Appendix A Boring Logs

BORING NUMBER 2022-GT-TA-01

AECOM

TOTAL DEPTH 8 FT BGS

CLIENT Wisconsin Department of Natural Resources
PROJECT NAME Superior Slips WDNR
PROJECT NUMBER 60685299
SITE NAME Tower Avenue Slip
DATE STARTED 07/30/2022 **COMPLETED** 07/30/2022
SURVEYING BY Affiliated Researchers
DRILLING CONTRACTOR Affiliated Researchers
ON 7/30/2022 **GROUND ELEVATION** 588.06 ft
DRILLING EQUIPMENT Russfelder P3
EASTING 147192.97 **NORTHING** 311735.89
DRILLING METHOD Vibracore
HOLE DIAMETER 0.25 ft
LOGGED BY KinnardH **CHECKED BY** KD/AB
CASING TYPE N/A

DEPTH (ft)	SAMPLE ID	RECOVERY %	PID (ppm)	GRAPHIC LOG	MATERIAL DESCRIPTION	Elevation (ft msl)
0						
			0		0.00 Organic soil (OL), <10% very fine sand, coal and roots - brown, wet - hydrocarbon odor, no staining - cohesive, very soft	588.1
1						
			0			
2						
3						
	2022-GT-TA-01 (3-4.5)		1.6			
4		79			3.80 - NAPL, petroleum hydrocarbon staining from 3.8 to 4.3 ft	584.3
					4.70 Well-graded SAND (SW), medium, subangular, <10% subrounded, fine to medium gravel - brown, wet	583.4
5						
	2022-GT-TA-01 (4.5-6)		0.7		5.10 - hydrocarbon odor, no staining - non-cohesive, loose	583.0
					5.60 Organic soil (OL), <10% coal and roots - brown, wet - peaty odor, no staining - cohesive, soft	582.5
6						
			0.6		- woody debris at 5.6 ft	
7						
			0			
8						

Refusal at 8.0 feet.
Bottom of borehole at 8 feet.

BORING NUMBER 2022-GT-TA-02

AECOM

TOTAL DEPTH 3.4 FT BGS

CLIENT Wisconsin Department of Natural Resources
PROJECT NAME Superior Slips WDNR
PROJECT NUMBER 60685299
SITE NAME Tower Avenue Slip
DATE STARTED 07/30/2022 **COMPLETED** 07/30/2022
SURVEYING BY Affiliated Researchers
DRILLING CONTRACTOR Affiliated Researchers
ON 7/30/2022 **GROUND ELEVATION** 577.65 ft
DRILLING EQUIPMENT Russfelder P3
EASTING 147441.07 **NORTHING** 312413.16
DRILLING METHOD Vibracore
HOLE DIAMETER 0.25 ft
LOGGED BY KinnardH **CHECKED BY** KD/AB
CASING TYPE N/A

DEPTH (ft)	SAMPLE ID	RECOVERY %	PID (ppm)	GRAPHIC LOG	MATERIAL DESCRIPTION	Elevation (ft msl)
0					0.00 Organic soil (OL), <10% very fine sand and roots - light brown, wet - no odor, no staining - cohesive, very soft	577.7
1			0			
2	2022-GT-TA-02 (1.5-3)	75	0			
3			0		3.10 Silty SAND(SM), very fine, well-graded, 10-20% silt - light brown, moist - no odor, no staining - non-cohesive, dense	574.6

Refusal at 3.4 feet.
Bottom of borehole at 3.4 feet.

Appendix B Photo Log

AECOM

PHOTOGRAPHIC LOG

Client Name: Wisconsin Department of Natural Resources	Site Location: Superior, WI	**BRRTS No.** 07-16-585325

Photo No. 1	**Date:** 7/30/22

Direction Photo Taken:

NA

Description:

2022-GT-TA-01 (0-2 ft)

Geotechnical Sample

Photo No. 2	**Date:** 7/30/22

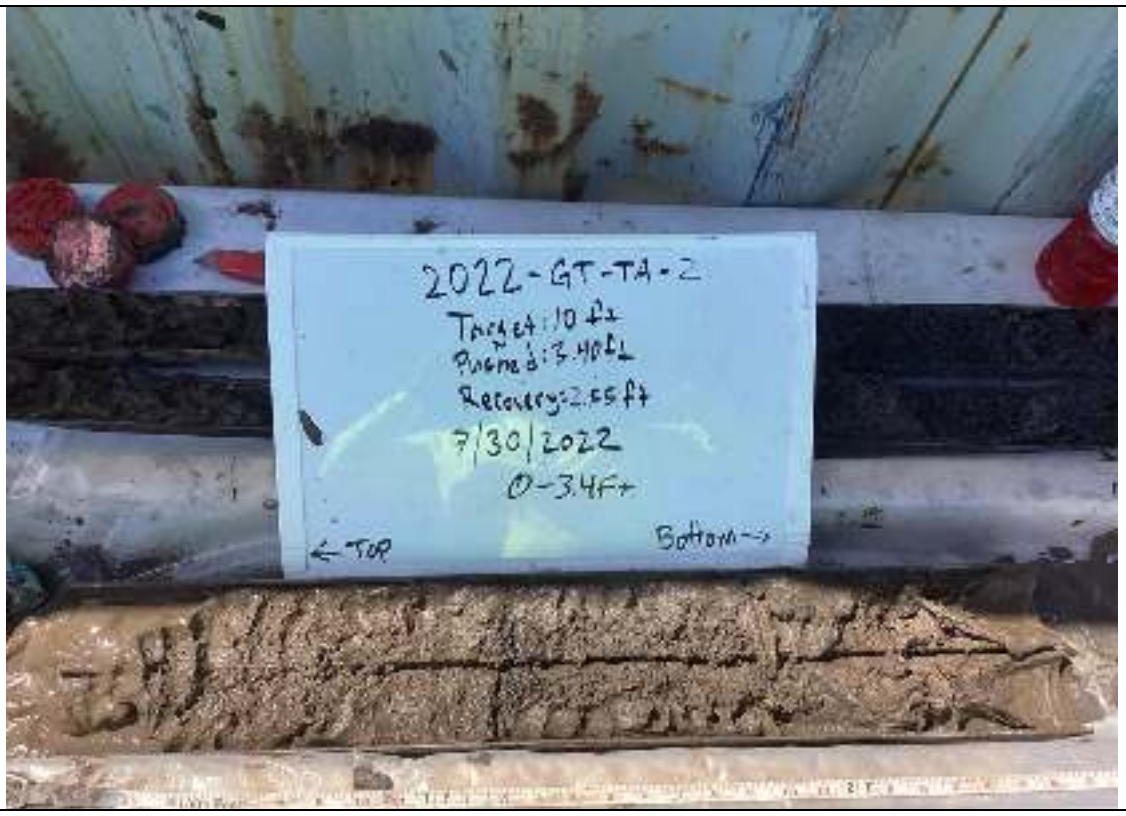
Direction Photo Taken:

NA

Description:

2022-GT-TA-02 (0-3.4 ft)

Geotechnical Sample



Appendix C Preliminary Engineering Assessment

AECOM

Preliminary Engineering Assessment Summary Report

Tower Avenue Slip

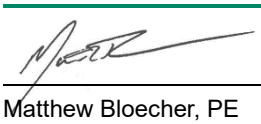
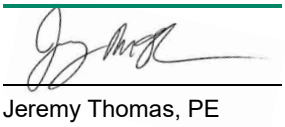
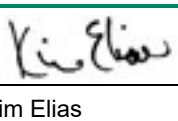
Wisconsin Department of Natural Resources

Project reference: WDNR Superior Slips ROAR
Project number: 60685299

June 2, 2023

Delivering a better world

Quality information

Prepared by	Checked by	Verified by	Approved by
			
Matthew Bloecher, PE Geotechnical Engineer	David Atkins, SE, PE Structural Engineer	Jeremy Thomas, PE Associate	Kim Elias Project Manager

Revision History

Revision	Revision date	Details	Authorized	Name	Position
0	11/21/2023	Draft 90%	Yes	Kim Elias	Proj. Manager
0	6/1/2023	Final	Yes	Kim Elias	Proj. Manager

Distribution List

# Hard Copies	PDF Required	Association / Company Name
None	Yes	WDNR

Prepared for:

Wisconsin Department of Natural Resources

Prepared by:

AECOM
1555 N. RiverCenter Drive
Suite 214
Milwaukee, WI 53212

T: +1-414-944-6080
aecom.com

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1. Introduction

1.1 Site Background

The Tower Avenue Slip (Slip) investigation area is located on the Wisconsin side of the St. Louis River within Saint Louis Bay near the confluence with Lake Superior. Various aliases have been used for the Slip in documents, including Tower Bay Slip, CHS Slip, and Barco Slip, and currently it is named the Tower Slip. WDNR has chosen to use the name “Tower Avenue Slip” to refer to the current investigation area. The Slip is an approximate 15-acre area served by the federal navigation channel in Howards Bay. It is bordered by Howards Bay to the north, Cenex-Harvest States, Inc. (CHS) to the east, Pettibone Corporation and Barko Hydraulics to the west, and the Burlington Northern railroad right-of-way to the south. The Slip and the area surrounding are within the City of Superior, Douglas County, Wisconsin. This slip is currently used for loading grain at the CHS terminal (east) and for loading tree trimming and harvesting equipment manufactured at the Barko Hydraulics facility (west). Additionally, the slip serves as an outfall for six municipal storm sewer drains. Refer to Figure C.1 for the current layout of the area surrounding the Slip.

1.2 Scope of Services

The main objective of the preliminary engineering assessment was to observe existing site shoreline conditions and identify data gaps related to a geotechnical and structural analysis of the existing slip shoreline. For the preliminary engineering assessment, the following scope of services was completed:

- Contact property owners to locate available historical design and construction records for existing wall segments.
- Perform a document review with scanning to archive electronic versions of available construction and design documents obtained from property owners.
- Perform an engineering site visit to view and document the current condition of walls surrounding the slip. Observations made from the site visits were used to compare existing site conditions to available record drawings.
- Conduct a minimum of two (2) vibracores within the slip for geotechnical testing.
- Assess geotechnical test results from collected vibracore samples.
- Prepare a summary report identifying the documents that were received and reviewed as part of the study.

