00			3.18	1.94	4.67
PCB33/53/20	1.88					
PCB40	0.55					
PCB41/64	<0.27					
PCB42/59/37	1.40					
PCB43	<0.27					
PCB44	3.57			3.85	2.56	5.27
PCB45	0.43					
PCB46	0.81					
PCB47/48/75	2.84					
PCB49	3.45			4.34	2.84	6.01
PCB52	3.79			5.24	3.47	7.18
PCB56/60	3.15					
PCB66	5.86			4.96	3.10	7.14
PCB70	3.86					
PCB74/61	1.60					
PCB81	<0.27					
PCB82	<0.17					
PCB83	0.57					
PCB84	1.30					
PCB85	0.41					
PCB86	0.47					
PCB87/115	0.73			1.14	0.69	1.69
PCB88	<0.17					
PCB92	0.72					
PCB95	2.75			3.93	2.32	5.92
PCB97	1.03					
PCB99	2.01			2.90	1.78	4.24
PCB101/90	5.04			5.11	3.34	7.09
PCB105	1.00			1.43	0.93	1.99
PCB107	3.90					
PCB110/77	5.08			4.62	2.98	6.47
PCB114/131/122	2.65					
PCB118	2.94			4.23	2.83	5.75
PCB128	0.86			0.70	0.46	0.96
PCB129/126	0.29	J				
PCB136	0.68					
PCB138/160	3.70			3.60	2.32	5.04
PCB141/179	0.51					
PCB146	0.66					

LEED Co - Lake Erie
Organochlorine Data
Standard Reference Material Report

Lab ID	ENV3617C
Sample ID	SRM 1941b
Matrix	Sediment
Collection Date	NA
Received Date	NA
Extraction Date	11/09/16
Extraction Batch	ENV3617
Date Acquired	15-Nov-2016, 13:32
Method	ECD1DUAL.M
Sample Dry Weight (g)	4.00
Sample Wet Weight (g)	4.10
% Dry	98
% Moisture	2
Dilution	1X

Target Compounds	Su Corrected Conc. (ng/dry g)	Q	Q	SRM 1941b Certified Conc. Conc. (ng/dry g)	-30% Conc. Conc. (ng/dry g)	+30% Conc. Conc. (ng/dry g)
PCB149/123	3.40			4.35	2.86	5.99
PCB151	0.85					
PCB153/132	4.19			5.47	3.61	7.53
PCB156/171/202	0.41			0.51	0.29	0.78
PCB158	0.00	U				
PCB166	0.35	J				
PCB167	0.18	J				
PCB169	0.06	J				
PCB170/190	9.74		*	1.35	0.88	1.87
PCB172	0.51					
PCB174	0.72					
PCB176/137	0.12	J				
PCB177	0.24					
PCB178	0.27					
PCB180	2.51			3.24	1.91	4.88
PCB183	0.74			0.98	0.62	1.39
PCB185	2.92					
PCB187	2.12			2.17	1.37	3.11
PCB189	<0.18					
PCB191	<0.18					
PCB194	0.69			1.04	0.69	1.43
PCB195/208	0.53			0.65	0.41	0.92
PCB196/203	0.33					
PCB199	1.57					
PCB200	0.01	J				
PCB201/157/173	0.59			0.78	0.52	1.05
PCB205	0.39					
PCB206	1.77			2.42	1.56	3.39
PCB209	4.39			4.86	3.09	6.90
Total HCH	0.2	J				
Total Chlordane	2					
Total DDT	8					
Total PCB	130					

Surrogate (Su)	Su Recovery (%)
DBOFB	90
PCB 103	94
PCB 198	93

5.4 APPENDIX D - TOTAL ORGANIC CARBON

B&B Laboratories
Project J16222
Report 16-3589

LEED Co. - Lake Erie
% Carbon Determination
Client Submitted Samples

Laboratory ID	LED0037		LED0038		LED0039		LED0046	
Sample ID	PC01R, PC02, PC03		PC04, PC05R1, PC06R2, PC07		PC09, PC10		BC01, BC02, BC03	
Matrix	Sediment		Sediment		Sediment		Sediment	
Collection Date	NA		NA		NA		NA	
Received Date	10/12/16		09/21/16		10/12/16		10/12/16	
Analysis Batch TC	LECO1824		LECO1824		LECO1824		LECO1824	
Preparation Date TC	11/14/16		11/14/16		11/14/16		11/14/16	
Analysis Date TC	11/14/16		11/14/16		11/14/16		11/14/16	
Sample Dry Weight (mg)	252.5		252.7		252.4		250.9	
Method TC	B&B SOP 1005		B&B SOP 1005		B&B SOP 1005		B&B SOP 1005	
Analysis Batch TOC	LECO1825		LECO1825		LECO1825		LECO1825	
Preparation Date TOC	11/14/16		11/14/16		11/14/16		11/14/16	
Analysis Date TOC	11/14/16		11/14/16		11/14/16		11/14/16	
Sample Dry Weight (mg)	252.9		254.7		250.9		253.7	
Method TOC	B&B SOP 1005		B&B SOP 1005		B&B SOP 1005		B&B SOP 1005	
Target Analyte	mg Carbon	Q	mg Carbon	Q	mg Carbon	Q	mg Carbon	Q
Total Carbon (TC)	4.13		4.79		5.05		8.88	
Total Organic Carbon (TOC)	1.51		2.14		1.95		7.38	
Total Inorganic Carbon (TIC)	2.62		2.65		3.10		1.50	
	% Carbon	Q	% Carbon	Q	% Carbon	Q	% Carbon	Q
Total Carbon (TC)	1.64		1.90		2.00		3.54	
Total Organic Carbon (TOC)	0.60		0.84		0.78		2.91	
Total Inorganic Carbon (TIC)	1.04		1.06		1.23		0.63	

B&B Laboratories
Project J16222
Report 16-3589

LEED Co. - Lake Erie
% Carbon Determination
Laboratory Duplicate Report

Laboratory ID	LED0037		LED0037DUP					
Sample ID	PC01R, PC02, PC03		PC01R, PC02, PC03					
Matrix	Sediment		Sediment					
Collection Date	NA		NA					
Received Date	10/12/16		10/12/16					
Analysis Batch TC	LECO1824		LECO1824					
Preparation Date TC	11/14/16		11/14/16					
Analysis Date TC	11/14/16		11/14/16					
Sample Dry Weight (mg)	252.5		250.8					
Method TC	B&B SOP 1005		B&B SOP 1005					
Analysis Batch TOC	LECO1825		LECO1825					
Preparation Date TOC	11/14/16		11/14/16					
Analysis Date TOC	11/14/16		11/14/16					
Sample Dry Weight (mg)	252.9		251.4					
Method TOC	B&B SOP 1005		B&B SOP 1005					
Target Analyte	mg Carbon	Q	mg Carbon	Q				
Total Carbon (TC)	4.13		4.07					
Total Organic Carbon (TOC)	1.51		1.40					
Total Inorganic Carbon (TIC)	2.62		2.67					
	% Carbon	Q	% Carbon	Q	RPD	Q	% Carbon MDL	% Carbon 2x MDL
Total Carbon (TC)	1.64		1.62		1		0.03	0.06
Total Organic Carbon (TOC)	0.60		0.55		7		0.03	0.06
Total Inorganic Carbon (TIC)	1.04		1.07		3		0.03	0.06

B&B Laboratories	LEED Co. - Lake Erie
Project J16222	Total Carbon
Report 16-3589	Method Blank Report

Laboratory ID	LC1824B
Sample ID	NA
Matrix	Sediment
Collection Date	NA
Received Date	NA
Analysis Batch TC	LECO1824
Preparation Date TC	11/14/16
Analysis Date TC	11/14/16
Sample Dry Weight (mg)	0.25
Method TC	B&B SOP 1005

Target Analyte	mg Carbon	Q		
Total Carbon (TC)	0.00	U		
	% Carbon	Q	% Carbon MDL	% Carbon 3x MDL
Total Carbon (TC)	0.00	U	0.03	0.09

B&B Laboratories	LEED Co. - Lake Erie
Project J16222	Total Organic Carbon
Report 16-3589	Method Blank Report

Laboratory ID	AC1825B
Sample ID	NA
Matrix	Sediment
Collection Date	NA
Received Date	NA
Analysis Batch TOC	LECO1825
Preparation Date TOC	11/14/16
Analysis Date TOC	11/14/16
Sample Dry Weight (mg)	0.25
Method TOC	B&B SOP 1005

Target Analyte	mg Carbon	Q		
Total Organic Carbon (TOC)	0.00	U		
	% Carbon	Q	% Carbon MDL	% Carbon 3x MDL
Total Organic Carbon (TOC)	0.00	U	0.03	0.09

B&B Laboratories
Project J16222
Report 16-3589

LEED Co. - Lake Erie
Total Carbon
Standard Reference Material Report

Laboratory ID	LC1824SRM
Sample ID	NA
Matrix	Sediment
Collection Date	NA
Received Date	NA
Analysis Batch TC	LECO1824
Preparation Date TC	11/14/16
Analysis Date TC	11/14/16
Sample Dry Weight (mg)	250.4
Method TC	B&B SOP 1005

Target Analyte	mg Carbon	Q					
Total Carbon (TC)	8.05				Reference Value SRM8704 % Carbon	-5%	+5%
	% Carbon	Q	% Dev.	Q			
Total Carbon (TC)	3.22		4		3.351 ± 0.017	3.167	3.536

B&B Laboratories
Project J16222
Report 16-3589

LEED Co. - Lake Erie
Total Organic Carbon
Standard Reference Material Report

Laboratory ID	AC1825SRM
Sample ID	NA
Matrix	Sediment
Collection Date	NA
Received Date	NA
Analysis Batch TOC	LECO1825
Preparation Date TOC	11/14/16
Analysis Date TOC	11/14/16
Sample Dry Weight (mg)	200.3
Method TOC	B&B SOP 1005

Target Analyte	mg Carbon	Q					
Total Organic Carbon (TOC)	6.00				Reference Value SRM1941b % Carbon	-5%	+5%
	% Carbon	Q	% Dev.	Q			
Total Organic Carbon (TOC)	2.99		0		2.99 ± 0.24	2.613	3.392

SRMs are acidified

5.5 Appendix E – Grain Size

GRAIN SIZE DATA RESULTS

Job Number	J16222
Client	LEED Co.
Job Description	Environmental Composite Cor
Core ID	LED0040; PC01R, PC02, PC03
Top Depth	0
Bottom Depth	0

Grain Size Data

D (mm)	Sieve #	% Finer
63	2.5"	100.00
19	3/4"	100.00
9.5	3/8"	100.00
4.75	4	99.12
2.36	8	95.31
2	10	94.06
1.18	16	90.19
0.85	20	88.49
0.425	40	76.36
0.3	50	68.38
0.25	60	65.01
0.18	80	61.60
0.15	100	60.12
0.075	200	56.51
0.0443		55.52
0.0315		53.54
0.0201		51.55
0.0118		47.59
0.0084		43.62
0.0061		37.67
0.0031		29.74
0.0013		21.81

% Passing #10	94.06
% Passing #200	56.51
% Pass 2µ	24.91

Maximum Particle Size
9.5 mm

Dispersing Agent
$(NaPO_3)_6$ @ 40 g/L

Soak Time in Dispersing Agent
16 hrs

Dispersing Device
Apparatus A, ASTM D-422

Dispersing Period
1 min

% Gravel	> 2 mm	5.94
% Sand	0.075 - 2 mm	37.54
% Silt	0.002 - 0.075 mn	31.60
% Clay	< 0.002 mm	24.91

GRAIN SIZE DATA RESULTS

Job Number	J16222
Client	LEED Co.
Job Description	Environmental Composite Core
Core ID	LED0041; PC04, PC05R1, PC06R2, PC07
Top Depth	0
Bottom Depth	0

Grain Size Data	D (mm)	Sieve #	% Finer
	63	2.5"	100.00
	19	3/4"	100.00
	9.5	3/8"	100.00
	4.75	4	98.80
	2.36	8	90.64
	2	10	88.99
	1.18	16	86.07
	0.85	20	84.92
	0.425	40	81.56
	0.3	50	79.09
	0.25	60	77.63
	0.18	80	75.04
	0.15	100	73.76
	0.075	200	71.45
	0.0416		72.39
	0.0296		70.41
	0.0190		66.44
	0.0114		56.52
	0.0083		47.60
	0.0060		40.66
	0.0030		31.73
	0.0013		21.82

% Passing #10	88.99
% Passing #200	71.45
% Pass 2µ	25.73

Maximum Particle Size
9.5 mm

Dispersing Agent
(NaPO3)6 @ 40 g/L

Soak Time in Dispersing Agent
16 hrs

Dispersing Device
Apparatus A, ASTM D-422

Dispersing Period
1 min

% Gravel	> 2 mm	11.01
% Sand	0.075 - 2 mm	17.54
% Silt	0.002 - 0.075 mm	45.72
% Clay	< 0.002 mm	25.73

GRAIN SIZE DATA RESULTS

Job Number	J16222
Client	LEED Co.
Job Description	Environmental Composite Co
Core ID	LED0042; PC09, PC10
Top Depth	0
Bottom Depth	0

Grain Size Data

D (mm)	Sieve #	% Finer
63	2.5"	100.00
19	3/4"	100.00
9.5	3/8"	100.00
4.75	4	100.00
2.36	8	100.00
2	10	100.00
1.18	16	100.00
0.85	20	100.00
0.425	40	97.83
0.3	50	97.21
0.25	60	96.85
0.18	80	96.15
0.15	100	95.73
0.075	200	94.08
0.0383		89.19
0.0276		85.23
0.0186		71.35
0.0118		47.57
0.0087		33.69
0.0063		25.77
0.0032		16.85
0.0014		12.88

% Passing #10	100.00
% Passing #200	94.08
% Pass 2µ	14.24

Maximum Particle Size
0.85 mm

Dispersing Agent
(NaPO3)6 @ 40 g/L

Soak Time in Dispersing Agent
16 hrs

Dispersing Device
Apparatus A, ASTM D-422

Dispersing Period
1 min

% Gravel	> 2 mm	0.00
% Sand	0.075 - 2 mm	5.92
% Silt	0.002 - 0.075 mn	79.84
% Clay	< 0.002 mm	14.24