1.3 Summary of Report

This report summarizes: historical documents received and reviewed pertaining to the existing slip shoreline; field observations made during the September 2022 site visit; and data gaps that will require further assessment and field investigation during the preliminary design phase of the overall Superior Slips ROAR project.

2. Site Information

2.1 Historical Site Information

Based on available property records, the following property owners are currently responsible for the shoreline along the Tower Avenue Slip:

East Shoreline

- Harvest States Cooperatives, known as CHS
- City of Superior
- Ewa Oftedahl

West Shoreline

- Barko Hydraulics, Inc.
- Pettibone Corporation (operated by Barko Hydraulics, Inc.)
- City of Superior

It should be noted that the extent of east shoreline considered in this report is maintained by CHS. Based on the most current property maps, CHS owns property between the slip and inland property owned by the City of Superior. South of the CHS property, a parcel is owned by an individual named Ewa Oftedahl. At the time of this report, contact information for Ewa Oftedahl was not available. Along the west shoreline, the property owned by Pettibone Corporation is currently operated by Barko Hydraulics, Inc. (Barko). As part of the preliminary engineering assessment, the current shoreline property owners/operators, except Ewa Oftedahl, were contacted prior to performing the site visits. During the conversations, AECOM requested site historical information pertaining to the existing shorelines. The following sections summarize information that was provided by the property owners.

2.1.1 East Shoreline - Harvest States Cooperatives

No information related to the existing bulkhead along the CHS property was made available. After discussions with the property owner, as-built documents likely exist in the company archives, but the location of them is currently unknown and would take time to find.

2.1.2 West Shoreline - Barko Hydraulics

No information related to the existing bulkhead along the Pettibone Corporation and Barko properties was available. After discussions with the property owner/operator, it was stated that the location of as-built construction drawings is unknown.

2.2 2021 Geophysical Survey

EA Engineering, Science, and Technology Inc., PBC (EA) completed a geophysical survey of the Slip in April through May 2020. Results from the geophysical survey were submitted to the WDNR as a technical memorandum titled *"Geophysical Survey for North End District and Clough Island Sediment Characterization, EA Project No. 15982.01,"* dated, June 15, 2021. The geophysical survey completed by EA included bathymetric survey, sub-bottom profiling, and acoustic survey. Excerpts from the EA report related to the Tower Avenue Slip are included in Appendix C.2.

2.3 2022 Remedial Investigation

A limited geotechnical investigation was performed to collect information on the nature and physical characteristics of the Tower Avenue Slip sediments. Sediment samples for geotechnical analysis (2022-GT-TA-01, and 2022-GT-TA-02) were collected by Affiliated on July 27, 2022 using a 25-ft vibracore

sampling vessel. The cores were observed for differentiating layers and sediment types. Sample depths for each parameter were determined based on lithology observed in the field. Geotechnical samples [2022-GT-TA-01 (3-4.5), 2022-GT-TA-01 (4.5-6) and 2022-GT-TA-02 (1.5-3)] were collected and analyzed by Pace Analytical of Green Bay, Wisconsin for moisture content, total organic carbon (TOC), Atterberg limits, bulk density, and particle size distribution. Laboratory methods utilized for each test are as follows:

- Moisture Content (ASTM 2974)
- TOC (elemental NC soil analyzer),
- Atterberg Limits (ASTM D4318),
- Bulk Density (ASTM D7263), and
- Particle Size (USCS) (ASTM D422 and ASTM D2487).

Refusal at locations 2022-GT-TA-01 and 2022-GT-AT-02 was 8.0 feet and 7.4 feet, respectively. The targeted sample depth was 10-ft below the sediment surface; however, shallow refusal was met after two attempts.

A map of the boring locations is provided as Figure C.2. Boring logs and laboratory results are included in Appendix C.3.

It should be noted that additional sediment core sampling and geophysical work have been completed by others at the site for remediation purposes. Although the information collected does not pertain to geotechnical parameters of soil for use in engineering analysis, the information may be useful for subsurface profile. Historical results from remediation sediment cores are not included in this summary report. For the additional information and core logs, please refer to the "*Remedial Investigation Report - Tower Avenue Boat Slip, AECOM Project number: 60685299*." Historical sediment sampling locations completed in the Tower Avenue Slip are shown in Figure C.2.

3. Site Observations

AECOM performed a water-based visual inspection of the existing shoreline of the Tower Avenue Slip on September 28, 2022. A land-based inspection was not performed at the time. The main objective of the visual inspection was to collect photographs of existing conditions and check if historical documents match existing site conditions. The following sections describe what was observed during the site visit. A summary of observations for the east shoreline steel sheet pile and concrete bulkheads is presented in Tables C.1 through C.3, and C.4, respectively. Condition of the west shoreline concrete bulkhead is presented in Table C.5. A photographic log referenced in the following sections is included as Appendix C.1.

3.1 East Shoreline Observations

The east shoreline of the Slip consists of a steel sheet pile bulkhead, sloped shoreline, and concrete bulkhead. The following subsection provides observations for each shoreline type.

3.1.1 Steel Bulkhead

The steel sheet pile bulkhead starts at the north end of the slip and runs approximately 1,798 feet south along the east shoreline. In general, the sheet piles and connection bolts appeared to be in good condition. The steel sheet pile bulkhead consists of three different configurations. For this report, the three different configurations will be described as the north, middle, and south segments. The following paragraphs provide a summary of observations for each segment.

The north segment of the steel sheet pile bulkhead starts at the mouth of the slip and has a length of approximately 595 feet along the east shoreline (Photo 2). At the north end of the segment, the steel sheet piling wraps at a 90-degree bend around the north shoreline of the CHS property (Photo 1). The sheet pile members have a width of approximately 37 inches and are Z-shape (Photo 3). Bolts with square washer plates were observed at approximately 56 inches from top of wall, which is at/near the water line. The washer plates were generally 5.5 x 9 inch with 1.5-inch bolt and hex nut. The steel sheeting had a 15-inch steel cap with rail welded to the top. Surficial backfill consisted of gravel and was approximately 8 inches below top of wall. A timber bumper is attached to the bulkhead and appeared to be in fair condition. During the site visit, no sinkholes of concern were observed.

The middle segment of the steel sheet pile bulkhead starts approximately 595 feet from the mouth of the slip and has a length of approximately 645 feet along the east shoreline (Photo 4). The sheet pile members have a width of approximately 24 inches and are Z-Shape (Photo 5). Bolts with circular washers were observed approximately 34 inches from top of wall. The washers had diameter of approximately 4.5 inches with 1.5-inch bolt and hex nut. The steel sheeting had a steel cap with 3.25-inch flange. Above the steel cap, a 20-inch concrete slab was present that extends behind the wall to the existing grain silos. The concrete slab appeared to be in good condition except for an area where ponding was noted (Photo 4). A timber bumper is attached to the bulkhead and appeared to be in fair condition.

The south segment of the steel sheet pile bulkhead starts approximately 1,240 feet from the mouth of the slip and has a length of approximately 559 feet (Photo 6 and 7). The sheet pile members have a width of approximately 25 inches and are Z-shape (Photo 8). Bolts with square washer plates were observed approximately 48 inches from top of wall, which is at/near the water line. The washer plates were generally 2.25 x 4 inches with 1.5-inch bolt and hex nut. The steel sheeting had a 19-inch steel cap with rail welded to the top. Behind the bulkhead, a concrete slab of unknown thickness extends from the wall to the concrete grain silos. A timber bumper attached to the bulkhead appeared to be in fair condition. At the south end of the segment, the sheet piling turns southeast and terminates (Photo 9).

3.1.2 East Sloping Shoreline

At the terminus of the east shoreline steel bulkhead, the shoreline transitions into a sloped earthen shoreline. The approximate length of the sloping shoreline is 390 feet. The shoreline is somewhat protected with rip rap consisting of repurposed broken concrete slabs and boulders. Slope angles were not determined during the site visit due to vegetative growth (Photo 10).

3.1.3 East Concrete Bulkhead

Beginning approximately 1,630 feet south of the slip mouth, a concrete wall runs approximately 345 feet along the east shoreline (Photo 11 and 12). Based on findings presented in the EA Geophysics Report, the concrete exposed above the water level is a cap supported by underlying timber piles (Appendix C.2). During the site visit, the water line was approximately 66 inches below the top of wall. The total thickness of the cap is estimated to be 80 inches based on below water measurements. The concrete appeared to be in fair to poor condition. Displacement and erosion were noted at the joint locations. Possible tie rods were noted at various locations along the cap (Photo 13). At approximately 325 feet south of the north end of the concrete bulkhead, a possible abandoned outfall was observed (Photo 14). At the south end of the concrete bulkhead, an operating stormwater outfall was observed (Photo 15).

South of the concrete bulkhead at approximately 2,540 feet south of the slip mouth, the shoreline transitions to a combination sloped shoreline with potential retaining walls (Photo 16). During the site visit, the shoreline had vegetative overgrowth and water was shallow, therefore, visual observations of the existing shoreline from a boat were limited. From the water, the shoreline south of the concrete bulkhead had riprap consisting of stone and repurposed broken concrete. A concrete wall segment was visible along this segment of shoreline, but confirmation of condition and dimensions was not documented due to access (Photo 17).

3.2 West Shoreline Observations

The west shoreline can be divided into north and south segments. The north segment consists of a concrete bulkhead and the south segment consists of sloping shoreline. The following sections provide observations for each shoreline type.