GRAIN SIZE DATA RESULTS

Job Number	J16222
Client	LEED Co.
Job Description	Environmental Composite Co
Core ID	LED0046; BC01, BC02, BC03
Top Depth	0
Bottom Depth	0

Grain Size Data

D (mm)	Sieve #	% Finer
63	2.5"	100.00
19	3/4"	100.00
9.5	3/8"	100.00
4.75	4	100.00
2.36	8	100.00
2	10	100.00
1.18	16	100.00
0.85	20	100.00
0.425	40	99.62
0.3	50	98.98
0.25	60	98.64
0.18	80	98.35
0.15	100	98.23
0.075	200	98.01
0.0375		93.10
0.0268		91.12
0.0175		85.18
0.0105		75.27
0.0077		67.35
0.0057		57.45
0.0029		45.56
0.0013		30.70

% Passing #10	100.00
% Passing #200	98.01
% Pass 2µ	37.25

Maximum Particle Size
0.85 mm

Dispersing Agent
(NaPO3)6 @ 40 g/L

Soak Time in Dispersing Agent
16 hrs

Dispersing Device
Apparatus A, ASTM D-422

Dispersing Period
1 min

% Grave	> 2 mm	0.00
% Sand	0.075 - 2 mm	1.99
% Silt	0.002 - 0.075 mn	60.76
% Clay	< 0.002 mm	37.25

5.6 APPENDIX F – TRACE METALS

TDI-BI/ B Laboratories LEED County Lake Erie Study (Job No. J16222 SDG NA)
Final Sediment Total Recoverable Trace Metals & Total Mercury Data for Samples Received 21 Sept. & 12 October 2016
(Report X1218-9457-001)

Sponsor ID	AE Sample ID	Collection Date	Location	Sample Type	Matrix	Processing (Note 3)	Method	Anal. Date
	Field Samples (Notes 1,2)							
	Uncensored (raw) sediment trace metals data							
LED0043	XX-3122	Not Applicable	PC01R, PC02, PC03	Composite Sed. Grabs	FW Sediment	Total Rec.	Note 4	Note 5
LED0044	XX-3123	Not Applicable	PC04, PC05R1, PC06R2, PC07	Composite Sed. Grabs	FW Sediment	Total Rec.	Note 4	Note 5
LED0045	XX-3124	Not Applicable	PC09, PC10	Composite Sed. Grabs	FW Sediment	Total Rec.	Note 4	Note 5
LED0046	XX-3125	Not Applicable	BC01, BC02, BC03	Composite Sed. Core	FW Sediment	Total Rec.	Note 4	Note 5
	Sediment trace metals data censored to the reporting limit							
LED0043	XX-3122	Not Applicable	PC01R, PC02, PC03	Composite Sed. Grabs	FW Sediment	Total Rec.	Note 4	Note 5
LED0044	XX-3123	Not Applicable	PC04, PC05R1, PC06R2, PC07	Composite Sed. Grabs	FW Sediment	Total Rec.	Note 4	Note 5
LED0045	XX-3124	Not Applicable	PC09, PC10	Composite Sed. Grabs	FW Sediment	Total Rec.	Note 4	Note 5
LED0046	XX-3125	Not Applicable	BC01, BC02, BC03	Composite Sed. Core	FW Sediment	Total Rec.	Note 4	Note 5

APPROVED:

PN Boothe

Dr. P.N. Boothe, Laboratory Manager

TDI-BI/ B Laboratories LEED County Lake Erie Study (Job No. J16222 SDG NA)
Final Sediment Total Recoverable Trace Metals & Total Mercury Data for Samples Received 21 Sept. & 12 October 2016
(Report X1218-9457-001)

Sponsor ID	AE Sample ID	Dry Wt. Ag (ppm)	Dry Wt. Al (ppm)	Dry Wt. As (ppm)	Dry Wt. B (ppm)	Dry Wt. Ba (ppm)	Dry Wt. Be (ppm)	Dry Wt. Cd (ppm)	Dry Wt. Co (ppm)	Dry Wt. Cr (ppm)	Dry Wt. Cu (ppm)	Dry Wt. Fe (ppm)	Dry Wt. Mn (ppm)	Dry Wt. Mo (ppm)
	Field Samples (Notes 1,2)													
	Uncensored (raw) sediment trace metals data													
LED0043	XX-3122	0.08	11650	13.1	10.8	116	0.72	0.17	11.9	18.6	22.6	26100	567	4.12
LED0044	XX-3123	0.10	11800	13.9	11.1	125	0.73	0.24	12.6	19.0	26.8	29000	423	4.12
LED0045	XX-3124	0.15	11500	14.6	10.8	75.4	0.60	0.51	12.6	26.1	42.4	33000	456	4.12
LED0046	XX-3125	0.38	20400	8.21	12.5	129	1.18	1.94	13.9	53.1	47.7	34000	567	1.78
	Sediment trace metals data censored to the reporting limit													
LED0043	XX-3122	< 0.1	11650	13.1	10.8	116	0.72	0.17	11.9	18.6	22.6	26100	567	4.12
LED0044	XX-3123	< 0.1	11800	13.9	11.1	125	0.73	0.24	12.6	19.0	26.8	29000	423	4.12
LED0045	XX-3124	0.15	11500	14.6	10.8	75.4	0.60	0.51	12.6	26.1	42.4	33000	456	4.12
LED0046	XX-3125	0.38	20400	8.21	12.5	129	1.18	1.94	13.9	53.1	47.7	34000	567	1.78

APPROVED

P.N. Boothe (signature)

Dr. P.N. Boothe, Laboratory Manager

TDI-BI/ B Laboratories LEED County Lake Erie Study (Job No. J16222 SDG NA)
Final Sediment Total Recoverable Trace Metals & Total Mercury Data for Samples Received 21 Sept. & 12 October 2016
(Report X1218-9457-001)

Sponsor ID	AE Sample ID	Dry Wt. Ni (ppm)	Dry Wt. Pb (ppm)	Dry Wt. Sb (ppm)	Dry Wt. Se (ppm)	Dry Wt. Sn (ppm)	Dry Wt. V (ppm)	Dry Wt. Zn (ppm)	Dry Wt. Hg (ppm)	Dry Wt. Ca (ppm)	Dry Wt. K (ppm)	Dry Wt. Mg (ppm)	Dry Wt. Na (ppm)	Percent Moisture
	Field Samples (Notes 1,2)													
	Uncensored (raw) sediment trace metals data													
LED0043	XX-3122	30.3	11.8	0.33	0.51	0.56	24.0	72.7	0.0138	28500	2580	10600	133	19.7
LED0044	XX-3123	30.2	16.0	0.38	0.51	1.22	23.6	111	0.0173	40800	2520	12900	144	17.9
LED0045	XX-3124	34.1	24.0	0.71	0.52	2.43	22.3	116	0.0354	32400	2270	12800	142	22.6
LED0046	XX-3125	51.4	44.9	0.61	1.55	2.85	50.7	204	0.335	14300	4250	13500	174	78.2
	Sediment trace metals data censored to the reporting limit													
LED0043	XX-3122	30.3	11.8	< 0.5	< 2	0.56	24.0	72.7	0.0138	28500	2580	10600	< 2000	
LED0044	XX-3123	30.2	16.0	< 0.5	< 2	1.22	23.6	111	0.0173	40800	2520	12900	< 2000	
LED0045	XX-3124	34.1	24.0	0.71	< 2	2.43	22.3	116	0.0354	32400	2270	12800	< 2000	
LED0046	XX-3125	51.4	44.9	0.61	< 2	2.85	50.7	204	0.335	14300	4250	13500	< 2000	

APPROVED

P.N. Boothe

Dr. P.N. Boothe, Laboratory Manager

TDI-BI/ B Laboratories LEED County Lake Erie Study (Job No. J16222 SDG NA)
Final Sediment Total Recoverable Trace Metals & Total Mercury Data for Samples Received 21 Sept. & 12 October 2016
(Report X1218-9457-001)

Sponsor ID	AE Sample ID	Collection Date	Location	Sample Type	Matrix	Processing (Note 3)	Method	Anal. Date
		Laboratory Quality Assurance Samples						
	Reporting Limit Sediment (ppm dry wt.)						Note 4	Note 5
	Reference Material (Note 3)							
	MESS3-1		Albion Env.	Reference Material	Marine Sed	Total Rec.	Note 4	Note 5
	Certified Value							
	Percent Recovery (% R)							
	Historical % R							
	Digestion Duplicates (Note 6)							
LED0043	XX-3122	Not Applicable	PC01R, PC02, PC03	Composite Sed. Grabs	FW Sediment	Total Rec.	Note 4	Note 5
	XX-3122-DUP	Not Applicable	PC01R, PC02, PC03	Digestion Duplicate	FW Sediment	Total Rec.	Note 4	Note 5
	Relative Percent Difference (RPD)							
	Matrix Spike (Note 7)							
LED0045	XX-3124	Not Applicable	PC09, PC10	Composite Sed. Grabs	FW Sediment	Total Rec.	Note 4	Note 5
	XX-3124-SPK	Not Applicable	PC09, PC10	Matrix Spike	FW Sediment	Total Rec.	Note 4	Note 5
	Expected Increase							
	% R							
	Blank Spikes (Note 7)							
	LCS-1						Note 4	Note 5
	Expected Increase							
	% R							
	Method Blank							
	MBLK-1 (Raw)						Note 4	Note 5
	MBLK-1 (Censored)						Note 4	Note 5

APPROVED:

Dr. P.N. Boothe, Laboratory Manager

TDI-BI/ B Laboratories LEED County Lake Erie Study (Job No. J16222 SDG NA)

Final Sediment Total Recoverable Trace Metals & Total Mercury Data for Samples Received 21 Sept. & 12 October 2016

(Report X1218-9457-001)

Sponsor ID	AE Sample ID	Dry Wt. Ag (ppm)	Dry Wt. Al (ppm)	Dry Wt. As (ppm)	Dry Wt. B (ppm)	Dry Wt. Ba (ppm)	Dry Wt. Be (ppm)	Dry Wt. Cd (ppm)	Dry Wt. Co (ppm)	Dry Wt. Cr (ppm)	Dry Wt. Cu (ppm)	Dry Wt. Fe (ppm)	Dry Wt. Mn (ppm)	Dry Wt. Mo (ppm)
	Reporting Limit Sediment (ppm dry wt.)	0.1	500	2	5	0.5	0.5	0.1	2	1	0.3	1000	0.5	1
	Reference Material (Note 3)													
	MESS3-1	0.18	13600	18.6	26.8	330	0.92	0.24	11.9	29.0	31.7	31300	329	2.37
	Certified Value	0.18	85900	21.2	NCV	340	2.30	0.24	14.4	105	33.9	43,400	324	2.78
	Percent Recovery (% R)	**102**	**16**	**88**		**97**	**40**	**100**	**83**	**28**	**94**	**72**	**102**	**85**
	Historical % R	111	23	88		98	48	104	90	32	102	83	96	97
	Digestion Duplicates (Note 6)													
LED0043	XX-3122	0.08	11650	13.1	10.8	116	0.72	0.173	11.9	18.6	22.6	26100	567	4.12
	XX-3122-DUP	0.09	12580	12.9	11.3	115	0.65	0.173	11.6	18.8	23.8	27600	620	4.26
	Relative Percent Difference (RPD)	**3.7**	**7.7**	**1.5**	**4.5**	**0.9**	**9.2**	**0.0**	**2.6**	**1.1**	**5.2**	**5.6**	**8.9**	**3.3**
	Matrix Spike (Note 7)													
LED0045	XX-3124	0.15	11500	14.6	10.8	75.4	0.60	0.510	12.6	26.1	42.4	33000	456	4.12
	XX-3124-SPK	2.55	11100	20.4	9.53	293	1.62	5.69	32.5	78.6	85.3	32400	971	4.18
	Expected Increase	2.50	Not Spiked	5.00	Not Spiked	200	1.00	5.00	20.0	50.0	50.0	Not Spiked	500	Not Spiked
	% R	**96**		**116**		**109**	**102**	**104**	**100**	**105**	**86**		**103**	
	Blank Spikes (Note 7)													
	LCS-1	0.49	0.23	1.03	0.01	41.1	0.21	1.04	3.98	10.2	10.2	0.46	95.4	0.01
	Expected Increase	0.50	Not Spiked	1.00	Not Spiked	40.0	0.20	1.00	4.00	10.0	10.0	Not Spiked	100	Not Spiked
	% R	**98**		**103**		**103**	**103**	**104**	**100**	**102**	**102**		**95**	
	Method Blank													
	MBLK-1 (Raw)	0.00	0.29	0.00	0.02	0.00	0.00	0.001	0.00	0.00	0.01	0.04	0.031	0.02
	MBLK-1 (Censored)	< 0.1	< 500	< 2	< 5	< 0.5	< 0.5	< 0.1	< 2	< 1	< 0.3	< 1000	< 0.5	< 1

APPROVED:

Dr. P.N. Boothe, Laboratory Manager

TDI-BI/ B Laboratories LEED County Lake Erie Study (Job No. J16222 SDG NA)
Final Sediment Total Recoverable Trace Metals & Total Mercury Data for Samples Received 21 Sept. & 12 October 2016
(Report X1218-9457-001)