3.2.1 West Concrete Bulkhead

The west concrete bulkhead starts at the mouth of the slip and runs south along the shoreline for approximately 785 feet (Photo 22). At the north end of the bulkhead, the concrete wraps around the north shoreline of the Barko parcel (Photo 18). Based on the EA Geophysics Report, the concrete at the bulkhead is likely a concrete cap supported by timber piles (Appendix C.2). Based on field measurements, the cap is approximately 48 inches thick with height of at least 48 inches. Actual height of the cap was not measurable due to lake level. In general, the concrete bulkhead appeared to be in poor condition. During the site visit, locations of concrete spalling and erosion were noted (Photos 19, 20, and 21). The observed degraded bulkhead locations had also been noted in the EA Geophysics Report (Appendix C.2). It should be noted that sinkholes were identified in the EA Geophysics Report and can be seen in public aerial photography. Based on the probable construction of the wall, backfill is likely migrating thorough holes located in the wall below the water line. The sinkholes were not visible during the site visit due to vegetation behind the bulkhead.

3.2.2 West Sloping Shoreline

At the south end of the bulkhead, the shoreline transitions into sloping shoreline (Photo 23). The length of sloping shoreline is approximately 660 feet. During the site visit, areas of shoreline erosion were noted (Photo 24). In general, the shoreline slopes were relatively steep and consist of cohesive soils (Photo 25).

4. Summary and Conclusions

The following sections describe additional information needed to perform a geotechnical and structural analysis of the existing bulkhead walls for anticipated remediation activities. Recommendations for filling data gaps are also provided.

4.1 East Shoreline - Summary

The following historical information is available:

- 2021 EA Geophysics Survey Report
  - Tower Avenue Slip Bathymetric Survey
  - Sub-Bottom Profiling
  - Acoustic Wall Survey

Based on the recent site observations and historical information obtained thus far, the following data gaps would need to be addressed to complete a geotechnical and structural analysis of the existing east bulkhead walls and shoreline slopes:

1. As-built construction drawings
2. Subsurface profile
3. Test Pit(s)
4. Topographic Survey

Based on conversations with the property owner during the coordination phase, as-built construction drawings for the steel sheet pile bulkhead likely exist, but the location of them was not readily available. For the concrete bulkhead, the existence of as-built drawings is unknown.

Based on observations made during the site visit, the concrete bulkhead is in fair to poor condition. If any removal of material was to be completed near the concrete bulkhead, a new bulkhead wall or other shoreline modification would likely need to be completed prior to any work. For the analysis of the steel sheet pile bulkhead and reconstruction of the concrete bulkhead, geotechnical borings should be performed behind the existing shoreline to determine the soil profile being retained and current soil conditions. If possible, geotechnical soil borings should also be performed within the Tower Avenue Slip. The overall subsurface investigation plan will be dependent on the availability of as-built drawings.

Additionally, a topographic survey of the existing conditions behind the shoreline should be completed to confirm top of wall elevations and backfill slopes. During the topographic survey, we recommend that a qualified engineer perform a site walk to confirm observations made and document any site changes since this site visit. Also, if as-built drawings or other construction documentation is not made available, test pits should be completed, where possible to confirm if a waler or tiebacks are present at the steel sheet pile locations.

4.2 West Shoreline - Summary

The following historical information is available:

- 2021 EA Geophysics Survey Report
  - Tower Avenue Slip Bathymetric Survey
  - Sub-Bottom Profiling
  - Acoustic Wall Survey

Based on the recent site observations and historical information obtained thus far, the following data gaps would need to be addressed to complete a geotechnical and structural analysis of the existing west bulkhead wall:

1. As-built construction drawings
2. Subsurface Profile
3. Topographic Survey

Based on conversations with the property owner during the coordination phase, the location of as-built drawings for the existing concrete bulkhead is unknown. Additionally, no soil boring information was provided.

Based on observations made during the site visit, the concrete bulkhead is in poor condition. If removal of any material was to be completed in the Tower Avenue Slip, a new bulkhead wall or other shoreline modifications would likely need to be completed prior to remediation activities to prevent failure of the wall. Additionally, modifications to the south sloping shoreline should be considered. For the construction of a new bulkhead wall, geotechnical borings should be performed behind the existing bulkhead to determine the soil profile being retained and current soil conditions. If possible, geotechnical soil borings should also be performed within the Tower Avenue Slip.

Additionally, a topographic survey of the existing conditions behind the wall should be completed to confirm top of wall elevations and shoreline slopes. During the topographic survey, a qualified engineer should perform a site walk to confirm observations are the same as described in this summary report and document any site changes since the September 2022 site visit.

5. General Qualifications

This report has been prepared in general accordance with normally accepted geotechnical engineering practices to aid in the evaluation of this site and to assist our Client in the design of this project. We have prepared this report for the purpose intended by our Client, and reliance on its contents by anyone other than our Client is done at the sole risk of the user. No other warranty, either expressed or implied, is made. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects relevant to the geotechnical characteristics. In the event that any changes in the design or location of the facilities as outlined in this report are planned, we should be informed so that the changes can be reviewed and the conclusions of this report modified as necessary in writing by the geotechnical engineer. As a check, we recommend that we be authorized to review the project plans and specifications to confirm that the recommendations contained in this report have been interpreted in accordance with our intent. Without this review, we will not be responsible for the misinterpretation of our data, our analysis, and/or our recommendations, nor how these are incorporated into the final design.

Figures

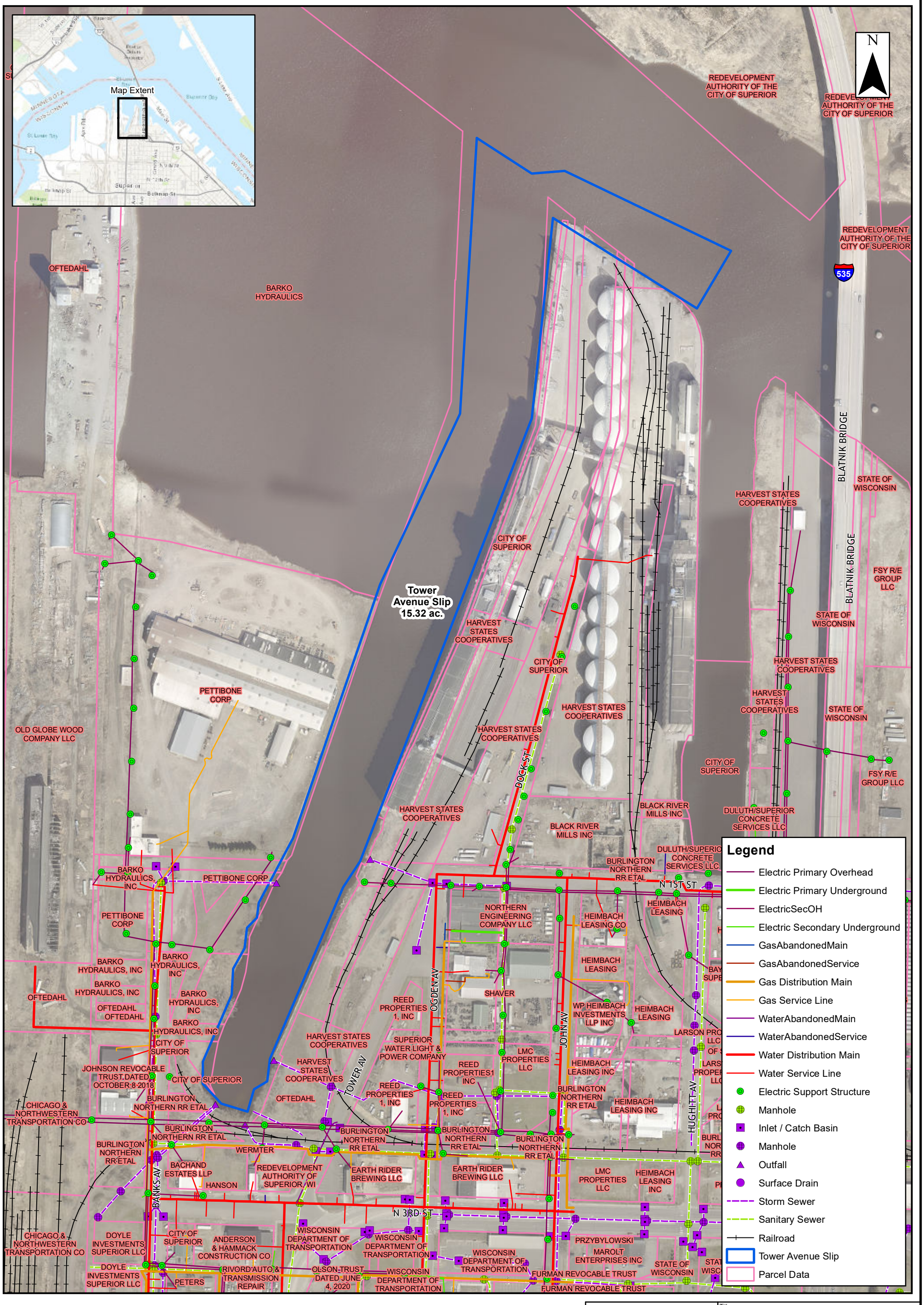

Image Source: Douglas County
Image Date: 2022

Storm and Sanitary Sewer Data from The City of Superior

Utility data from Superior Water, Light & Power

Parcel data from the City of Superior/Douglas County

0 125 250 500
Feet

AECOM

Title: **Site Layout Tower Avenue Slip**

Project: PEA Survey Report
Tower Avenue Slip
Superior, Wisconsin

Client: **Wisconsin DNR**

Scale:	Drawn by:	Date:	Project No.:	File Name:	Figure:
As Shown		11/21/2022	60685299	--	C.1
	Chk'd by:	Date:			

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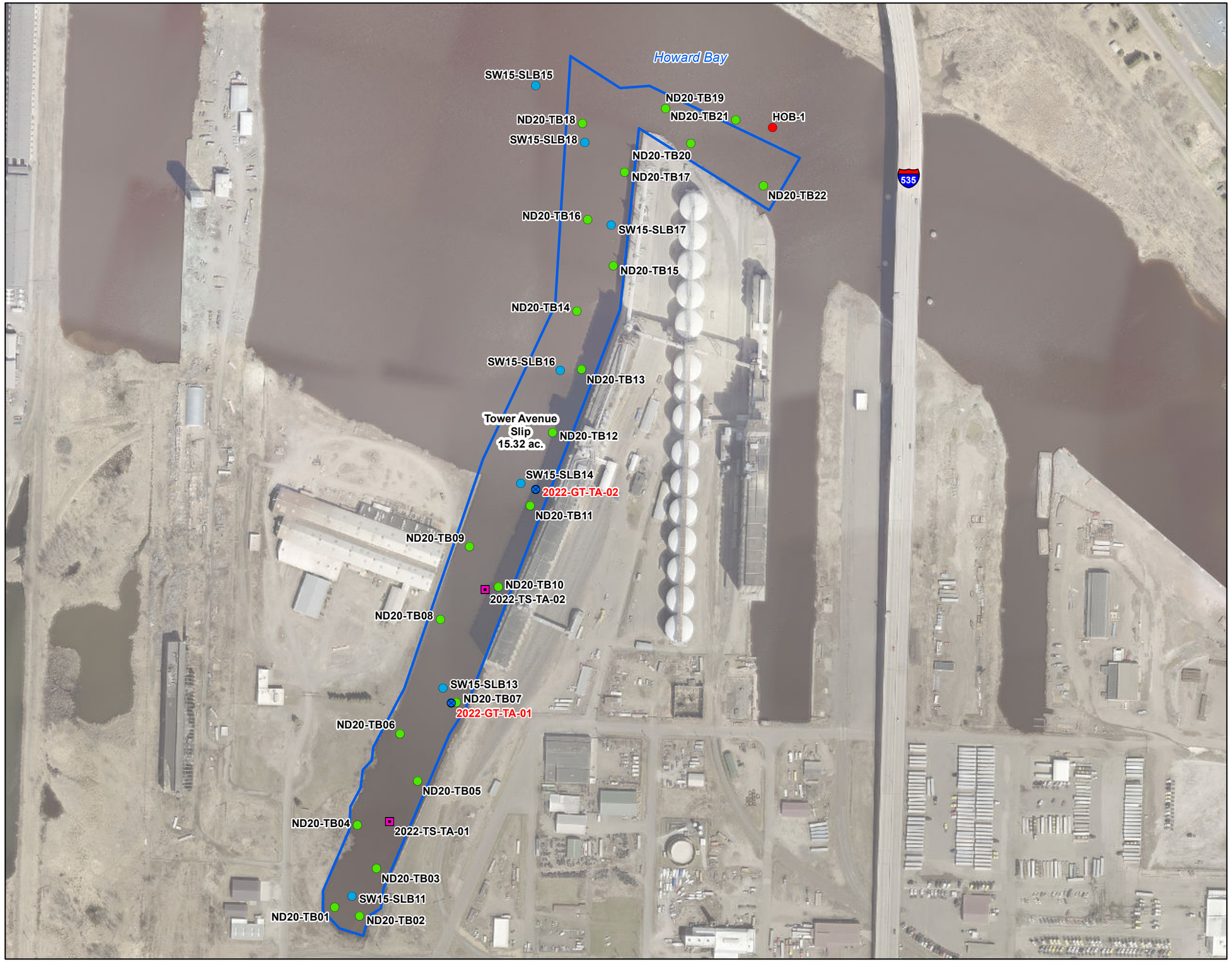

VICINITY MAP

Legend

- 2022 Geotechnical Sample Location
- 2022 Treatability Study Sample Location
- 2020 Sediment Sample Location
- 2015 Sediment Sample Location
- 1994 Sediment Sample Location
- Sediment Characterization and Survey Area

Image Source: Douglas County
Image Date: 2022

N

0 150 300 600
Feet

AECOM

Title: **Sample Locations Tower Avenue Slip**

Project: Superior Slips
Superior, Wisconsin

Client: Wisconsin DNR

File Name: --

Project No.:	Date:	Figure:
60685299	11/15/2022	C.2

Path: L:\DCS\GIS\Projects\Superior\MXD\Tower Ave\Sample Location Map Tower Ave Slip.mxd

Tables

AECOM

TABLE C.1. Steel Bulkhead Wall Observations - Tower Avenue-North Segment - East Shoreline

Concrete Cap		
	Movement/Rotation	N/A
	Control Joints and Expansion Joints	N/A
	Cracks	N/A
Ground Surface		
	Sinkholes	None visible.
	Cracks	None visible.
Steel Sheet Piles		
	Corrosion	Steel corrosion typical for assumed age of steel.
	Waler	Not visible.
	Bolts/Anchor Rods	Bolts and washers appear in typical condition for age. Tieback system unknown.
	Fender	Timber rub rail in fair condition.

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TABLE C.2. Steel Bulkhead Wall Observations - Tower Avenue-Middle Segment - East Shoreline

Concrete Cap		
	Movement/Rotation	Not visible.
	Control Joints and Expansion Joints	Appeared in good condition.
	Cracks	Minimal.
Ground Surface		
	Sinkholes	Ponding water noted on concrete slab behind bulkhead at time of site visit.
	Cracks	None visible.
Steel Sheet Piles		
	Corrosion	Assumed protective paint coating deteriorated at water level. Steel corrosion typical for assumed age of piling.
	Waler	Not visible.
	Bolts/Anchor Rods	Bolts for waler connection appear in good condition. Tieback system unknown.
	Fender	Timber rub rail in fair condition.

AECOM

TABLE C.3. Steel Bulkhead Wall Observations - Tower Avenue-South Segment - East Shoreline

Concrete Cap		
	Movement/Rotation	N/A
	Control Joints and Expansion Joints	N/A
	Cracks	N/A
Ground Surface		
	Sinkholes	Concrete slab behind wall appeared to be in good condition.
	Cracks	None visible.
Steel Sheet Piles		
	Corrosion	Steel corrosion typical for assumed age of steel.
	Waler	Not visible
	Bolts/Anchor Rods	Bolts and washers appear in typical condition for age. Tieback system unknown.
	Fender	Timber rub rail in fair condition.

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TABLE C.4. Concrete Bulkhead Wall Observations - Tower Avenue Slip - East Shoreline

Concrete Cap		
	Movement/Rotation	Movement noted at joint locations.
	Control Joints and Expansion Joints	Spalling of concrete noted near joints.
	Cracks	Visible cracking in cap at multiple locations.
Ground Surface		
	Sinkholes	Not visible due to vegetation.
	Cracks	Not visible due to vegetation.
Steel Sheet Piles		
	Corrosion	N/A
	Waler	N/A
	Bolts/Anchor Rods	N/A
	Fender	N/A

AECOM

TABLE C.5. Concrete Bulkhead Wall Observations - Tower Avenue Slip - West Shoreline

Concrete Cap		
	Movement/Rotation	Movement noted at joint locations.
	Control Joints and Expansion Joints	Spalling of concrete noted near joints. Spalling at multiple locations along bulkhead.
	Cracks	Visible cracking in cap at multiple locations. Loss of concrete and moderate corrosion of steel bumper at crack locations.
Ground Surface		
	Sinkholes	Not visible due to vegetation.
	Cracks	Not visible due to vegetation.
Steel Sheet Piles		
	Corrosion	N/A
	Waler	N/A
	Bolts/Anchor Rods	N/A
	Fender	N/A

Appendix C.1

Photographic Log

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
1	09/28/22

Direction Photo Taken:
South-southwest

Description:
Looking at northeast shoreline of CHS property and location where the steel sheet pile bulkhead starts.

Photo No.	Date:
2	09/28/22

Direction Photo Taken:
South

Description:
Looking at steel sheet pile bulkhead along the east slip shoreline.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
3	09/28/22

Direction Photo Taken:
East

Description:
Typical layout of steel sheet pile bulkhead located along the northern segment of the east slip shoreline. The bulkhead along the east shoreline consists of three different segments. For this segment, 2 sheet pile span measured 74 inches (37 inch single) and connection bolts were located 56 inches from top of wall.

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Photo No.	Date:
4	09/28/22

Direction Photo Taken:
North-northeast

Description:
Change in sheet pile configuration between north and middle bulkhead segments. Configuration change is at bend in shoreline located approximately 590 feet from the mouth of the slip. Ponding water was noted on the concrete cap/slab at the location depicted in the photo.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
5	09/28/22

Direction Photo Taken:
East-southeast

Description:
Typical layout of steel sheet pile bulkhead located along the middle segment of the east slip shoreline. Concrete cap/slab measured 20 inches thick. Two sheet pile span measured 48 inches (24 inch single). Connection bolts measured 14 inches from top of steel/concrete interface.

Photo No.	Date:
6	09/28/22

Direction Photo Taken:
Southeast

Description:
Looking at change in sheet pile configuration between middle and south bulkhead segments. Location of change is approximately 1,230 feet along bulkhead south of the slip mouth.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
7	09/28/22

Direction Photo Taken:
South-southwest

Description:
Conditions of east shoreline steel sheet pile bulkhead south segment.

Photo No.	Date:
8	09/28/22

Direction Photo Taken:
Southwest

Description:
Typical configuration of steel bulkhead south segment. Two sheet pile span measured 50 inches (25 inch single). Bolt connection measured 48 inches from top of wall.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
9	09/28/22

Direction Photo Taken:
Northeast

Description:
Looking at terminus of east shoreline steel sheet pile bulkhead. Bulkhead terminus at approximately 1,765 feet along shoreline south of mouth of slip.