Sponsor ID	AE Sample ID	Dry Wt. Ni (ppm)	Dry Wt. Pb (ppm)	Dry Wt. Sb (ppm)	Dry Wt. Se (ppm)	Dry Wt. Sn (ppm)	Dry Wt. V (ppm)	Dry Wt. Zn (ppm)	Dry Wt. Hg (ppm)	Dry Wt. Ca (ppm)	Dry Wt. K (ppm)	Dry Wt. Mg (ppm)	Dry Wt. Na (ppm)	Percent Moisture
	Reporting Limit Sediment (ppm dry wt.)	1	0.1	0.5	2	0.2	2	1	0.002	4000	2000	4000	2000	
	Reference Material (Note 3)													
	MESS3-1	36.0	16.6	0.70	0.90	0.62	66.8	142	0.097	14400	4250	13700	12000	
	Certified Value	46.9	21.1	1.02	0.72	NCV	243	159	0.091	14700	26000	16000	16000	
	Percent Recovery (% R)	77	79	68	125		27	89	107	98	16	86	75	
	Historical % R	84	80	71	93		33	90	102	96	21	89	79	
	Digestion Duplicates (Note 6)													
LED0043	XX-3122	30.3	11.8	0.33	0.51	0.56	24.0	72.7	0.0138	28500	2580	10600	133	
	XX-3122-DUP	30.0	11.7	0.36	0.44	0.54	25.9	78.1	0.0143	31700	2750	11400	134	
	Relative Percent Difference (RPD)	1.0	0.9	7.3	13.3	2.0	7.6	7.2	3.6	10.6	6.4	7.3	0.7	
	Matrix Spike (Note 7)													
LED0045	XX-3124	34.1	24.0	0.71	0.52	2.43	22.3	186	0.0354	32400	2270	12800	142	
	XX-3124-SPK	135	69.1	5.12	5.59	2.10	72.1	309	1.83	32500	2130	12600	128	
	Expected Increase	100	50.0	5.00	5.00	Not Spiked	50.0	200	1.89	Not Spiked	Not Spiked	Not Spiked	Not Spiked	
	% R	101	90	88	101		100	97	95					
	Blank Spikes (Note 7)													
	LCS-1	20.5	9.72	0.99	1.13	0.00	8.95	41.3	NA	0.98	0.22	0.66	0.52	
	Expected Increase	20.0	10.0	1.00	1.00	Not Spiked	10.0	40.0		Not Spiked	Not Spiked	Not Spiked	Not Spiked	
	% R	103	97	99	113		90	103						
	Method Blank													
	MBLK-1 (Raw)	0.00	0.00	0.00	0.01	0.00	0.00	0.04	0.000	0.69	0.26	0.60	0.52	
	MBLK-1 (Censored)	< 1	< 0.1	< 0.5	< 2	< 0.2	< 2	< 1	< 0.002	< 4000	< 2000	< 4000	< 2000	

APPROVED:

Dr. P.N. Boothe, Laboratory Manager

Notes:

1. Metals concentration units are total recoverable metals in micrograms per gram (parts per million) on a dry weight basis. This data report applies only to the samples listed and the report shall not be reproduced except in full. Mercury (Hg) are total sediment Hg in ppm. To provide the maximum amount of information to the sponsor for data interpretation, sediment metal levels are reported both raw (uncensored) and censored to the reporting limit. Data censored to the reporting limit are most commonly reported to regulatory agencies.
2. Sediment samples were received in good condition from the sponsor (TDI-BI/B&B Laboratories, 14391B South Dowling, College Station, TX 77845) and kept refrigerated until further processing. Sediment samples were then homogenized and freeze-dried to a constant weight in the original bottles. The percent moisture was determined to allow conversion between wet (as received) and the dry weight concentrations reported here. The dried sediment samples were then ground to a fine powder. For EPA method 200.8 approximately 0.2 g of the dried and powdered sediment samples were subjected to a strong acid leaching digestion at 95 deg. C. for six hours. The acid leachate was then brought to approximately 20 ml final volume with deionized water. The leachate (digestate) was then diluted further as needed to keep the solution concentration within the calibration range of the ICP-MS instrument and to adjust as needed the acid strength for analysis.
3. The heated, strong acid leach digestion used for this study is NOT a total digestion quantifying all of a given element present in the sediment matrix. The percentage of metal leached into solution for analysis varies by element. For example, for the more refractory metals (e.g. Al, Cr, V) only a relatively small percentage is leached into solution for analysis. For many other elements (including many pollutant metals) that are largely adsorbed onto the sediment particles, a much higher percentage is leached into solution for analysis. A marine sediment reference material (MESS-3) was used to estimate the percentage of each element leached into solution for analysis. The percentage released is compared to a historical percentage that is typically observed for such a heated strong acid leach. The leaching efficiency observed between the observed and historical percentage leached was generally in agreement for this sample set. The leaching efficiency can be used to estimate the total metal present in the sediment samples.
4. Metals concentrations (except Hg) were determined in the sediment leachate according to EPA method 200.8 (ICP-MS). All metals were determined by standard mode ICP-MS except that calcium (Ca), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), nickel (Ni), potassium (K), selenium (Se), and vanadium (V) were determined by method 200.8 modified for dynamic reaction cell (DRC)-ICP-MS using ammonia as the cell gas. Arsenic (As) was determined by DRC-ICP-MS using oxygen as the cell gas DRC-ICP-MS are interference control technologies that minimize the overestimation of aqueous trace metals levels associated with isobaric interferences that can occur with standard mode ICP-MS. Isobaric interferences are a significant concern especially for many sediment matrices because of elevated concentrations of Ca, Mg, Na, Cl, etc. Total sediment Hg was determined using EPA method 7473. In this method, the dried and powdered sediment samples are analyzed directly by thermal decomposition, amalgamation and atomic absorption spectrophotometry.
5. Sediment leachates were analyzed by EPA 200.8 (see note 4) on 12-15-2016. Dry, homogenized sediment samples were analyzed for Hg (see note 4) on 12-13-2016.
6. For digestion (leach) duplicates, different aliquots of freeze-dried sediments are digested and analyzed individually as separate samples. An RPD of < 20% is expected for digestion duplicates.
7. The trace metals spike is added to the spiked samples prior to the leaching procedure and carried through the entire process in the same manner as the other unknown sediment samples. Major elements in high concentrations (Al,Ca,K,Mg,Fe) and a few rarely requested elements (B,Mo,Sn) were not spiked. All matrix spike percent recoveries (% R) were acceptable.

Attachment 7

Federal Aviation Administration Determination Letters

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2016-WTE-5048-OE
Prior Study No.
2014-WTE-684-OE

Issued Date: 02/22/2017

Lorry Wagner
LEEDCo
1938 Euclid Avenue
Ste 200
Cleveland, OH 44115

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Wind Turbine Turbine 1
Location:	Cleveland, OH
Latitude:	41-36-02.80N NAD 83
Longitude:	81-48-02.20W
Heights:	569 feet site elevation (SE)
	479 feet above ground level (AGL)
	1048 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s) is(are) met:

As a condition to this Determination, the structure is to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, white paint/synchronized red lights - Chapters 4,12&13(Turbines).

Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to (877) 487-6867 so a Notice to Airmen (NOTAM) can be issued. As soon as the normal operation is restored, notify the same number.

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 56 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

See attachment for additional condition(s) or information.

This determination expires on 08/22/2018 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.
(b) extended, revised, or terminated by the issuing office.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

This determination is subject to review if an interested party files a petition that is received by the FAA on or before March 24, 2017. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager, Airspace Policy & Regulation, Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591.

This determination becomes final on April 03, 2017 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Airspace Regulations & ATC Procedures Group via telephone -- 202-267-8783 - or facsimile 202-267-9328.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights, and frequencies or use of greater power will void this determination. Any future construction or alteration, including increase to heights, power, or the addition of other transmitters, requires separate notice to the FAA.

Obstruction marking and lighting recommendations for wind turbine farms are based on the scheme for the entire project. ANY change to the height, location or number of turbines within this project will require a reanalysis of the marking and lighting recommendation for the entire project. In particular, the removal of previously planned or built turbines/turbine locations from the project will often result in a change in the marking/lighting recommendation for other turbines within the project. It is the proponent's responsibility to contact the FAA to discuss the process for developing a revised obstruction marking and lighting plan should this occur.

In order to ensure proper conspicuity of turbines at night during construction, all turbines should be lit with temporary lighting once they reach a height of 200 feet or greater until such time the permanent lighting configuration is turned on. As the height of the structure continues to increase, the temporary lighting should be relocated to the uppermost part of the structure. The temporary lighting may be turned off for periods when they would interfere with construction personnel. If practical, permanent obstruction lights should be installed and operated at each level as construction progresses. An FAA Type L-810 steady red light fixture shall be used to light the structure during the construction phase. If power is not available, turbines shall be lit with self-contained, solar powered LED steady red light fixture that meets the photometric requirements of an FAA Type L-810 lighting system. The lights should be positioned to ensure that a pilot has an unobstructed view of at least one light at each level. The use of a NOTAM (D) to not light turbines within a project until the entire project has been completed is prohibited.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation.

An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

If we can be of further assistance, please contact Paul Holmquist, at (425) 227-2625. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2016-WTE-5048-OE.

Signature Control No: 299560645-322889480 (DNH -WT)
Mike Helvey
Manager, Obstruction Evaluation Group

Attachment(s)
Additional Information
Map(s)

Additional information for ASN 2016-WTE-5048-OE

Narrative for ASNs
2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

Abbreviations

AGL - above ground level | AMSL - above mean sea level | RWY - runway
VFR - visual flight rules | IFR - instrument flight rules | NM - nautical mile
ASN- Aeronautical Study Number | MVA - minimum vectoring altitude

Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

The proposed project consisting of seven, 479 AGL (1048 AMSL) wind turbines would be located between 7.3 and 9.7 NM northwest of Burke Lakefront Airport, Cleveland, OH. For the sake of efficiency this narrative contains all turbines within this project that have similar impacts. Separate determinations will be issued for each turbine which will be available on the FAA's website at htttp://oeaaa.faa.gov.

The turbine(s) exceed(s) Part 77 standards as described below.

Section 77.17(a)(3): A height that increases a minimum instrument flight altitude within a terminal area (TERPS criteria).

The turbines studied under the ASNs listed below would increase the Sector A Minimum Vectoring Altitude (MVA) from 1800 feet AMSL to 2000 feet AMSL for the Cleveland Ohio Terminal Radar Approach Control (CLE ATCT/TRACON)

2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

There would be no impact to this standard if the turbines do not exceed 849 feet AMSL (280 AGL).

The study was not circularized for public comment as the impact to Cleveland TRACON's MVA identified above only requires FAA comment. Cleveland Air Traffic Control has responded to this study with no objection to the increase in MVA height.

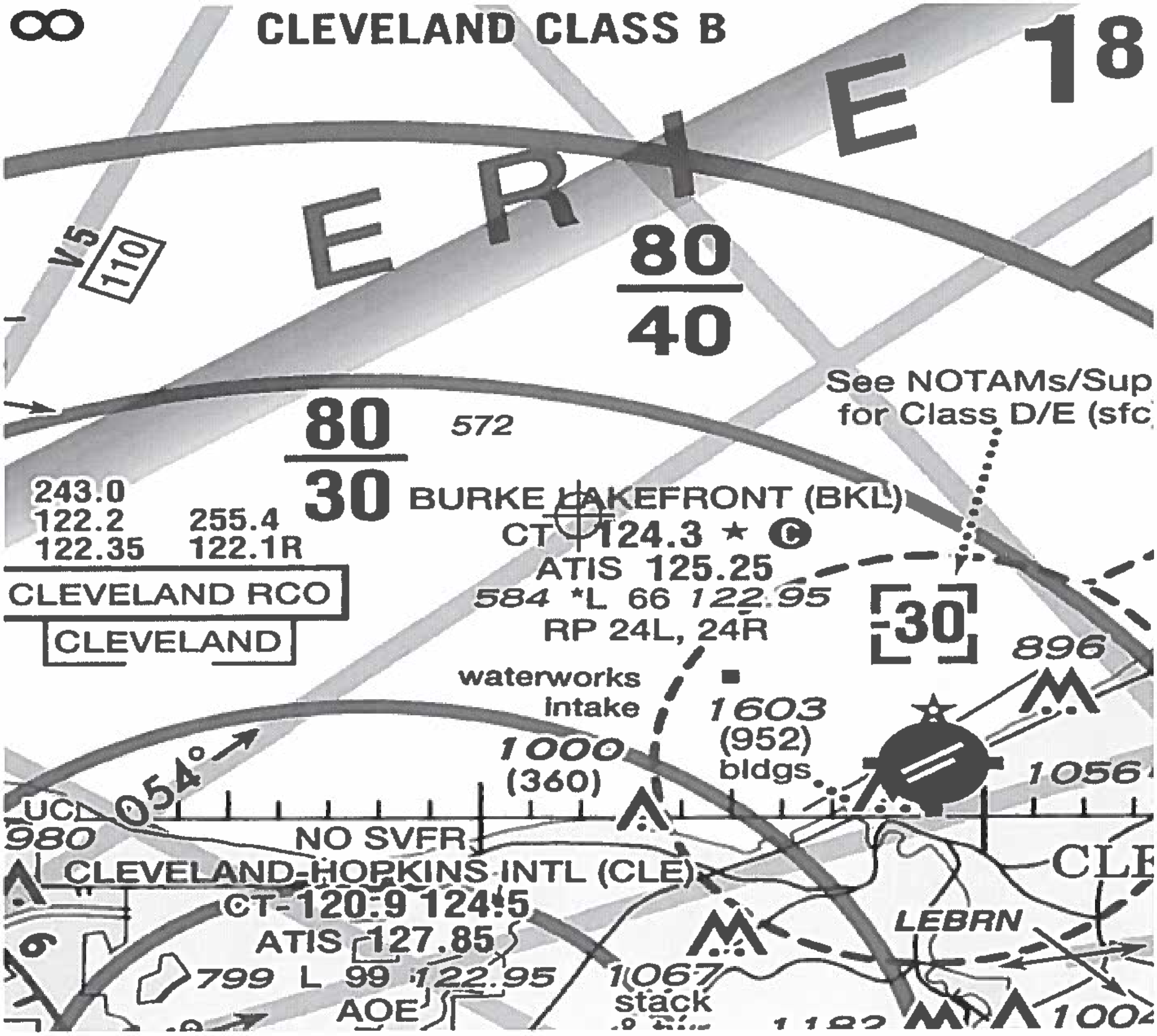
Aeronautical study disclosed that the proposed structure would have no effect on any existing or proposed arrival, departure, or en route instrument flight rule (IFR) operations or procedures other than the MVA impact identified above.

Study for possible visual flight rules (VFR) effect disclosed that the proposed structure would have no effect on any existing or proposed arrival or departure VFR operations or procedures. It would not conflict with airspace required to conduct normal VFR traffic pattern operations at any known public use or military airport. At 479 feet above ground level the proposed structure would not have a substantial adverse effect on VFR en route flight operations.

The proposed structure would be appropriately obstruction marked and/or lighted to make it more conspicuous to airmen should circumnavigation be necessary.

Therefore, it is determined that the proposed construction would not have a substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on any air navigation facility and would not be a hazard to air navigation provided the conditions set forth within this determination are met.