Photo No.	Date:
10	09/28/22

Direction Photo Taken:
South-southeast

Description:
Condition of east slip shoreline between steel sheet pile bulkhead to the north and concrete wall to the south. Shoreline at this location is sloped with broken concrete and boulder riprap.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
11	09/28/22

Direction Photo Taken:
Southeast

Description:
Condition of north end of concrete wall located along the east slip shoreline. The concrete wall is located approximately 2,155 feet along the shoreline south of the slip mouth.

Photo No.	Date:
12	09/28/22

Direction Photo Taken:
South

Description:
Typical condition of concrete wall along slip east shoreline. The concrete wall is approximately 360 feet long.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
13	09/28/22

Direction Photo Taken:
Southeast

Description:
Typical condition of concrete wall located along east slip shoreline. Possible tie rod located in left of photo. Typical joint condition depicted in right side of photo.

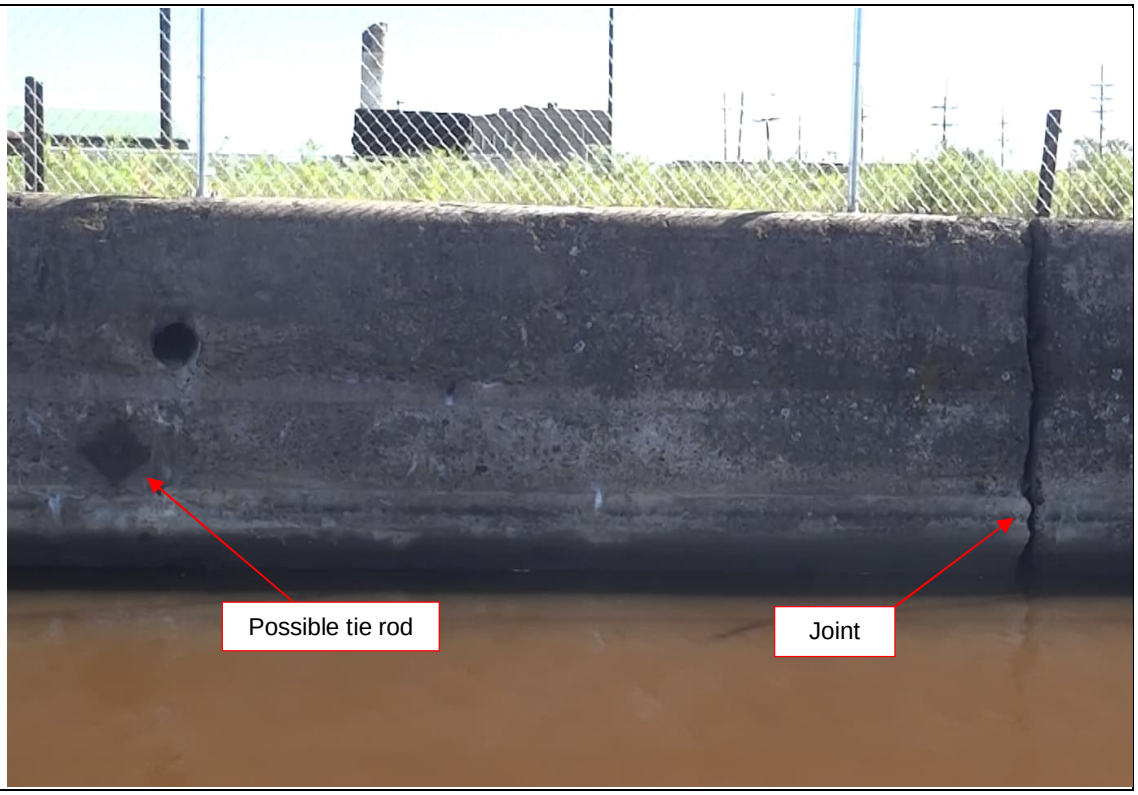


Photo No.	Date:
14	09/28/22

Direction Photo Taken:
Southeast

Description:
Possible outlet located approximately 325 feet south from the north end of the east shoreline concrete wall. Steel sheeting was observed above the water line.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
15	09/28/22

Direction Photo Taken:
Southwest

Description:
Possible storm sewer outfall located near the south end of the east slip shoreline concrete wall.

Photo No.	Date:
16	09/28/22

Direction Photo Taken:
South-southeast

Description:
East shoreline conditions south of concrete bulkhead. Shoreline is along Oftedahl property. Access along shoreline limited due to shallow water conditions.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No. 17	Date: 09/28/22
Direction Photo Taken: South	
Description: Retaining wall observed along the east shoreline south of the east concrete wall. Dimensions of retaining wall were not recorded due to access.	

Photo No. 18	Date: 09/28/22
Direction Photo Taken: Southwest	
Description: North end of west slip shoreline. North shoreline of Barko property has steel sheets adjacent to the terminus of the concrete bulkhead. Conditions below water line are unknown.	

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
19	09/28/22

Direction Photo Taken:
West-northwest

Description:
Example of typical spalling noted along west slip shoreline concrete wall.

Photo No.	Date:
20	09/28/22

Direction Photo Taken:
Northwest

Description:
Example of concrete erosion observed at locations along the existing concrete wall.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
21	09/28/22

Direction Photo Taken:
West and Downward

Description:
Close up of steel bumper located on west slip shoreline concrete wall. Steel moderately corroded at locations exposed to elements.

Photo No.	Date:
22	09/28/22

Direction Photo Taken:
North

Description:
Looking north at concrete wall along west slip shoreline. Height of wall at time of site visit was 4 feet above water level. Width of concrete wall measured 4 feet.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
23	09/28/22

Direction Photo Taken:
Northwest

Description:
Conditions at south end of concrete wall along west shoreline of slip.

Photo No.	Date:
24	09/28/22

Direction Photo Taken:
Northwest

Description:
South segment of slip west shoreline. Native cohesive soils exposed in left of photo. Conditions indicative of shoreline erosion where vegetation was not present.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Wisconsin Department of Natural Resources	Superior Slips ROAR Tower Avenue Slip, Superior, WI	60685299

Photo No.	Date:
25	09/28/22

Direction Photo Taken:
Southwest

Description:
Typical condition of shoreline along southern segment of slip west shoreline. Slopes showed signs of erosion with native cohesive soils exposed.

Appendix C.2

Historical Site Documents

appeared to range from 2 to 5 ft (Figure A-19). There was no distinct reflector below the disturbed material, suggesting the parent material resided directly beneath the disturbed sediment horizon and was homogenous. Multiple sediment cores (ND20-GM01, GM 03, GM06, GM08, GM10, and GM12) were obtained along the western margin of the survey area and indicated the upper sediment column was comprised of a mix of silts and sands. The penetration depths for all cores were less than 10 ft, providing limited insight into the deeper strata comprising the parent material.

With the exception of modest differences in bathymetry associated with the dredged ship berth, sedimentary conditions along the centerline and eastern side of the General Mills Slip were analogous to those along the western side (Figures A-20 and A-21). A fine-grained surface deposit associated with recent deposition was noted over much of the surveyed area. This veneer of material ranged in thickness from 1 to 4 ft depending upon location within the slip and the frequency of disturbance by vessels mooring to and departing from the General Mills Dock. Sediment cores collected near the centerline (ND20-GM02, GM04, GM05, GM07, GM09, and GM11) consistently displayed deposits of silt over very fine sand. All core penetration depths were less than 10 ft. However, based on the lakebed morphology at the sampling locations, the cores samples were able to characterize the sediment column to elevations between 561 and 576 ft IGLD85. Dense, very fine sand was captured in the bottom of each core obtained near the centerline regardless of the actual lakebed elevation that was ultimately sampled. These findings suggest the cores were sampling the parent material underlying the General Mills Slip, which was comprised of this very fine sand.

5. TOWER AVENUE SLIP RESULTS

The Tower Avenue Slip is located in Howards Bay and bounded by the Paper Calmenson Dock to the west and Cenex Harvest State Cooperatives (CHS) Dock to the east. The northeast-southwest orientation of the slip differs from the other slips included within the investigation. The slip was constructed in the late 1880s and early 1890s, following the 1880s shoreline and morphology of Tower Bay, ultimately minimizing the volume of upland soils that required removal. The construction required the formation of quay walls along the natural banks of Tower Bay and placement of fill material on the submerged lands of the state. In addition, the natural sediments of Tower Bay were removed by dredging the southwestern extents and infilling of a creek that conveyed runoff from what is now the Billings Park section of Superior. Upon completion, dock space was created on both sides of the bay to provide cargo transfer, bulk storage and industrial space to accommodate the rapidly increasing commerce within Superior Harbor (Sigma Group 2019b).

Coal was stockpiled on the Paper Calmenson Dock on the west side of Tower Slip in the 1890s, which was eventually replaced by steel storage, ship repair, and ultimately heavy equipment storage. Once the dock space on the east side was established, it was used extensively for small to mid-sized manufacturing, including iron works, smelting and refining industries, bulk material (sand, gravel, stone, coal, and salt) storage, and handling of various building materials up until 1940 (Sigma Group 2019b). By 1941, the Farmers' Union Grain Terminal grain elevators were constructed on what is now the CHS Dock. The elevators were originally owned by Farmers'

Union before ownership was transferred to Harvest States Cooperative and eventually CHS. Aerial images indicate the original creek that was filled as part of the alteration of the uplands has re-emerged as a narrow stream that caries runoff from the industrial land parcels on Winter Street through a series of culverts before discharging through a concrete outfall in the southwest corner of the slip.

5.1 Bathymetry

The Tower Avenue Slip survey area covered 16.9 acres of submerged lands within the confines of the slip, as well as 8.7 acres of coverage that extended into Howards Bay (Figure A-22). Multibeam data were collected from the approximate centerline of Howards Bay to the limits of navigation in the headwaters to the south, providing some insights into the relatively complex bottom topography within the slip. Similar to the Oil Barge Dock Slip, shallow water and debris (trees and anthropogenic) prevented access by the R/V *Abraham Lincoln* and complete coverage of the water body at the southwestern limits.