Sectional Map for ASN 2016-WTE-5048-OE



Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2016-WTE-5049-OE
Prior Study No.
2014-WTE-685-OE

Issued Date: 02/22/2017

Lorry Wagner
LEEDCo
1938 Euclid Avenue
Ste 200
Cleveland, OH 44115

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Wind Turbine Turbine 2
Location:	Cleveland, OH
Latitude:	41-36-22.40N NAD 83
Longitude:	81-48-21.60W
Heights:	569 feet site elevation (SE)
	479 feet above ground level (AGL)
	1048 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s) is(are) met:

As a condition to this Determination, the structure is to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, white paint/synchronized red lights - Chapters 4,12&13(Turbines).

Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to (877) 487-6867 so a Notice to Airmen (NOTAM) can be issued. As soon as the normal operation is restored, notify the same number.

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 56 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

See attachment for additional condition(s) or information.

This determination expires on 08/22/2018 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.
(b) extended, revised, or terminated by the issuing office.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

This determination is subject to review if an interested party files a petition that is received by the FAA on or before March 24, 2017. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager, Airspace Policy & Regulation, Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591.

This determination becomes final on April 03, 2017 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Airspace Regulations & ATC Procedures Group via telephone -- 202-267-8783 - or facsimile 202-267-9328.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights, and frequencies or use of greater power will void this determination. Any future construction or alteration, including increase to heights, power, or the addition of other transmitters, requires separate notice to the FAA.

Obstruction marking and lighting recommendations for wind turbine farms are based on the scheme for the entire project. ANY change to the height, location or number of turbines within this project will require a reanalysis of the marking and lighting recommendation for the entire project. In particular, the removal of previously planned or built turbines/turbine locations from the project will often result in a change in the marking/lighting recommendation for other turbines within the project. It is the proponent's responsibility to contact the FAA to discuss the process for developing a revised obstruction marking and lighting plan should this occur.

In order to ensure proper conspicuity of turbines at night during construction, all turbines should be lit with temporary lighting once they reach a height of 200 feet or greater until such time the permanent lighting configuration is turned on. As the height of the structure continues to increase, the temporary lighting should be relocated to the uppermost part of the structure. The temporary lighting may be turned off for periods when they would interfere with construction personnel. If practical, permanent obstruction lights should be installed and operated at each level as construction progresses. An FAA Type L-810 steady red light fixture shall be used to light the structure during the construction phase. If power is not available, turbines shall be lit with self-contained, solar powered LED steady red light fixture that meets the photometric requirements of an FAA Type L-810 lighting system. The lights should be positioned to ensure that a pilot has an unobstructed view of at least one light at each level. The use of a NOTAM (D) to not light turbines within a project until the entire project has been completed is prohibited.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation.

An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

If we can be of further assistance, please contact Paul Holmquist, at (425) 227-2625. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2016-WTE-5049-OE.

Signature Control No: 299560647-322889482 (DNH -WT)
Mike Helvey
Manager, Obstruction Evaluation Group

Attachment(s)
Additional Information
Map(s)

Narrative for ASNs
2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

Abbreviations

AGL - above ground level
AMSL - above mean sea level
RWY - runway
VFR - visual flight rules
IFR - instrument flight rules
NM - nautical mile
ASN- Aeronautical Study Number
MVA - minimum vectoring altitude
Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

The proposed project consisting of seven, 479 AGL (1048 AMSL) wind turbines would be located between 7.3 and 9.7 NM northwest of Burke Lakefront Airport, Cleveland, OH. For the sake of efficiency this narrative contains all turbines within this project that have similar impacts. Separate determinations will be issued for each turbine which will be available on the FAA's website at htttp://oeaaa.faa.gov.

The turbine(s) exceed(s) Part 77 standards as described below.

Section 77.17(a)(3): A height that increases a minimum instrument flight altitude within a terminal area (TERPS criteria).

The turbines studied under the ASNs listed below would increase the Sector A Minimum Vectoring Altitude (MVA) from 1800 feet AMSL to 2000 feet AMSL for the Cleveland Ohio Terminal Radar Approach Control (CLE ATCT/TRACON)

2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

There would be no impact to this standard if the turbines do not exceed 849 feet AMSL (280 AGL).

The study was not circularized for public comment as the impact to Cleveland TRACON's MVA identified above only requires FAA comment. Cleveland Air Traffic Control has responded to this study with no objection to the increase in MVA height.

Aeronautical study disclosed that the proposed structure would have no effect on any existing or proposed arrival, departure, or en route instrument flight rule (IFR) operations or procedures other than the MVA impact identified above.

Study for possible visual flight rules (VFR) effect disclosed that the proposed structure would have no effect on any existing or proposed arrival or departure VFR operations or procedures. It would not conflict with airspace required to conduct normal VFR traffic pattern operations at any known public use or military airport. At 479 feet above ground level the proposed structure would not have a substantial adverse effect on VFR en route flight operations.

The proposed structure would be appropriately obstruction marked and/or lighted to make it more conspicuous to airmen should circumnavigation be necessary.

Therefore, it is determined that the proposed construction would not have a substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on any air navigation facility and would not be a hazard to air navigation provided the conditions set forth within this determination are met.

Sectional Map for ASN 2016-WTE-5049-OE

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2016-WTE-5050-OE
Prior Study No.
2014-WTE-686-OE

Issued Date: 02/22/2017

Lorry Wagner
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1938 Euclid Avenue
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Cleveland, OH 44115

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Wind Turbine Turbine 3
Location:	Cleveland, OH
Latitude:	41-36-41.50N NAD 83
Longitude:	81-48-41.10W
Heights:	569 feet site elevation (SE)
	479 feet above ground level (AGL)
	1048 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s) is(are) met:

As a condition to this Determination, the structure is to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, white paint/synchronized red lights - Chapters 4,12&13(Turbines).

Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to (877) 487-6867 so a Notice to Airmen (NOTAM) can be issued. As soon as the normal operation is restored, notify the same number.

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 56 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

See attachment for additional condition(s) or information.

This determination expires on 08/22/2018 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.
(b) extended, revised, or terminated by the issuing office.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

This determination is subject to review if an interested party files a petition that is received by the FAA on or before March 24, 2017. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager, Airspace Policy & Regulation, Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591.

This determination becomes final on April 03, 2017 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Airspace Regulations & ATC Procedures Group via telephone -- 202-267-8783 - or facsimile 202-267-9328.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights, and frequencies or use of greater power will void this determination. Any future construction or alteration, including increase to heights, power, or the addition of other transmitters, requires separate notice to the FAA.

Obstruction marking and lighting recommendations for wind turbine farms are based on the scheme for the entire project. ANY change to the height, location or number of turbines within this project will require a reanalysis of the marking and lighting recommendation for the entire project. In particular, the removal of previously planned or built turbines/turbine locations from the project will often result in a change in the marking/lighting recommendation for other turbines within the project. It is the proponent's responsibility to contact the FAA to discuss the process for developing a revised obstruction marking and lighting plan should this occur.

In order to ensure proper conspicuity of turbines at night during construction, all turbines should be lit with temporary lighting once they reach a height of 200 feet or greater until such time the permanent lighting configuration is turned on. As the height of the structure continues to increase, the temporary lighting should be relocated to the uppermost part of the structure. The temporary lighting may be turned off for periods when they would interfere with construction personnel. If practical, permanent obstruction lights should be installed and operated at each level as construction progresses. An FAA Type L-810 steady red light fixture shall be used to light the structure during the construction phase. If power is not available, turbines shall be lit with self-contained, solar powered LED steady red light fixture that meets the photometric requirements of an FAA Type L-810 lighting system. The lights should be positioned to ensure that a pilot has an unobstructed view of at least one light at each level. The use of a NOTAM (D) to not light turbines within a project until the entire project has been completed is prohibited.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation.

An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

If we can be of further assistance, please contact Paul Holmquist, at (425) 227-2625. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2016-WTE-5050-OE.

Signature Control No: 299560648-322889486 (DNH -WT)
Mike Helvey
Manager, Obstruction Evaluation Group

Attachment(s)
Additional Information
Map(s)

Additional information for ASN 2016-WTE-5050-OE

Narrative for ASNs
2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

Abbreviations

AGL - above ground level
AMSL - above mean sea level
RWY - runway
VFR - visual flight rules
IFR - instrument flight rules
NM - nautical mile
ASN- Aeronautical Study Number
MVA - minimum vectoring altitude
Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

The proposed project consisting of seven, 479 AGL (1048 AMSL) wind turbines would be located between 7.3 and 9.7 NM northwest of Burke Lakefront Airport, Cleveland, OH. For the sake of efficiency this narrative contains all turbines within this project that have similar impacts. Separate determinations will be issued for each turbine which will be available on the FAA's website at htttp://oeaaa.faa.gov.

The turbine(s) exceed(s) Part 77 standards as described below.

Section 77.17(a)(3): A height that increases a minimum instrument flight altitude within a terminal area (TERPS criteria).

The turbines studied under the ASNs listed below would increase the Sector A Minimum Vectoring Altitude (MVA) from 1800 feet AMSL to 2000 feet AMSL for the Cleveland Ohio Terminal Radar Approach Control (CLE ATCT/TRACON)

2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

There would be no impact to this standard if the turbines do not exceed 849 feet AMSL (280 AGL).

The study was not circularized for public comment as the impact to Cleveland TRACON's MVA identified above only requires FAA comment. Cleveland Air Traffic Control has responded to this study with no objection to the increase in MVA height.

Aeronautical study disclosed that the proposed structure would have no effect on any existing or proposed arrival, departure, or en route instrument flight rule (IFR) operations or procedures other than the MVA impact identified above.

Study for possible visual flight rules (VFR) effect disclosed that the proposed structure would have no effect on any existing or proposed arrival or departure VFR operations or procedures. It would not conflict with airspace required to conduct normal VFR traffic pattern operations at any known public use or military airport. At 479 feet above ground level the proposed structure would not have a substantial adverse effect on VFR en route flight operations.

The proposed structure would be appropriately obstruction marked and/or lighted to make it more conspicuous to airmen should circumnavigation be necessary.

Therefore, it is determined that the proposed construction would not have a substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on any air navigation facility and would not be a hazard to air navigation provided the conditions set forth within this determination are met.

Sectional Map for ASN 2016-WTE-5050-OE

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2016-WTE-5051-OE
Prior Study No.
2014-WTE-687-OE

Issued Date: 02/22/2017

Lorry Wagner
LEEDCo
1938 Euclid Avenue
Ste 200
Cleveland, OH 44115

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Wind Turbine Turbine 4
Location:	Cleveland, OH
Latitude:	41-37-01.00N NAD 83
Longitude:	81-49-01.10W
Heights:	569 feet site elevation (SE)
	479 feet above ground level (AGL)
	1048 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s) is(are) met:

As a condition to this Determination, the structure is to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, white paint/synchronized red lights - Chapters 4,12&13(Turbines).

Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to (877) 487-6867 so a Notice to Airmen (NOTAM) can be issued. As soon as the normal operation is restored, notify the same number.

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 56 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

See attachment for additional condition(s) or information.

This determination expires on 08/22/2018 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.
(b) extended, revised, or terminated by the issuing office.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

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This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights, and frequencies or use of greater power will void this determination. Any future construction or alteration, including increase to heights, power, or the addition of other transmitters, requires separate notice to the FAA.

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An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

If we can be of further assistance, please contact Paul Holmquist, at (425) 227-2625. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2016-WTE-5051-OE.

Signature Control No: 299560650-322889484 (DNH -WT)
Mike Helvey
Manager, Obstruction Evaluation Group

Attachment(s)
Additional Information
Map(s)

Additional information for ASN 2016-WTE-5051-OE

Narrative for ASNs
2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

Abbreviations

AGL - above ground level
AMSL - above mean sea level
RWY - runway
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ASN- Aeronautical Study Number
MVA - minimum vectoring altitude
Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

The proposed project consisting of seven, 479 AGL (1048 AMSL) wind turbines would be located between 7.3 and 9.7 NM northwest of Burke Lakefront Airport, Cleveland, OH. For the sake of efficiency this narrative contains all turbines within this project that have similar impacts. Separate determinations will be issued for each turbine which will be available on the FAA's website at htttp://oeaaa.faa.gov.

The turbine(s) exceed(s) Part 77 standards as described below.

Section 77.17(a)(3): A height that increases a minimum instrument flight altitude within a terminal area (TERPS criteria).

The turbines studied under the ASNs listed below would increase the Sector A Minimum Vectoring Altitude (MVA) from 1800 feet AMSL to 2000 feet AMSL for the Cleveland Ohio Terminal Radar Approach Control (CLE ATCT/TRACON)

2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

There would be no impact to this standard if the turbines do not exceed 849 feet AMSL (280 AGL).