Tower Avenue Slip extends approximately 2,770 ft from Howards Bay into the headwaters before terminating at an earthen berm and several outfall structures in various states of repair. Access to the slip from Howards Bay appears to be restricted to a relatively narrow, 300-ft-wide passage between a shallow embayment to the west exhibiting depths ranging from 4 to 20 ft and the CHS Dock to the east. Once the Paper Calmenson Dock is encountered at the approximate midpoint of the slip, the width tapers to approximately 250 ft, then further constricts to less than 200 ft at the headwaters. A minimum depth of 1 ft was detected along the western and eastern banks within the headwaters of the slip, as well as the northern and eastern limits of the CHS Dock. A maximum water depth of 41 ft was measured along the northwestern margin of the CHS Dock and again within a roughly circular bottom feature 45 ft northwest of the dock (Figure A-22).

Deeper water in excess of 30 ft was noted at the apparent berthing area along the northwestern wall of the CHS Dock. The depth contours maintain a nearly rectangular shape up to 700 ft into the slip, indicative of a bottom deformation related to dredging employed to maintain adequate water depths for deeper draft vessels calling on the CHS Dock. In addition, the lakebed morphology at this location displayed a significant bottom scour feature approximately 90 ft in diameter. Its areal size and shape, depth relative the surrounding lakebed, and position within the established berthing area suggest it was a scour feature possibly produced by propeller wash from deep-draft vessels entering and leaving the berthing area.

Beyond the dredged ship berth, water depths of 30 ft measured along the sheet pile wall of the CHS dock and east of the slip centerline gradually decreased to 10 ft over a distance of 1,000 ft as the survey progressed south (Figure A-23). The sheet pile wall associated with the CHS Dock terminated 1,765 ft south of the slip entrance. At that point, a 400-ft-long section of exposed bank comprised of a combination of soil, construction debris, broken concrete and rock was encountered. Bottom slopes near this bank were relatively steep (50%) as water depths ranged from 11 ft at the base to 1 ft along the immediate shoreline. Beyond that section of bank, the southeastern margins of the slip were comprised of vertical concrete wall sections, an earthen

bank, and multiple discharge outfalls. Water depths varied from 10 ft at the base of the concrete wall to 2 ft over a sediment deposit in the southeast corner of the coverage area. The sediment deposit corresponded to the location of a deteriorated outfall constructed of brick. As a result, the sediment deposit may be the accumulation of displaced soils that became entrained in rain and snow meltwater and discharged into the end of the slip by the outfall.

On the western side of the slip, the strong bottom slopes marking the margins of a large shoal occupying the embayment east of the Globe Elevators Dock was clearly visible near the northern opening (Figure A-22). Water depths west of the slip centerline were consistently shallower than those measured on the east side, likely due to predominant shoaling patterns over the past several years, lack of deep draft vessel activity, and no defined need to maintain water depths via dredging. The concrete wall at Paper Calmenson Dock on the west side of the slip extended nearly 800 ft from the shallow embayment to where it terminated in the southwestern portion of the Tower Avenue Slip. Water depths ranging from 9 to 20 ft were common along this section of the slip and they generally decreased with distance into the slip (Figure A-22).

One minor, but notable bottom feature consisting of a subtle bottom depression 2 to 3 ft deep was detected just northeast of the Paper Calmenson Dock wall. Given the shoaling patterns and overall lack of commercial vessel activity on the western side of the slip, this 550-ft-long and 50-ft-wide linear topographic feature was an unexpected find. However, based on its shape and location, it was not representative of an erosional or propeller wash feature like those found on the east side of the Tower Avenue Slip or other slips surveyed as part of the investigation. This feature may be the lateral displacement of accumulated sediment by the movement (towing) of the M/V *Ryerson* on 6 November 2019. As the ship was towed away from the dock, the heavy stern section of the vessel was likely pulled through sediment that had accumulated within its long-term (>4 years) berth causing the material to be displaced to the east, creating the depression and a subtle bathymetric ridge to the east. The vessel movement occurred 6 months prior to the bathymetric survey and the resulting bottom feature persisted, indicating a general lack of energy at the bottom of the slip to support reworking of the sediments in this area.

Shallow water was detected approximately 850 ft along the western margin of the slip at the base of an exposed shoreline (Figure A-22). The shoreline was comprised of soils, rock, slag, and construction debris with both live trees and broken pilings often protruding. The water depths along the margin ranged from 1 to 8 ft and the general slope of the bank was broader relative to the eastern side, suggesting erosion and/or prior slope failures were allowing measurable volumes of soil to accumulate on the bottom of the slip at this location. Depths within the headwaters of the slip were approximately 10 ft near the centerline and 7 ft at the limits of coverage (Figure A-23). Several outfalls were noted protruding from the shoreline in this portion of the of the survey area, one located in the southwest corner was actively discharging small volumes of turbid water at the time of the survey (Figure A-24).

Outside the confines of the slip, the parcel of bottom surveyed in Howards Bay displayed water depths ranging from 1 to 39 ft. The shallowest depths and strongest bottom slope (29%) were identified at the northern end of the CHS Dock as depths rapidly increased from 1 to 28 ft which was common at the toes of the navigation channel (Figure A-25). Additionally, the northeastern

margin of the larger-scale shoal west of the Tower Avenue Slip was visible in the data. Similar to other sections of the navigation channel included in the survey, portions of the sailing line for deeper draft vessels were evident in the bathymetry as well. The control depth for Howards Bay is 27 ft below LWD and water depths ranging from 33 to 39 ft were noted at the northern limits of the bathymetric coverage, indicative of frequent sediment resuspension and displacement possibly by propeller wash.

When the bathymetric data were presented as lakebed elevation values, the bottom topography relative to IGLD85 was derived (Figure A-26). In general, the topographic high points of 600 ft were detected at the northern end of the CHS Dock, as well as along the banks at the headwaters of the slip. The lowest elevation within the slip (561 ft) was measured at the entrance to the slip in proximity to the northwestern corner of the CHS Dock. The topographic low was a bottom depression caused by propeller wash of larger, loaded ships entering or leaving the berth. The bottom of the dredged Howards Bay channel resides at an elevation of approximately 573 ft, while the dredged berth adjacent to the CHS displayed bottom elevations ranging from 568 to 571 ft. The elevations on the western side of the slip centerline were generally higher due to considerable shoaling and the lack of a need to dredge that side of the slip. The bottom elevations adjacent to the western wall were commonly 591 ft, gradually increasing to 594 ft at the extent of coverage within the headwaters.

5.2 Sub-bottom Profiling

Sub-bottom profiling data were collected over 10 transects established within the Tower Avenue Slip survey area, each approximately 2,800 ft long and oriented parallel to the long axis of the slip. In general, the results for the Tower Avenue Slip were comparable to those derived for the General Mills Slip. Deposits of fine-grained material (silts) of varying thickness were detected at the sediment-water interface throughout the survey area. These lower density silts resided over mixed intervals of sand, silt and clay that comprise a layer of sediment that has been periodically disturbed by dredging, vessel movements, and other industrial activities within the slip. Due to the shallow water depths in the southwestern extents of the survey area, several artifacts (acoustic multiples) were captured in the acoustic record along with the desired sonar returns. These acoustic multiples limited the value of the sub-bottom data collected in the shallows by obscuring any backscatter deeper than 10 ft below the sediment-water interface.

Along the western margin of the slip, the depth of acoustic penetration was approximately 8 to 10 ft in the headwaters, but the data returns failed to display any significant density interfaces. Sediment cores collected near the headwaters (ND20-TB01 and TB04) penetrated 20 ft into the sediment column and recovered various intervals of clayey silt over the parent unit of very fine sand (Figure A-27). The layer of dense sand that would have served as a strong acoustic reflector was over 10 ft below the sediment-water interface, and not detected by the sub-bottom profiler. Detailed core logs for all locations sampled as part of the Tower Avenue Slip site assessment are presented in Appendix C.

Approximately 500 ft north of the headwaters an abrupt change in bathymetry and substrate type was noted in the sonar record for the western transect. The lakebed flattened and sonar

backscatter indicated a 1-ft-thick layer of lower density material overlying a sharp increase in surface sediment density. These returns are generally indicative of a firm layer of material in the upper sediment column (Figure A-27). This segment of the survey line did run parallel to the west slip wall (Paper Calmenson Dock), but the stand-off distance of 30 ft was expected to be sufficient to prevent biasing the acoustic records with side lobe artifacts. The distinct acoustic reflector imaged within the upper sediment column persisted over a distance of 850 ft before terminating and the sediments transitioning to a lower density substrate. Again, this transition point in the sonar corresponded to the northern limits of the western slip wall. Sediment cores collected in proximity to the acoustic reflector (ND20-TB06, TB08, and TB09) penetrated 10 ft in the sediment column and recovered intervals of clayey silt over dense sand (Figure A-27). The lack of an obvious, strong and continuous reflector near the sediment-water interface, as well as the general alignment of the mapped reflector with the start and end points of the Paper Calmenson Dock wall indicated that despite the 30-ft offset, the wall likely contributed to a biased data record. Further analysis may reveal the primary cause of the bias and potential remedies. However, adjacent survey lines should not be impacted in the same manner and can be utilized to assess sedimentary conditions.

As the survey transect progressed north beyond the Paper Calmenson Dock wall and into Howards Bay, the acoustic profile was able to penetrate deeper in the lakebed. The sonar returns indicated the presence of a fine-grained, low-density sediment deposit overlying higher density and/or disturbed sediments at several locations (Figure A-27). The thickness of this surface deposit varied from 1 to 3 ft, while more chaotic, underlying stratum ranged from 1 to 5 ft thick. The survey transect along the western margin of the slip ended in the Howards Bay navigation channel and collected data over the large scour feature identified in the bathymetry. Evaluation of the sediment lithology based on the vibratory cores that aligned with the western survey transect displayed no clear pattern or consistency in findings that would allow a continuous sediment horizon to be accurately mapped.