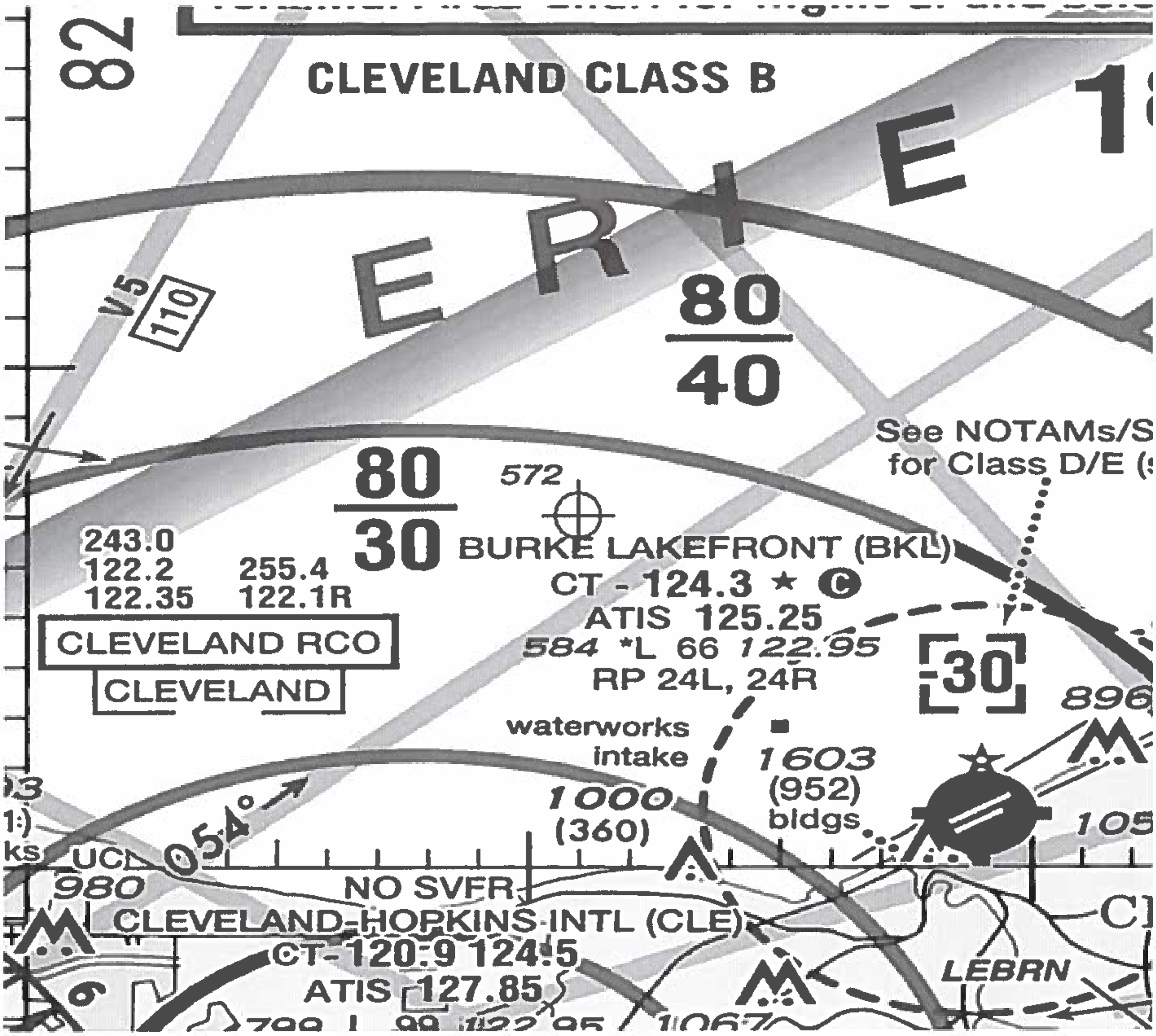
The study was not circularized for public comment as the impact to Cleveland TRACON's MVA identified above only requires FAA comment. Cleveland Air Traffic Control has responded to this study with no objection to the increase in MVA height.

Aeronautical study disclosed that the proposed structure would have no effect on any existing or proposed arrival, departure, or en route instrument flight rule (IFR) operations or procedures other than the MVA impact identified above.

Study for possible visual flight rules (VFR) effect disclosed that the proposed structure would have no effect on any existing or proposed arrival or departure VFR operations or procedures. It would not conflict with airspace required to conduct normal VFR traffic pattern operations at any known public use or military airport. At 479 feet above ground level the proposed structure would not have a substantial adverse effect on VFR en route flight operations.

The proposed structure would be appropriately obstruction marked and/or lighted to make it more conspicuous to airmen should circumnavigation be necessary.

Therefore, it is determined that the proposed construction would not have a substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on any air navigation facility and would not be a hazard to air navigation provided the conditions set forth within this determination are met.


CLEVELAND CLASS B
ERIE
80
40
80
30
572
See NOTAMs/S
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CT - 120.9 124.5
ATIS 127.85
LEBRN
V5
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Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2016-WTE-5052-OE
Prior Study No.
2014-WTE-688-OE

Issued Date: 02/22/2017

Lorry Wagner
LEEDCo
1938 Euclid Avenue
Ste 200
Cleveland, OH 44115

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Wind Turbine Turbine 5
Location:	Cleveland, OH
Latitude:	41-37-21.00N NAD 83
Longitude:	81-49-21.00W
Heights:	569 feet site elevation (SE)
	479 feet above ground level (AGL)
	1048 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s) is(are) met:

As a condition to this Determination, the structure is to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, white paint/synchronized red lights - Chapters 4,12&13(Turbines).

Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to (877) 487-6867 so a Notice to Airmen (NOTAM) can be issued. As soon as the normal operation is restored, notify the same number.

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 56 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

See attachment for additional condition(s) or information.

This determination expires on 08/22/2018 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.
(b) extended, revised, or terminated by the issuing office.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

This determination is subject to review if an interested party files a petition that is received by the FAA on or before March 24, 2017. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager, Airspace Policy & Regulation, Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591.

This determination becomes final on April 03, 2017 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Airspace Regulations & ATC Procedures Group via telephone -- 202-267-8783 - or facsimile 202-267-9328.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights, and frequencies or use of greater power will void this determination. Any future construction or alteration, including increase to heights, power, or the addition of other transmitters, requires separate notice to the FAA.

Obstruction marking and lighting recommendations for wind turbine farms are based on the scheme for the entire project. ANY change to the height, location or number of turbines within this project will require a reanalysis of the marking and lighting recommendation for the entire project. In particular, the removal of previously planned or built turbines/turbine locations from the project will often result in a change in the marking/lighting recommendation for other turbines within the project. It is the proponent's responsibility to contact the FAA to discuss the process for developing a revised obstruction marking and lighting plan should this occur.

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This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation.

An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

If we can be of further assistance, please contact Paul Holmquist, at (425) 227-2625. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2016-WTE-5052-OE.

Signature Control No: 299560651-322889485 (DNH -WT)
Mike Helvey
Manager, Obstruction Evaluation Group

Attachment(s)
Additional Information
Map(s)

Additional information for ASN 2016-WTE-5052-OE

Narrative for ASNs
2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

Abbreviations

AGL - above ground level
AMSL - above mean sea level
RWY - runway
VFR - visual flight rules
IFR - instrument flight rules
NM - nautical mile
ASN- Aeronautical Study Number
MVA - minimum vectoring altitude
Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

The proposed project consisting of seven, 479 AGL (1048 AMSL) wind turbines would be located between 7.3 and 9.7 NM northwest of Burke Lakefront Airport, Cleveland, OH. For the sake of efficiency this narrative contains all turbines within this project that have similar impacts. Separate determinations will be issued for each turbine which will be available on the FAA's website at htttp://oeaaa.faa.gov.

The turbine(s) exceed(s) Part 77 standards as described below.

Section 77.17(a)(3): A height that increases a minimum instrument flight altitude within a terminal area (TERPS criteria).

The turbines studied under the ASNs listed below would increase the Sector A Minimum Vectoring Altitude (MVA) from 1800 feet AMSL to 2000 feet AMSL for the Cleveland Ohio Terminal Radar Approach Control (CLE ATCT/TRACON)

2016-WTE-5048-OE
2016-WTE-5049-OE
2016-WTE-5050-OE
2016-WTE-5051-OE
2016-WTE-5052-OE
2016-WTE-5053-OE
2016-WTE-5054-OE

There would be no impact to this standard if the turbines do not exceed 849 feet AMSL (280 AGL).

The study was not circularized for public comment as the impact to Cleveland TRACON's MVA identified above only requires FAA comment. Cleveland Air Traffic Control has responded to this study with no objection to the increase in MVA height.

Aeronautical study disclosed that the proposed structure would have no effect on any existing or proposed arrival, departure, or en route instrument flight rule (IFR) operations or procedures other than the MVA impact identified above.

Study for possible visual flight rules (VFR) effect disclosed that the proposed structure would have no effect on any existing or proposed arrival or departure VFR operations or procedures. It would not conflict with airspace required to conduct normal VFR traffic pattern operations at any known public use or military airport. At 479 feet above ground level the proposed structure would not have a substantial adverse effect on VFR en route flight operations.

The proposed structure would be appropriately obstruction marked and/or lighted to make it more conspicuous to airmen should circumnavigation be necessary.

Therefore, it is determined that the proposed construction would not have a substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on any air navigation facility and would not be a hazard to air navigation provided the conditions set forth within this determination are met.

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Structure:	Wind Turbine Turbine 6
Location:	Cleveland, OH
Latitude:	41-37-40.60N NAD 83
Longitude:	81-49-40.40W
Heights:	569 feet site elevation (SE)
	479 feet above ground level (AGL)
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Signature Control No: 299560652-322889483 (DNH -WT)
Mike Helvey
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2016-WTE-5048-OE
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AGL - above ground level	AMSL - above mean sea level	RWY - runway
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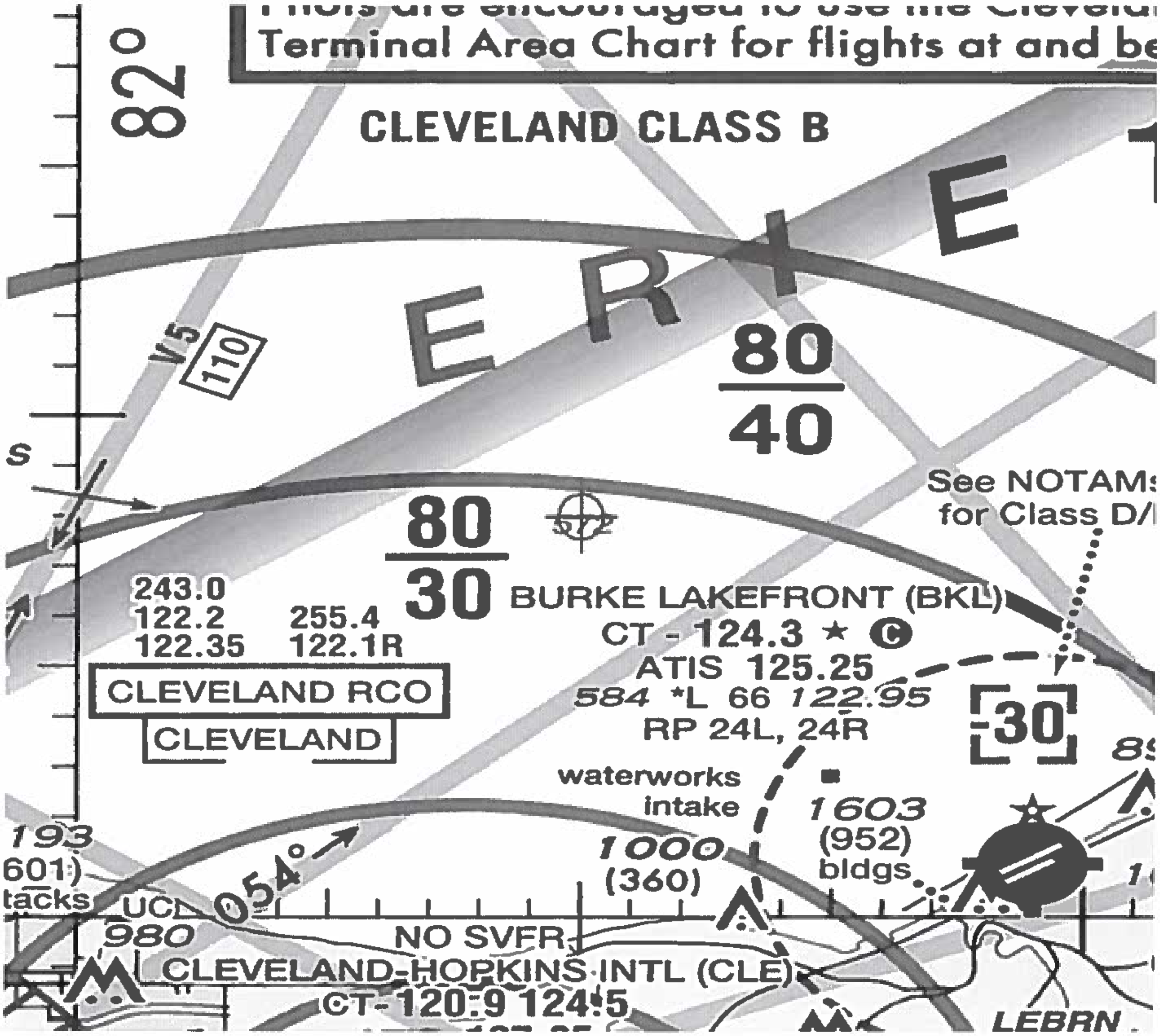
Sectional Map for ASN 2016-WTE-5054-OE



Attachment 8

Turbine Specifications Abstract
General Description 3MW Platform

This Document is an abstract and origins from: 0053-3707 V03 2016-05-06

General Description

3MW Platform

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Denmark · www.vestas.com

Table of contents

Recipient acknowledges that (i) this General Description is provided for recipient's information only, and, does not create or constitute a warranty, guarantee, promise, commitment, or other representation (Commitment) by Vestas Wind Systems or any of its affiliated or subsidiary companies (Vestas), all of which are disclaimed by Vestas and (ii) any and all Commitments by Vestas to recipient as to this general description (or any of the contents herein) are to be contained exclusively in signed written contracts between recipient and Vestas, and not within this document.

See general reservations, notes and disclaimers (including, section 12, p. 43) to this general description.

1 Introduction

The 3MW Platform wind turbine configurations covered by this General Description are listed below with designations according to IEC61400-22.

The maximum DIBt 2012 wind class is listed where applicable.

Please refer to the Performance Specification for the relevant turbine variant for full wind class definition.

This General Description contains data and descriptions common among the platform variants.

The variant specific performance can be found in the Performance Specifications for the turbine variant and operational mode required.

Turbine Type Class	Turbine Type | Operating Mode
V105-3.45 MW	V105-3.45 MW IEC IA 50/60 Hz | Mode 0
	V105-3.45 MW IEC IA 50/60 Hz | Reactive Power Optimized Mode (QO1)
	V105-3.6 MW IEC IA 50/60 Hz | Power Optimized Mode (PO1)
	V105-3.3 MW IEC IA 50/60 Hz | Load Optimized Mode (LO1)
	V105-3.0 MW IEC IA 50/60 Hz | Load Optimized Mode (LO2)
V112-3.45 MW	V112-3.45 MW IEC IA 50/60 H0z | Mode 0
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	V112-3.3 MW IEC IA 50/60 Hz | Load Optimized Mode (LO1)
	V112-3.0 MW IEC IA 50/60 Hz | Load Optimized Mode (LO2)
V117-3.45 MW	V117-3.45 MW IEC IB + IIA 50/60 Hz | Mode 0
	V117-3.45 MW IEC IB + IIA 50/60 Hz | Reactive Power Optimized Mode (QO1)
	V117-3.6 MW IEC S + IIA 50/60 Hz | Power Optimized Mode (PO1)

	V117-3.3 MW IEC IB + IIA 50/60 Hz | Load Optimized Mode (LO1)
	V117-3.0 MW IEC IB + IIA 50/60 Hz | Load Optimized Mode (LO2)
V126-3.45 MW Low Torque (LTq)	V126-3.45 MW IEC IIB + IIIA 50/60 Hz LTq | Mode 0
	V126-3.45 MW IEC IIB + IIIA 50/60 Hz LTq | Reactive Power Optimized Mode (QO1)
	V126-3.3 MW IEC IIB + IIIA 50/60 Hz LTq | Load Optimized Mode (LO1)
	V126-3.0 MW IEC IIB + IIIA 50/60 Hz LTq | Load Optimized Mode (LO2)
V126-3.45 MW High Torque (HTq)	V126-3.45 MW IEC IIA + IIIA 50/60 Hz HTq | Mode 0
	V126-3.45 MW IEC IIA + IIIA 50/60 Hz HTq | Reactive Power Optimized Mode (QO1)
	V126-3.6 MW IEC IIA + IIIA 50/60 Hz HTq | Power Optimized Mode (PO1)
	V126-3.3 MW IEC IIA + IIIA 50/60 Hz HTq | Load Optimized Mode (LO1)
	V126-3.0 MW IEC IIA + IIIA 50/60 Hz HTq | Load Optimized Mode (LO2)
	V126-3.45 MW WZ 3 GK II TK A 50 Hz HTq | Mode 0
	V126-3.45 MW WZ 3 GK II TK A 50 Hz HTq | Reactive Power Optim. Mode (QO1)

General Description

Turbine Type Class	Turbine Type | Operating Mode
V136-3.45 MW	V136-3.45 MW IEC IIIA 50/60 Hz | Mode 0
	V136-3.45 MW IEC IIIA 50/60 Hz | Reactive Power Optimized Mode (QO1)
	V136-3.3 MW IEC IIIA 50/60 Hz | Load Optimized Mode (LO1)
	V136-3.0 MW IEC IIIA 50/60 Hz | Load Optimized Mode (LO2)
	V136-3.45 MW WZ 2 GK II TK A 50 Hz | Mode 0
	V136-3.45 MW WZ 2 GK II TK A 50 Hz | Reactive Power Optimized Mode (QO1)

Table 1-1: 3MW Platform turbine configurations covered.

2 General Description

Vestas 3MW Platform comprises a family of wind turbines sharing a common design basis.

The 3MW Platform family of wind turbines includes V105-3.45 MW, V112-3.45 MW, V117-3.45 MW, V126-3.45 MW and V136-3.45 MW.

These turbines are pitch regulated upwind turbines with active yaw and a threeblade rotor.

The wind turbine family provides rotors with a diameter in the range 105 m to 136 m and a rated output power of 3.45 MW.

A 3.45 MW Reactive Power Optimized Mode (QO1) is available for all variants.

A 3.6 MW Power Optimized Mode (PO1) is available for all variants except V1363.45 MW and V126-3.45 MW Low Torque (LTq).

Also, a 3.3 MW Load Optimized Mode (LO1) and a 3.0 MW Load Optimized Mode (LO2) are available for all variants.

The wind turbine family utilises the OptiTip® concept and a power system based on an induction generator and full-scale converter. With these features, the wind turbine is able to operate the rotor at variable speed and thereby maintain the power output at or near rated power even in high wind speed. At low wind speed, the OptiTip® concept and the power system work together to maximise the power output by operating at the optimal rotor speed and pitch angle.

Operating the wind turbine in the 3.45 MW Reactive Power Optimized Mode (QO1) is achieved by applying an extended ambient temperature derate strategy compared with 3.45 MW Mode 0 operation.

Operating the wind turbine in the 3.6 MW Power Optimized Mode (PO1) is achieved by applying an extended ambient temperature derate strategy and reduced reactive power capability compared with 3.45 MW Mode 0 operation.

3 Mechanical Design

3.1 Rotor

The wind turbine is equipped with a rotor consisting of three blades and a hub. The blades are controlled by the microprocessor pitch control system OptiTip®. Based on the prevailing wind conditions, the blades are continuously positioned to optimise the pitch angle.

Rotor	V105	V112	V117	V126	V136

Diameter	105 m	112 m	117 m	126 m	136 m
Swept Area	8659 m²	9852 m²	10751 m²	12469 m²	14527 m²
Speed, Dynamic Operation Range	8.3-17.6	8.1-17.6	6.7-17.5	5.9-16.3 (6.2-16.3)	5.6-15.3
Rotational Direction	Clockwise (front view)				
Orientation	Upwind				
Tilt	6°				
Hub Coning	4°				
No. of Blades	3				
Aerodynamic Brakes	Full feathering				

Table 3-1: Rotor data

3.2 Blades

The blades are made of carbon and fibreglass and consist of two airfoil shells bonded to a supporting beam.

Blades	**V105**	**V112**	**V117**	**V126**	**V136**
Type Description	Airfoil shells bonded to supporting beam			Infused structural airfoil shell	
Blade Length	51.15 m	54.65 m	57.15 m	61.66 m	66.66 m
Material	Fibreglass reinforced epoxy, carbon fibres and Solid Metal Tip (SMT).				
Blade Connection	Steel roots inserted				
Airfoils	High-lift profile				
Maximum Chord	4.0 m				4.1 m

Table 3-2: Blades data

3.3 Blade Bearing

The blade bearings are double-row four-point contact ball bearings.

Blade Bearing	
Lubrication	Grease

Table 3-3: Blade bearing data

3.4 Pitch System

The turbine is equipped with a pitch system for each blade and a distributor block, all located in the hub. Each pitch system is connected to the distributor block with flexible hoses. The distributor block is connected to the pipes of the hydraulic rotating transfer unit in the hub by means of three hoses (pressure line, return line and drain line).

Each pitch system consists of a hydraulic cylinder mounted to the hub and a piston rod mounted to the blade bearing via a torque arm shaft. Valves facilitating operation of the pitch cylinder are installed on a pitch block bolted directly onto the cylinder.

Pitch System	
Type	Hydraulic
Number	1 per blade
Range	-10° to 90°

Table 3-4: Pitch system data

Hydraulic System	
Main Pump	Two redundant internal-gear oil pumps
Pressure	260 bar
Filtration	3 µm (absolute)

Table 3-5: Hydraulic system data.

3.5 Hub

The hub supports the three blades and transfers the reaction loads to the main bearing and the torque to the gearbox. The hub structure also supports blade bearings and pitch cylinders.

Hub	
Type	Cast ball shell hub
Material	Cast iron

Table 3-6: Hub data

3.6 Main Shaft

The main shaft transfers the reaction forces to the main bearing and the torque to the gearbox.

Main Shaft	
Type Description	Hollow shaft
Material	Cast iron

Table 3-7: Main shaft data

3.7 Main Bearing Housing

The main bearing housing covers the main bearing and is the first connection point for the drive train system to the bedplate.

Main Bearing Housing	
Material	Cast iron

Table 3-8: Main bearing housing data

3.8 Main Bearing

The main bearing carries all thrust loads.

Main Bearing	
Type	Double-row spherical roller bearing
Lubrication	Automatic grease lubrication

Table 3-9: Main bearing data

3.9 Gearbox

The main gear converts the low-speed rotation of the rotor to high-speed generator rotation.

The disc brake is mounted on the high-speed shaft. The gearbox lubrication system is a pressure-fed system.

Gearbox	
Type	Planetary stages + one helical stage
Gear House Material	Cast
Lubrication System	Pressure oil lubrication
Backup Lubrication System	Oil sump filled from external gravity tank
Total Gear Oil Volume	1000-1200
Oil Cleanliness Codes	ISO 4406-/15/12
Shaft Seals	Labyrinth

Table 3-10: Gearbox data

3.10 Generator Bearings

The bearings are grease lubricated and grease is supplied continuously from an automatic lubrication unit.

Document no.: 0053-

Type: T05 -

3.11 High-Speed Shaft Coupling

The coupling transmits the torque of the gearbox high-speed output shaft to the generator input shaft.

The coupling consists of two 4-link laminate packages and a fibreglass intermediate tube with two metal flanges.

The coupling is fitted to two-armed hubs on the brake disc and the generator hub.

3.12 Yaw System

The yaw system is an active system based on a robust pre-tensioned plain yawbearing concept with PETP as friction material.

Yaw System	
Type	Plain bearing system
Material	Forged yaw ring heat-treated. Plain bearings PETP
Yawing Speed (50 Hz)	0.45°/sec.

Yawing Speed (60 Hz)	0.55°/sec.

Table 3-11: Yaw system data

Yaw Gear	
Type	Multiple stages geared
Ratio Total	944:1
Rotational Speed at Full Load	1.4 rpm at output shaft

Table 3-12: Yaw gear data

3.13 Crane

The nacelle houses the internal safe working load (SWL) service crane. The crane is a single system hoist.

Crane	
Lifting Capacity	Maximum 800 kg

Table 3-13: Crane data

3.14 Towers

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. The towers are designed with the majority of internal welded connections replaced by magnet supports to create a predominantly smooth-walled tower.

Magnets provide load support in a horizontal direction and internals, such as platforms, ladders, etc., are supported vertically (that is, in the gravitational direction) by a mechanical connection. The smooth tower design reduces the required steel thickness, rendering the tower lighter compared to one with all internals welded to the tower shells.

Available hub heights are listed in the Performance Specification for each turbine variant. Designated hub heights include a distance from the foundation section to the ground level of approximately 0.2 m depending on the thickness of the bottom flange and a distance from tower top flange to centre of the hub of 2.2 m.

Towers	
Type	Cylindrical/conical tubular

Table 3-14: Tower structure data

3.15 Nacelle Bedplate and Cover

The nacelle cover is made of fibreglass. Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel. The roof section is equipped with wind sensors and skylights. The skylights can be opened from inside the nacelle to access the roof and from outside to access the nacelle. Access from the tower to the nacelle is through the yaw system.

The nacelle bedplate is in two parts and consists of a cast iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train and transmits forces from the rotor to the tower through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw gears are bolted to the front nacelle bedplate.

The crane girders are attached to the top structure. The lower beams of the girder structure are connected at the rear end. The rear part of the bedplate serves as the foundation for controller panels, the cooling system and transformer. The nacelle cover is installed on the nacelle bedplate.

Type Description	**Material**
Nacelle Cover	GRP
Bedplate Front	Cast iron
Bedplate Rear	Girder structure

Table 3-15: Nacelle bedplate and cover data

3.16 Thermal Conditioning System

The thermal conditioning system consists of a few robust components:

- The Vestas CoolerTop® located on top of the rear end of the nacelle. The CoolerTop® is a free flow cooler, thus ensuring that there are no electrical components in the thermal conditioning system located outside the nacelle.

- The Liquid Cooling System, which serves the gearbox, hydraulic systems, generator and converter is driven by an electrical pumping system.
- The transformer forced air cooling comprised of an electrical fan.

3.16.1 Generator and Converter Cooling

The generator and converter cooling systems operate in parallel. A dynamic flow valve mounted in the generator cooling circuit divides the cooling liquid flow. The cooling liquid removes heat from the generator and converter unit using a free-air flow radiator placed on the top of the nacelle. In addition to the generator, converter unit and radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

3.16.2 Gearbox and Hydraulic Cooling

The gearbox and hydraulic cooling systems are coupled in parallel. A dynamic flow valve mounted in the gearbox cooling circuit divides the cooling flow. The cooling liquid removes heat from the gearbox and the hydraulic power unit through heat exchangers and a free-air flow radiator placed on the top of the nacelle. In addition to the heat exchangers and the radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

3.16.3 Transformer Cooling

The transformer is equipped with forced-air cooling. The ventilator system consists of a central fan, located below the converter and an air duct leading the air to locations beneath and between the high voltage and low voltage windings of the transformer.

3.16.4 Nacelle Cooling

Hot air generated by mechanical and electrical equipment is dissipated from the nacelle by a fan system located in the nacelle.

3.16.5 Optional Air Intake Hatches

Specific air intakes in the nacelle can optionally be fitted with hatches which can be operated as a part of the thermal control strategy. In case of lost grid to the turbine, the hatches will automatically be closed.

4 Electrical Design

4.1 Generator

The generator is a three-phase asynchronous induction generator with cage rotor that is connected to the grid through a full-scale converter. The generator housing allows the circulation of cooling air within the stator and rotor. The air-to-water heat exchange occurs in an external heat exchanger.

Generator	
Type	Asynchronous with cage rotor
Rated Power [P_N]	3650 kW / 3800 kW
Frequency [f_N]	0-100 Hz
Voltage, Stator [U_{NS}]	3 x 750 V (at rated speed)
Number of Poles	4/6
Winding Type	Form with VPI (Vacuum Pressurized Impregnation)

Electrical Design

Generator	
Winding Connection	Star or Delta
Rated rpm	1450-1550 rpm
Overspeed Limit Acc. to IEC (2 minutes)	2400 rpm
Generator Bearing	Hybrid/ceramic
Temperature Sensors, Stator	3 PT100 sensors placed at hot spots and 3 as backup
Temperature Sensors, Bearings	1 per bearing
Insulation Class	F or H
Enclosure	IP54

Table 4-1: Generator data

4.2 Converter

The converter is a full-scale converter system controlling both the generator and the power quality delivered to the grid. The converter consists of 3 machine-side converter units and 3 line-side converter units operating in parallel with a common controller.

The converter controls conversion of variable frequency AC power from the generator into fixed frequency AC power with desired active and reactive power levels (and other grid connection parameters) suitable for the grid. The converter is located in the nacelle and has a grid side voltage rating of 650

V. The generator side voltage rating is up to 750 V dependent on generator speed.

Converter	
Rated Apparent Power [S_N]	4400 kVA
Rated Grid Voltage	3 x 650 V
Rated Generator Voltage	3 x 750 V
Rated Grid Current	3900 A (≤30°C ambient) / 3950 (≤20°C ambient)
Rated Generator Current	3400 A (≤30°C ambient) / 3450 (≤20°C ambient)
Enclosure	IP54

Table 4-2: Converter data

4.3 HV Transformer

The step-up HV transformer is located in a separate locked room in the back of the nacelle.

The transformer is a three-phase, two-winding, dry-type transformer that is selfextinguishing. The windings are delta-connected on the high-voltage side unless otherwise specified.

The transformer comes in different versions depending on the market where it is intended to be installed.