The sub-bottom data collected along the centerline of the slip is generally comparable to the record produced by the western transect with two notable exceptions. The apparent hard reflector that was determined to be an unanticipated artifact associated with the west slip wall was not represented (Figure A-28). However, the ridge of sediment to the immediate west of the M/V *Ryerson* was represented in the transect data. The profiler was able to identify a 2- to 3-ft-thick layer of low-density material residing at the sediment-water interface over this feature. Beneath this surface layer the acoustic pulses penetrated an additional 5 to 8 ft into the bathymetric ridge. The bulk of the material has an acoustic signature similar to other higher density or chaotic/disturbed sediment deposits. No clear indication of underlying sediment horizons was detected. One additional bottom feature that was noticed in the sonar data collected along the centerline was a previously disturbed, but infilled pit approximately 1,900 ft north of the headwaters and 500 ft south of the mouth. The detectable margins of the pit based on the sonar records indicated the feature was approximately 200 ft wide and 12 ft deep prior to being filled (Figure A-28). The sediments within the pit were relatively low density, which allowed the acoustic pulses to penetrate up to 20 ft over this location. Sediment Core ND20-TB14 was attempted at this location, but only recovered a 0.8-ft-thick sample of stiff clay. Adjacent survey transects also detected the feature indicating it was rather sizable and may have

been a relic bottom scour featured formed by propeller wash and may have been intentionally filled during a recent dredging project.

The sub-bottom profile collected along the eastern margin covered an area of lakebed that has been heavily impacted by vessel and construction activity over the history of the CHS dock. As a result, the acoustic returns were expected to display a considerable amount of disturbance and thinner layers of low-density silts. The acoustic data collected within 900 ft from the headwaters characterized the area adjacent to the southeast slip wall, several outfall structures, and the armored shoreline up to the start of the sheet pile wall on the west side of the CHS Dock. Similar to the findings on the western transect, sonar penetration appeared low with little backscatter detected after a continuous reflector was mapped in the top few feet of the sonar record (Figure A-29). Closer examination indicated the strong acoustic reflector aligned with the southeast slip wall and was another example of side lobe artifacts from wall reflection impacting data quality. Similar, acoustic artifacts associated with the sheet pile walls of the CHS dock were captured in the data record as well.

Beyond the limits of southeast wall and associated interference, the sub-bottom profiler increased penetration depth and occasionally exceeded 15 ft below the sediment-water interface. The sonar returns displayed a thin veneer of silt over a 2- to 5-ft layer of higher density, but disturbed sediments. The low-density silt overburden was nearly continuous but did exhibit increased thickness in several small pockets adjacent to bathymetric features where enhanced deposition of fine-grained material is common (Figure A-29). The sediment cores collected over this segment of the sub-bottom transect (ND20-TB03, TB05, and TB07) all show intervals of silts and clays in the surface sediments overlying sand deposits at depth.

As the transect progressed toward the berthing area and mouth of the slip, the thickness values for the low-density silt layer gradually decreased (Figure A-29). This material was eventually found to be absent from the area in proximity to the CHS berth likely due to frequent resuspension and displacement events that occur with each ship movement. The darker sonar returns, indicative of higher density and/or disturbed material, was commonly detected at the sediment-water interface in the northeastern quadrant of the sub-bottom survey area. The vibracores collected along this segment of the eastern transect (ND20-TB10, TB11, TB12, TB13, TB15, and TB17) displayed fine-grained material in the surface intervals (Figure A-29). Due to the increased density and perhaps more cohesive nature of these sediments, this material would normally be expected to remain in-place and relatively stable given the general lack of energy in the bottom waters of Howards Bay. Despite its relative stability under normal conditions, this type of material is subject to resuspension and advection when energy from ship movements (bow wake, propeller wash, etc.) is applied to the bed as evidenced in the numerous bottom scour features noted in the bathymetric survey.

5.3 Acoustic Wall Survey

West Wall

The west wall of the Tower Avenue slip retains the fill material used to create the current Paper Calmenson Dock during its original construction in the late 1800s. It was imaged using both the MBES system and the side-scan sonar over a distance of approximately 850 ft. The resulting data records were divided into eight segments, each 120 ft long, to display elements of the wall in adequate detail. Position information was presented as both stationing (linear reference system – Station 0+00 to Station 9+60), as well as in Wisconsin State Plane coordinates. The acoustic imagery derived from the side-scan sonar and MBES has been compiled in Attachment 3.

The west wall appeared to consist of solid concrete above and below the waterline with little textural differences noted along the first 785 ft of the structure. Similar to the other concrete walls surveyed, the acoustic data indicated that a network if vertical pilings exist below the waterline. However, the pilings apparently lack timber crossmembers suggesting they are simply used as batter piles to prevent damage to the lower section of the wall by steel hulled vessels or have been driven to provide additional lateral support to the wall. In general, the wall surface residing under the waterline and behind the pilings appears intact, while sections of the wall above the waterline display a considerable amount of deterioration and spalling over its length.

Between Stations 0+00 and Station 2+40 the wall appears to be in good structural condition with some relatively minor cracks or fractures noted above the waterline. A modest accumulation of material was identified at the base of the wall between Stations 0+00 and 0+50, but the morphology of the deposit (broad and flat) suggests the sediment was the product of natural shoaling processes versus evidence of a breach in the wall higher in the water column. Beyond Station 2+50 the fractures and spalling in the wall becomes more significant, but the lack of any evidence of damage or fill accumulating on the bottom indicates the sections of wall below the water line remain intact.

From Station 3+80 toward the headwaters, the west wall of the slip began to display a considerable amount of wear and deterioration. Small, discrete accumulations of material became detectable underwater and at the base of the wall, which commonly aligned with points that show loss of concrete above the waterline. The most significant find during the survey was a 15-ft-wide and 2-ft-high accumulation of material at the base of the wall approximately 570 ft into the slip. Both the surface photographs of the section of the wall above the waterline and aerial photographs of the Paper Calmenson Dock indicated the accumulation of material corresponded to a deposit of boulders and soil mound residing just behind the wall. Further analysis of the aerial images identified numerous sinkholes or pits opening in the soils behind the dock. When examined from above, these holes formed a straight line and were equidistant (12 ft) from the edge of the slip wall. As a result, it appears that the boulder deposit may have been an attempt to fill in a major sinkhole caused by the loss of fill material into the slip through a breach in the wall a few feet below the waterline. Moreover, each of the sinkholes noted in the aerial photography may identify an area of fill material subsidence and/or loss, with each

sinkhole potentially corresponding to the location of a minor breach in the wall which could be allowing material flow into the slip during rain or snow melt events.

Between Stations 6+00 and 7+20 there was little damage noted along the wall either above or below the waterline. However, the MBES did image what appeared to be an approximately 50-ft-long timber rub rail secured on the wall at approximately mid-depth. The actual composition and functionality were unknown, but it may have contributed to the preservation of this segment of the wall by preventing contact by steel-hulled ships or barges previously moored at this berth. The MBES also imaged a 35-ft-long linear object stretching from Station 7+15 to 7+50 resting at the sediment-water interface and a few feet away from the base of the wall. The origin of the object is unknown, but may have been recently placed on the lakebed and comprised of a lower density material that allowed it to remain proud on the bottom and not sink below the mudline.

The above-water portion of the concrete wall ended at Station 7+85 and the shoreline transitioned to a composition of soil, broken concrete, and rock. A large bollard fixed within a concrete base was imaged above the water at approximately Station 8+05 and pilings were noted above the waterline beyond the limits of acoustic imaging at Stations 9+50 and 9+60. Although the concrete wall terminated at Station 7+85, the underwater acoustic imagery indicated that a vertical structure continued for an additional 70 ft beneath the waterline. Based on the side-scan returns, the texture of the structure was quite similar to those identified along the west side of the Oil Barge Dock Slip, suggesting vertical planks or boards held in place by timbers and backfill. Aerial photographs obtained in August 2010, during a period when water levels oscillated around the LWD (601.1 ft), indicated the presence of a wooden crib structure extending 70 ft southwest of the concrete wall. Based on the evidence available, this wooden structure may be a remnant of the original quay wall used to support the filling process in the late 1800s and may be considered a cultural resource element of the site.

East Wall

The east wall of the Tower Avenue slip retains the fill material deposited in the late 1880s and used to create the structure now known as the CHS Dock. The entire east wall is comprised of steel sheet pile that was driven into the Tower Bay sediments. Based on the overall condition, the sheet piles do not represent components of the original structure. The wall was imaged using both the MBES system and the side-scan sonar over a distance of approximately 1,760 ft. The resulting data records were divided into 15 segments, each 120 ft long, to display elements of the wall in adequate detail. Position information was presented as both stationing (Station 0+00 to Station 9+60) as well as in Wisconsin State Plane coordinates. The acoustic imagery derived from the side-scan sonar and MBES has been compiled in Attachment 3.

The entire east wall is comprised of steel sheet pile, and with one exception, appeared to be intact and in good condition. The MBES data produced high quality images of the wall for the entire length, while the side-scan sonar was confounded somewhat by acoustic ringing, resulting in acoustic multiples appearing in much of the data. The alternating facies produced by the interlocked flange and web sections of the sheet pile produced a profile that was clearly visible in

both data sets, but MBES was better suited for rendering an image from the acoustic returns. The MBES data also indicated that no sediment deposits existed at the base of the wall, suggesting no breaches or significant loss of fill material through the sheet pile.

The only notable feature on the wall was detected by the MBES between Stations 0+00 and 0+10, as what appeared to be a substantial dent in the northeast corner of the wall. The side-scan sonar was unable to resolve this feature, but the MBES displayed an approximately 8-ft-long and 8-ft-high shadow in the acoustic record. A subtle ripple was noted in the sheet pile between Stations 0+10 and 0+20 suggesting the apparent dent was attributable to a ship maneuvering into the berth making contact with the wall and using it as a pivot point. Neither the sonar imagery nor associated bathymetry data yielded evidence of a puncture or discharge of fill material into the slip.