- For 50 Hz regions the transformer is as default designed according to IEC standards. However on special request, a 60 Hz transformer based on IEC standards could also be delivered. Refer to Table 4-3.
- For turbines installed in Member States of the European Union, it is required to fulfil the Ecodesign regulation No 548/2014 set by the European Commission. Refer to Table 4-4.
- For 60 Hz regions the transformer is as default designed mainly according to IEEE standards but on areas not covered by IEEE standards, the design is also based on parts of the IEC standards. Refer to Table 4-5.

4.3.1 IEC 50 Hz/60 Hz version

Transformer

Type description	Dry-type cast resin transformer.
Basic layout	3 phase, 2 winding transformer.
Applied standards	IEC 60076-11, IEC 60076-16, IEC 61936-1.
Cooling method	AF
Rated power	4000 kVA
Rated voltage, turbine side	
U_m 1.1kV	0.650 kV
Rated voltage, grid side	
U_m 12.0kV	10.0-11.0 kV
U_m 24.0kV	11.1-22.0 kV
U_m 36.0kV	22.1-33.0 kV
U_m 41.5kV	33.1-36.0 kV
Insulation level AC / LI / LIC	
U_m 1.1kV	3[1] / - / - kV
U_m 12.0kV	28[1] / 75 / 75 kV
U_m 24.0kV	50[1] / 125 / 125 kV
U_m 36.0kV	70[1] / 170 / 170 kV
U_m 41.5kV	80[1] / 170 / 170 kV
Off-circuit tap changer	±2 x 2.5 %
Frequency	50 Hz / 60Hz
Vector group	Dyn5 / YNyn0
No-load loss [2]	~6.0 kW
Load loss @ rated power HV, 120□C [2]	~30.1 kW
No-load reactive power [2]	~16 kVAr
Full load reactive power [2]	~345 kVAr
No-load current [2]	~0.5 %
Positive sequence short-circuit impedance @ rated power, 120□C [3]	~9.0 %
Positive sequence short-circuit resistance@ rated power, 120□C [2]	~0.8 %
Zero sequence short-circuit impedance@ rated power, 120□C [2]	~8.2 %
Zero sequence short-circuit resistance@ rated power, 120□C [2]	~0.7 %
Inrush peak current [2]	

Dyn5	6-9 x $\hat{I}_n$
YNyn0	8-12 x $\hat{I}_n$

Transformer	
Half crest time [2]	~0.7 s
Sound power level	□ 80 dB(A)
Average temperature rise at max altitude	□90 K
Max altitude [1]	2000 m
Insulation class	155 (F)
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1
Corrosion class	C4
Weight	□9500 kg
Temperature monitoring	PT100 sensors in LV windings and core
Overvoltage protection	Surge arresters on HV terminals
Temporary earthing	3 x Ø20 mm earthing ball points

Table 4-3: Transformer data for IEC 50 Hz/60 Hz version

NOTE [1] @1000m. According to IEC 60076-11, AC test voltage is altitude dependent. All values are preliminary.
[2] Based on an average of calculated values across voltages and manufacturers. All values are preliminary.
[3] Subjected to standard IEC tolerances. All values are preliminary.
[4] Transformer max altitude may be adjusted to match turbine location.

Transformer	
Type description	Ecodesign dry-type cast resin transformer.
Basic layout	3 phase, 2 winding transformer.
Applied standards	IEC 60076-11, IEC 60076-16, IEC 61936-1, Commission Regulation No 548/2014.

[1] **4.3.2 Ecodesign - IEC 50 Hz/60 Hz version**

Cooling method	AF
Rated power	4000 kVA
Rated voltage, turbine side	
U_m 1.1kV	0.650 kV
Rated voltage, grid side	
U_m 12.0kV	10.0-11.0 kV
U_m 24.0kV	11.1-22.0 kV
U_m 36.0kV	22.1-33.0 kV
U_m 40.5kV	33.1-36.0 kV
Insulation level AC / LI / LIC	
U_m 1.1kV	3[1] / - / - kV
U_m 12.0kV	28[1] / 75 / 75 kV
U_m 24.0kV	50[1] / 125 / 125 kV
U_m 36.0kV	70[1] / 170 / 170 kV
U_m 40.5kV	80[1] / 170 / 170 kV
Transformer	
Off-circuit tap changer	±2 x 2.5 %
Frequency	50 Hz / 60 Hz
Vector group	Dyn5 / YNyn0
Peak Efficiency Index (PEI) [2]	Ecodesign requirement
U_m 12.0kV	> 99.348
U_m 24.0kV	> 99.348
U_m 36.0kV	> 99.348
U_m 40.5kV	> 99.158
No-load loss [2]	
U_m 12.0kV	< 5800 W
U_m 24.0kV	< 5800 W
U_m 36.0kV	< 5800 W
U_m 40.5kV	< 6900 W
Load loss @ rated power HV, 120□C [2]	
U_m 12.0kV	< 29300 W
U_m 24.0kV	< 29300 W
U_m 36.0kV	< 29300 W
U_m 40.5kV	< 37850 W
No-load reactive power [3]	~25 kVAr
Full load reactive power [3]	~370 kVAr
No-load current [3]	~0.5 %

Positive sequence short-circuit impedance @ rated power, 120□C [4]	~9.0 %
Positive sequence short-circuit resistance@ rated power, 120□C [3]	~0.8 %
Zero sequence short-circuit impedance@ rated power, 120□C [3]	~8.2 %
Zero sequence short-circuit resistance@ rated power, 120□C [3]	~0.7 %
Inrush peak current [3]	
Dyn5	6-9 x $\hat{I}_n$
YNyn0	8-12 x $\hat{I}_n$
Half crest time [3]	~ 0.7 s
Sound power level	□ 80 dB(A)
Average temperature rise at max altitude	□90 K
Max altitude [5]	2000 m
Insulation class	155 (F)
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1
Corrosion class	C4
Weight	□10000 kg
Temperature monitoring	PT100 sensors in LV windings and core
Overvoltage protection	Surge arresters on HV terminals
Temporary earthing	3 x Ø20 mm earthing ball points

Table 4-4: Transformer data for Ecodesign IEC 50 Hz/60 Hz version.

NOTE

[1] @1000m. According to IEC 60076-11, AC test voltage is altitude dependent. All values are preliminary.

[2] For Ecodesign transformers, PEI is the legal requirement and is calculated according to the Commission Regulation based on rated power, no-load and load losses. Losses are maximum values and will not simultaneously occur in a specific design as this will be incompliant with the PEI requirement. All values are preliminary.

[3] Based on an average of calculated values across voltages and manufacturers.

All values are preliminary.

[4] Subjected to standard IEC tolerances. All values are preliminary.

[5] Transformer max altitude may be adjusted to match turbine location.

4.3.3 IEEE 60Hz version

Transformer	
Type description	Dry-type cast resin transformer.
Basic layout	3 phase, 2 winding transformer.
Applied standards	UL 1562, CSA C22.2 No. 47, IEEE C57.12, IEC 60076-11, IEC 60076-16, IEC 61936-1.
Cooling method	AFA
Rated power	4000 kVA
Rated voltage, turbine side	
N_{LL} 1.2 kV	0.650 kV
Rated voltage, grid side	
N_{LL} 15.0 kV	10.0-15.0 kV
N_{LL} 25.0 kV	15.1-25.0 kV
N_{LL} 34.5 kV	25.1-34.5 kV
Insulation level AC / LI & LIC	
N_{LL} 1.2 kV	4[1] / +10 kV
N_{LL} 15.0 kV	34[1] / +95 kV
N_{LL} 25.0 kV	50[1] / +125 kV
N_{LL} 34.5 kV	70[1] / (+150 & -170) or +170 kV
Off-circuit tap changer	±2 x 2.5 %
Frequency	60 Hz
Vector group	Dyn5 / YNyn0
No-load loss [2]	~6.0 kW
Load loss @ rated power HV, 120□C [2]	~30.1 kW
No-load reactive power [2]	~16 kVAr
Full load reactive power [2]	~345 kVAr
No-load current [2]	~0.5 %
Positive sequence short-circuit impedance @ rated power, 120□C [3]	~9.0 %
Positive sequence short-circuit resistance @ rated power, 120□C [2]	~0.7 %

Zero sequence short-circuit impedance @ rated power, 120□C [2]	~8.3 %
Zero sequence short-circuit	~0.7 %

General Description
Electrical Design

Transformer	
resistance @ rated power, 120□C [2]	
Inrush peak current [2]	
Dyn5	6-9 x În
YNyn0	8-12 x În
Half crest time [2]	~ 0.7 s
Sound power level	□ 80 dB(A)
Average temperature rise at max altitude	□ 90 K
Max altitude [4]	2000 m
Insulation class	150□C
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1
Corrosion class	C4
Weight	□ 9500 kg
Temperature monitoring	PT100 sensors in LV windings and core
Overvoltage protection	Surge arresters on HV terminals
Temporary earthing	3 x Ø20 mm earthing ball points

Table 4-5: Transformer data for IEEE 60 Hz version

NOTE

[1] @1000m. According to IEEE C57.12, AC test voltage is altitude dependent. All values are preliminary.

[2] Based on an average of calculated values across voltages and manufacturers.
All values are preliminary.

[3] Subjected to standard IEEE C57.12 tolerances. All values are preliminary. [4] Transformer max altitude may be adjusted to match turbine location.

4.4 HV Cables

The high-voltage cable runs from the transformer in the nacelle down the tower to the HV switchgear located at the bottom of the tower. The high-voltage cable is a four-core, rubber-insulated, halogen-free, high-voltage cable.

HV Cables	
High-Voltage Cable Insulation Compound	Improved ethylene-propylene (EP) based material-EPR or high modulus or hard grade ethylene-propylene rubber-HEPR
Conductor Cross Section	3 x 70 / 70 mm^2
Maximum Voltage	24 kV for 10.0-22.0 kV rated voltage 42 kV for 22.1-36.0 kV rated voltage

Table 4-6: HV cables data

4.5 HV Switchgear

A gas insulated switchgear is installed in the bottom of the tower as an integrated part of the turbine. Its controls are integrated with the turbine safety system which monitors the condition of the switchgear and high voltage safety related devices in the turbine. This ensures all protection devices are fully operational whenever high voltage components in the turbine are energised. The earthing switch of the circuit breaker contains a trapped-key interlock system with its counterpart installed on the access door to the transformer room in order to avoid unauthorized access to the transformer room during live condition.

The switchgear is available in three variants with increasing features, see Table 4-7. Beside the increase in features, the switchgear can be configured depending on the number of grid cables planned to enter the individual turbine. The design of the switchgear solution is optimized such grid cables can be connected to the switchgear even before the tower is installed and still maintain its protection toward weather conditions and internal condensation due to a gas tight packing.

The switchgear is available in an IEC version and in an IEEE version. The IEEE version is however only available in the highest voltage class. The electrical parameters of the switchgear are seen in Table 4-8 for the IEC version and in Table 4-9 for the IEEE version.

HV Switchgear

Variant	Basic	Streamline	Standard
IEC standards	○	⊙	⊙
IEEE standards	⊙	○	⊙
Vacuum circuit breaker panel	⊙	⊙	⊙
Overcurrent, short-circuit and earth fault protection	⊙	⊙	⊙
Disconnector / earthing switch in circuit breaker panel	⊙	⊙	⊙
Voltage Presence Indicator System for circuit breaker	⊙	⊙	⊙
Voltage Presence Indicator System for grid cables	⊙	⊙	⊙
Double grid cable connection	⊙	⊙	⊙
Triple grid cable connection	⊙	○	○
Preconfigured relay settings	⊙	⊙	⊙
Turbine safety system integration	⊙	⊙	⊙
Redundant trip coil circuits	⊙	⊙	⊙
Trip coil supervision	⊙	⊙	⊙
Pendant remote control from outside of tower	⊙	⊙	⊙
Sequential energization	⊙	⊙	⊙
Reclose blocking function	⊙	⊙	⊙
HV Switchgear			
Variant	**Basic**	**Streamline**	**Standard**
Heating elements	⊙	⊙	⊙
Trapped-key interlock system for circuit breaker panel	⊙	⊙	⊙

UPS power back-up for protection circuits	⊙	⊙	⊙
Motor operation of circuit breaker	⊙	⊙	⊙
Cable panel for grid cables (configurable)	○	⊙	⊙
Switch disconnector panels for grid cables – max three panels (configurable)	○	⊙	⊙
Earthing switch for grid cables	○	⊙	⊙
Internal arc classification	○	⊙	⊙
Supervision on MCB's	○	⊙	⊙
Motor operation of switch disconnector	○	○	⊙
SCADA ready	○	○	⊙
SCADA operation of circuit breaker	○	○	⊙
SCADA operation of switch disconnector	○	○	⊙

Table 4-7: HV switchgear variants and features.

4.5.1 IEC 50/60Hz version

HV Switchgear	
Type description	Gas Insulated Switchgear
Applied standards	IEC 62271-103 IEC 62271-1, 62271-100, 62271-102, 62271-200, IEC 60694
Insulation medium	SF_6
Rated voltage	
U_r 24.0kV	10.0-22.0 kV
U_r 36.0kV	22.1-33.0 kV
U_r 40.5kV	33.1-36.0 kV
Rated insulation level AC // LI Common value / across isolation distance	
U_r 24.0kV	50 / 60 // 125 / 145 kV
U_r 36.0kV	70 / 80 // 170 / 195 kV
U_r 40.5kV	85 / 90 // 185 / 215 kV
Rated frequency	50 Hz / 60 Hz

Rated normal current	630 A
Rated Short-time withstand current	
U_r 24.0kV	20 kA
U_r 36.0kV	25 kA
U_r 40.5kV	25 kA
Rated peak withstand current 50 / 60 Hz	
U_r 24.0kV	50 / 52 kA
U_r 36.0kV	62.5 / 65 kA
HV Switchgear	
U_r 40.5kV	62.5 / 65 kA
Rated duration of short-circuit	1 s
Internal arc classification (option)	
U_r 24.0kV	IAC A FLR 20 kA, 1 s
U_r 36.0kV	IAC A FLR 25 kA, 1 s
U_r 40.5kV	IAC A FLR 25 kA, 1 s
Connection interface	Outside cone plug-in bushings, IEC interface C1.
Loss of service continuity category	LSC2
Ingress protection	
Gas tank	IP 65
Enclosure	IP 2X
LV cabinet	IP 3X
Corrosion class	C3

Table 4-8: HV switchgear data for IEC version.

4.5.2 IEEE 60Hz version

HV Switchgear	
Type description	Gas Insulated Switchgear
Applied standards	IEEE 37.20.3, IEEE C37.20.4, IEC 62271-200, ISO 12944.
Insulation medium	SF_6
Rated voltage	
U_r 38.0kV	22.1-36.0 kV
Rated insulation level AC / LI	70 / 150 kV
Rated frequency	60 Hz

Rated normal current	600 A
Rated Short-time withstand current	25 kA
Rated peak withstand current	65 kA
Rated duration of short-circuit	1 s
Internal arc classification (option)	IAC A FLR 25 kA, 1 s
Connection interface grid cables	Outside cone plug-in bushings, IEEE 386 interface type deadbreak, 600A.
Ingress protection	
Gas tank	NEMA 4X / IP 65
Enclosure	NEMA 2 / IP 2X
LV cabinet	NEMA 2 / IP 3X
Corrosion class	C3

Table 4-9: HV switchgear data for IEEE version.

4.6 AUX System

The AUX system is supplied from a separate 650/400/230 V transformer located in the nacelle inside the converter cabinet. All motors, pumps, fans and heaters are supplied from this system.

230 V consumers are generally supplied from a 400/230 V transformer located in the tower base. Internal heating and ventilation of cabinets as well as specific option 230 V consumers are supplied from the auxiliary transformer in the converter cabinet.

Power Sockets	
Single Phase (Nacelle)	230 V (16 A) (standard) 110 V (16 A) (option) 2 x 55 V (16 A) (option)
Single Phase (Tower Platforms)	230 V (10 A) (standard) 110 V (16 A) (option) 2 x 55 V (16 A) (option)
Three Phase (Nacelle and Tower Base)	3 x 400 V (16 A)

Table 4-10: AUX system data

4.7 Wind Sensors

The turbine is either equipped with two ultrasonic wind sensors or optional one ultrasonic wind sensor and one mechanical wind vane and anemometer. The sensors have built-in heaters to minimise interference from ice and snow. The wind sensors are redundant, and the turbine is able to operate with one sensor only.

4.8 Vestas Multi Processor (VMP) Controller

The turbine is controlled and monitored by the VMP8000 control system.

VMP8000 is a multiprocessor control system comprised of main controller, distributed control nodes, distributed IO nodes and ethernet switches and other network equipment. The main controller is placed in the tower bottom of the turbine. It runs the control algorithms of the turbine, as well as all IO communication.

The communications network is a time triggered Ethernet network (TTEthernet).

The VMP8000 control system serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Reactive power control and variable speed operation.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.
- Monitoring of the smoke detection system.

4.9 Uninterruptible Power Supply (UPS)

During grid outage, an UPS system will ensure power supply for specific components.

The UPS system is built by 3 subsystems:

1. 230V AC UPS for all power backup to nacelle and hub control systems
2. 24V DC UPS for power backup to tower base control systems and optional SCADA Power Plant Controller.
3. 230V AC UPS for power backup to internal lights in tower and nacelle.

Internal light in the hub is fed from built-in batteries in the light armature.

UPS		
Backup Time	**Standard**	**Optional**
Control System* **(230V AC and 24V DC UPS)**	15 min	Up to 400 min**
Internal Lights **(230V AC UPS)**	30 min	60 min***
Optional SCADA Power Plant Controller **(24V DC UPS)**	N/A	48 hours****

Table 4-11: UPS data

**The control system includes: the turbine controller (VMP8000), HV switchgear functions, and remote control system.*

***Requires upgrade of the 230V UPS for control system with extra batteries.*

****Requires upgrade of the 230V UPS for internal light with extra batteries.*

*****Requires upgrade of the 24V DC UPS with extra batteries.*

NOTE For alternative backup times, consult Vestas.

5 Turbine Protection Systems

5.1 Braking Concept

The main brake on the turbine is aerodynamic. Stopping the turbine is done by full feathering the three blades (individually turning each blade). Each blade has a hydraulic accumulator to supply power for turning the blade.

In addition, there is a mechanical disc brake on the high-speed shaft of the gearbox with a dedicated hydraulic system. The mechanical brake is only used as a parking brake and when activating the emergency stop buttons.

5.2 Short Circuit Protections

Breakers	Breaker for Aux. Power. (not settled)	Breaker for Converter Modules (not settled)
Breaking Capacity, Icu, Ics	TBD	TBD
Making Capacity, Icm	TBD	TBD

Table 5-1: Short circuit protection data

5.3 Overspeed Protection

The generator rpm and the main shaft rpm are registered by inductive sensors and calculated by the wind turbine controller to protect against overspeed and rotating errors.

The safety-related partition of the VMP8000 control system monitors the rotor rpm. In case of an overspeed situation, the safety-related partition of the VMP8000 control system activates the emergency feathered position (full feathering) of the three blades independently of the non-safety related partition of VMP8000 control system.

Overspeed Protection	
Sensors Type	Inductive
Trip Level (variant dependent)	15.3-17.6 rpm / 2000 (generator rpm)

Table 5-3: Overspeed protection data

5.4 Arc Detection

The turbine is equipped with an Arc Detection system including multiple optical arc detection sensors placed in the HV transformer compartment and the converter cabinet. The Arc Detection system is connected to the turbine safety system ensuring immediate opening of the HV switchgear if an arc is detected.

5.5 Smoke Detection

The turbine is equipped with a Smoke Detection system including multiple smoke detection sensors placed in the nacelle (above the disc brake), in the transformer compartment, in main electrical cabinets in the nacelle and above the HV switchgear in the tower base. The Smoke Detection system is connected to the turbine safety system ensuring immediate opening of the HV switchgear if smoke is detected.

5.6 Lightning Protection of Blades, Nacelle, Hub and Tower

The Lightning Protection System (LPS) helps protect the wind turbine against the physical damage caused by lightning strikes. The LPS consists of five main parts:

- Lightning receptors. All lightning receptor surfaces on the blades including the Solid Metal Tips (SMT) are unpainted as standard.
- Down conducting system (a system to conduct the lightning current down through the wind turbine to help avoid or minimise damage to the LPS itself or other parts of the wind turbine).
- Protection against overvoltage and overcurrent. □ Shielding against magnetic and electrical fields.
- Earthing system.

Lightning Protection Design Parameters			Protection Level I
Current Peak Value	i_{max}	[kA]	200
Impulse Charge	$Q_{impulse}$	[C]	100
Long Duration Charge	Q_{long}	[C]	200
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/□]	10
Average Steepness	di/dt	[kA/□s]	200

Table 5-4: Lightning protection design parameters

NOTE The Lightning Protection System is designed according to IEC standards (see section 8 Design Codes, p. 28).

5.7 EMC

The turbine and related equipment fulfils the EU Electromagnetic Compatibility (EMC) legislation:

- DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.

5.8 Earthing

The Vestas Earthing System consists of a number of individual earthing electrodes interconnected as one joint earthing system.

The Vestas Earthing System includes the TN-system and the Lightning Protection System for each wind turbine. It works as an earthing system for the medium voltage distribution system within the wind farm.

The Vestas Earthing System is adapted for the different types of turbine foundations. A separate set of documents describe the earthing system in detail, depending on the type of foundation.

In terms of lightning protection of the wind turbine, Vestas has no separate requirements for a certain minimum resistance to remote earth (measured in ohms) for this system. The earthing for the lightning protection system is based on the design and construction of the Vestas Earthing System.

A primary part of the Vestas Earthing System is the main earth bonding bar placed where all cables enter the wind turbine. All earthing electrodes are connected to this main earth bonding bar. Additionally, equipotential connections are made to all cables entering or leaving the wind turbine.

Requirements in the Vestas Earthing System specifications and work descriptions are minimum requirements from Vestas and IEC. Local and national requirements, as well as project requirements, may require additional measures.

5.9 Corrosion Protection

Classification of corrosion protection is according to ISO 12944-2.

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5-M	C3
Hub	C5-M	C3
Tower	C5-I	C3

Table 5-5: Corrosion protection data for nacelle, hub, and tower

6 Safety

The safety specifications in this section provide limited general information about the safety features of the turbine and are not a substitute for Buyer and its agents taking all appropriate safety precautions, including but not limited to (a) complying with all applicable safety, operation, maintenance, and service agreements, instructions, and requirements, (b) complying with all safety-related laws, regulations, and ordinances, and (c) conducting all appropriate safety training and education.

6.1 Access

Access to the turbine from the outside is through a door located at the entrance platform approximately 3 meter above ground level. The door is equipped with a lock. Access to the top platform in the tower is by a ladder or service lift. Access to the nacelle from the top platform is by ladder. Access to the transformer room in the nacelle is controlled with a lock. Unauthorised access to electrical switchboards and power panels in the turbine is prohibited according to IEC 60204-1 2006.

6.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch, from the spinner by opening the nose cone, or from the roof of the nacelle. Rescue equipment is placed in the nacelle.

The hatch in the roof can be opened from both the inside and outside.

Escape from the service lift is by ladder.

An emergency response plan, placed in the turbine, describes evacuation and escape routes.

Safety

6.3 Rooms/Working Areas

The tower and nacelle are equipped with power sockets for electrical tools for service and maintenance of the turbine.

6.4 Floors, Platforms, Standing, and Working Places

All floors have anti-slip surfaces.

There is one floor per tower section.

Rest platforms are provided at intervals of 9 metres along the tower ladder between platforms.

Foot supports are placed in the turbine for maintenance and service purposes.

6.5 Service Lift

The turbine is delivered with a service lift installed as an option.

6.6 Climbing Facilities

A ladder with a fall arrest system (rigid rail) is installed through the tower.

There are anchor points in the tower, nacelle and hub, and on the roof for attaching fall arrest equipment (full-body harness).

Over the crane hatch there is an anchor point for the emergency descent equipment.

Anchor points are coloured yellow and are calculated and tested to 22.2 kN.

6.7 Moving Parts, Guards, and Blocking Devices

All moving parts in the nacelle are shielded.

The turbine is equipped with a rotor lock to block the rotor and drive train.

Blocking the pitch of the cylinder can be done with mechanical tools in the hub.

6.8 Lights

The turbine is equipped with lights in the tower, nacelle, transformer room, and hub.

There is emergency light in case of the loss of electrical power.

6.9 Emergency Stop

There are emergency stop buttons in the nacelle, hub and bottom of the tower.

6.10 Power Disconnection

The turbine is equipped with breakers to allow for disconnection from all power sources during inspection or maintenance. The switches are marked with signs and are located in the nacelle and bottom of the tower.

Environment

6.11 Fire Protection/First Aid

A handheld 5-6 kg CO_2 fire extinguisher, first aid kit and fire blanket are required to be located in the nacelle during service and maintenance.

- A handheld 5-6 kg CO_2 fire extinguisher is required only during service and maintenance activities, unless a permanently mounted fire extinguisher located in the nacelle is mandatorily required by authorities.
- First aid kits are required only during service and maintenance activities. □ Fire blankets are required only during non-electrical hot work activities.

6.12 Warning Signs

Warning signs placed inside or on the turbine must be reviewed before operating or servicing the turbine.

6.13 Manuals and Warnings

The Vestas Corporate OH&S Manual and manuals for operation, maintenance and service of the turbine provide additional safety rules and information for operating, servicing or maintaining the turbine.

7 Environment

7.1 Chemicals

Chemicals used in the turbine are evaluated according to the Vestas Wind Systems A/S Environmental System certified according to ISO 14001:2004. The following chemicals are used in the turbine:

- Anti-freeze to help prevent the cooling system from freezing.
- Gear oil for lubricating the gearbox.
- Hydraulic oil to pitch the blades and operate the brake.
- Grease to lubricate bearings.
- Various cleaning agents and chemicals for maintenance of the turbine.

8 Design Codes

8.1 Design Codes – Structural Design

The turbine design has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes	
Nacelle and Hub	IEC 61400-1 Edition 3 EN 50308
Tower	IEC 61400-1 Edition 3 Eurocode 3
Blades	DNV-OS-J102 IEC 1024-1

Colours

Design Codes	
	IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) IEC WT 01 IEC DEFU R25 ISO 2813 DS/EN ISO 12944-2
Gearbox	ISO 81400-4
Generator	IEC 60034
Transformer	IEC 60076-11, IEC 60076-16, CENELEC HD637 S1
Lightning Protection	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006 IEC 61400-24:2010
Rotating Electrical Machines	IEC 34

Safety of Machinery, Safety-related Parts of Control Systems	IEC 13849-1
Safety of Machinery – Electrical Equipment of Machines	IEC 60204-1

Table 8-1: Design codes

9 Colours

9.1 Nacelle Colour

Colour of Vestas Nacelles	
Standard Nacelle Colour	RAL 7035 (light grey)
Standard Logo	Vestas

Table 9-1: Colour, nacelle

9.2 Tower Colour

Colour of Vestas Tower Section		
	External:	**Internal:**
Standard Tower Colour	RAL 7035 (light grey)	RAL 9001 (cream white)

Table 9-2: Colour, tower

9.3 Blade Colour

Blade Colour	
Standard Blade Colour	RAL 7035 (light grey). All lightning receptor surfaces on the blades including the Solid Metal Tips (SMT) are unpainted as standard.
Tip-End Colour Variants	RAL 2009 (traffic orange), RAL 3020 (traffic red)
Gloss	< 30% DS/EN ISO 2813

Table 9-3: Colour, blades

10 General Reservations, Notes and Disclaimers

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- The general descriptions in this document apply to the current version of the 3MW Platform wind turbines. Updated versions of the 3MW Platform wind turbines, which may be manufactured in the future, may differ from this general description. In the event that Vestas supplies an updated version of a specific 3MW Platform wind turbine, Vestas will provide an updated general description applicable to the updated version.
- Vestas recommends that the grid be as close to nominal as possible with limited variation in frequency and voltage.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- All listed start/stop parameters (e. g. wind speeds and temperatures) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.
- The earthing system must comply with the minimum requirements from Vestas, and be in accordance with local and national requirements and codes of standards.
- This document, General Description, is not an offer for sale, and does not contain any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method). Any guarantee, warranty and/or verification of the power

curve and noise (including, without limitation, the power curve and noise verification method) must be agreed to separately in writing.