Between Stations 0+00 and Station 5+85, the east wall was constructed in a true north-south orientation. At Station 5+85, the wall alignment shifted to the northeast-southwest orientation that mirrored the relic Tower Bay shoreline. In addition, there was a transition in the type or size of the sheet pile used to construct the wall at that point. A concrete cap existed on the top of the wall and a formidable timber fendering system was in-place at the waterline along the face of wall. Subtle changes in bathymetry were noted in the MBES images, marking the end of the dredge cuts within the berthing area where depth was maintained to facilitate the commercial vessels utilizing the CHS Dock.

At Station 16+00 water depths began to shallow from 20 to 14 ft, eventually decreasing to 10 ft at Station 17+00. No discrete sediment deposits indictive breaches in the wall were detected. The end of the sheet pile wall was identified at Station 17+65, when the wall turned 45 degrees and tied into the shoreline. From Station 17+70 through 18+00, the shoreline was comprised of soil, concrete rubble, and construction debris, extending approximately 400 ft to the southwest between the end of the east wall and the start of the southeast wall.

Southeast Wall

The southeast wall of the Tower Avenue slip retains the fill material used to the create the base of the CHS Dock where it tied into the original Tower Bay shoreline. In contrast to the east wall, the southeast wall was comprised of concrete and timber. It was imaged using both the MBES system and the side-scan sonar over a distance of approximately 360 ft. The resulting data records were divided into three segments, each 120 ft long, to display elements of the wall in adequate detail. Position information was presented as both stationing (linear reference system – Station 0+00 to Station 3+60) as well as in Wisconsin State Plane coordinates. The acoustic imagery derived from the side-scan sonar and MBES has been compiled in Attachment 3.

Similar to the west wall in the Oil Barge Dock Slip, the southeast wall in the Tower Avenue Slip appears to consist of a deteriorating concrete cap that was cast over the compacted fill material originally used to cover the freshwater marshland. The side-scan sonar suggested the structure below the water line was comprised of numerous vertical pilings with a single timber crossmember below the concrete cap tying the support system together. The concrete above the

water line appears to have been cast in place with steel binders embedded in the pour and used to hold adjoining sections together. Spalling and the gradual erosion of the concrete by rainwater over time may have caused several of those binders to be displaced and come to rest in the sediments at the foot of the wall. One such binder was clearly visible in both the side-scan sonar and MBES imagery at Station 0+50, resting at a 45-degree angle with one end in the sediments and the other suspended in the water column by the timber framing.

Besides the obvious deterioration of the concrete cap between Stations 0+00 and 1+50, there were also some indications of fill material loss into the slip, suggesting existing or prior breaches in the wall. The survey data displayed the southwestern half of a sediment mound at Station 0+00. Although more attributable to shoreline erosion and deposition in the waterway than an existing wall breach, the feature remains noteworthy as the northwestern limit of the wall cap may be experiencing some undermining as material is washed into the slip as runoff. Sediment accumulations of various size and age were also detected along the base of the wall at Stations 0+50, 1+00, and 1+20, again suggesting potential breaches in the wall below the waterline.

Between Stations 1+50 and 2+40 the concrete cap displayed less evidence of deterioration and the support structure under the waterline appeared to be intact. No accumulation of sediment or fill was noted, suggesting no loss of fill material into the slip. A deflection in the timber crossmember was captured in the side-scan imagery at Station 1+35, but not readily detected by the MBES system.

From Station 2+40 to the limits of sonar coverage the concrete cap and structural components below the waterline appeared relatively intact. Erosion and spalling were evident on the concrete sections above the waterline, but less severe than what was identified between Stations 0+00 and 1+50. The sediment-water interface showed little indication of any accumulation of material, suggesting no discharge of fill material into the slip. One rectangular opening was observed at the end of the wall and imaged by both surface photographs and the side-scan sonar. The overall purpose of the structure was unknown, but the side-scan data suggested it was a blind opening with a solid wall approximately 7 ft inside the dock. Another large outfall in combination with a short sheet pile wing wall was observed at Station 3+55 beyond the limit of sonar coverage, but its purpose was unknown.

6. SUMMARY OF FINDINGS

Geophysical surveying efforts, including precision multibeam bathymetric, sub-bottom profiling, and an acoustic dock wall survey, were conducted prior to sediment sampling to establish a basemap of the project area. In addition, the completion of these efforts provided the water depths, bottom elevations, and apparent sediment thickness data necessary for evaluations of the volumes of sediment that could be removed as part of future remediation efforts. The multibeam bathymetric and sub-bottom profiling surveys were completed in the Hallet Dock 8 Slip, Oil Barge Dock Slip, General Mills Slip, and Tower Avenue Slip. However, the dock wall acoustic surveys were only completed within the Oil Barge Dock and Tower Avenue Slips.

These evaluations utilized various forms of remote sensing, which in turn produced high-resolution base maps of water depth and lakebed elevation for each slip surveyed. In addition, these data were used to develop a DEM suitable for the creation of a site model within a GIS environment. Additionally, the geophysical effort included the completion of underwater acoustic imagery surveys of the quay walls within the Oil Barge Dock and Tower Avenue Slips. These images of the submerged components of each wall were merged with corresponding digital photographs of the above water portions of each wall to support a first order assessment of conditions and stability of these structures.

Ultimately, these geophysical data sets data will be used in conjunction with chemical analytical data to evaluate initial extents of sediment contamination as described below. They are sufficiently robust for use as part of future feasibility studies or to serve as the basis of remedial design evaluations. Key findings from each area are summarized below.

6.1 Hallet Dock 8 Slip

The Hallet Dock 8 slip is currently 140 wide and 2,400 ft long, with the southern limits of the slip corresponding to the relic (1890) shoreline. When corrected and referenced to the LWD for Lake Superior (601.1 ft), water depths within the slip ranged from 10 ft in the extreme southeastern corner to 37 ft near the northeastern corner of the Hallet Dock 8. In general, the sub-bottom data were representative of a disturbed or modified bed with multiple, discontinuous strata visible in the top 15 to 20 ft of penetration.

6.2 Oil Barge Dock

The Oil Barge Slip is currently an 840-ft-long and 95-ft-wide slip that resides between the BP Oil Dock and Midwest Energy Resources Dock. The Oil Barge Dock Slip survey area was comprised of the 2-acre parcel of submerged lands between the eastern and western walls, as well as 4.8 acres of coverage that extended into St. Louis Bay. Multibeam bathymetry data were collected from the approximate centerline of South Channel to the limits of navigation in the headwaters to the south. Shallow water and debris (timbers associated with a failing bulkhead) prevented access and complete coverage of the water body. Minimum water depths of 3 ft were detected in the southeastern limits of coverage, while a maximum water depth of 25 ft was measured at the entrance to the slip near the centerline.

Sub-bottom profiling data were collected over 10 north-south oriented survey transects within the 95-ft-wide BP Oil Barge Dock Slip. Similar to the Hallet Dock 8 Slip, the sediment column displays evidence of a significantly disturbed or modified bed with several discontinuous strata visible in within 15 to 20 ft of the sediment-water interface. Three principal material types, each with unique acoustic signatures that were a product of either physical composition and/or degree of disturbance, were detected within sediment column. Recently deposited fine-grained sediments (silts) overlying mixed or chaotic layers of material were noted in the upper sediment column, while bedded, homogenous parent sediments (silty clays) were found at depth within the profile. The thickness of each type of material encountered varied significantly based on

location within the slip, bathymetry, degree of anthropogenic influence, and structural integrity of the adjacent walls.

In general, the west wall between Stations 0+00 and 1+20 appeared intact but displayed signs of damage and deterioration both above and below the waterline. The east wall is the product of different construction techniques employed in different timeframes. As a result, the condition of the wall segments at the time of the survey was directly dependent upon the construction technique employed, the material used, and the age of each segment.

Additional investigation of stability by means of divers or ROV and potential mitigation measures would be recommended during future evaluations of potential remedial actions in this area.

6.3 General Mills Slip

The General Mill Slip is located at the confluence of St. Louis Bay to the northwest and Howards Bay to the east. The General Mills Slip is approximately 1,800 ft long and extends 500 ft south of the 1880s historical shoreline for this portion of Superior. The General Mills Slip survey area was comprised of the 7.4-acre parcel of submerged lands between the General Mills Dock to the east and ruins of the Great Northern Dock to the west, plus 6.7 acres of coverage that extended into South Channel and St. Louis Bay (Figure A-15). When corrected and referenced to the LWD for Lake Superior, water depths within the confines of the slip ranged from 2 ft in the extreme southeastern corner and southwestern margin of the coverage area to 38 ft at the center of a discrete scour feature near the centerline of the slip.

Sub-bottom profiling data were collected over 10 north-south oriented transects established within the 180-ft-wide General Mills Slip survey area. Similar to the other slips surveyed as part of this investigation, the acoustic profiles displayed evidence of multiple, distinct sediment strata within the upper sediment column. In general, fine-grained, lower density sediments (silts) with thicknesses ranging from 1 to 4 ft were found over intervals of mixed or chaotic layers of material. These mixed strata were 2 to 6 ft thick and commonly comprised of intervals of sand or sand mixed with silts and clays. The parent sediment was determined to be a homogenous, fine sand that resided below the localized disturbances caused by construction activity or repeated dredging to maintain suitable water depths for vessels utilizing the General Mills Dock.

6.4 Tower Avenue Slip

The Tower Avenue Slip is located in Howards Bay and bounded by the Paper Calmenson to the west and CHS docks to the east. The Tower Avenue Slip survey area covered 16.9 acres of submerged lands within the confines of the slip, as well as 8.7 acres of coverage that extended into Howards Bay. The Tower Avenue Slip extends approximately 2,770 ft from Howards Bay into the headwaters before terminating at an earthen berm and several outfall structures in various states of repair. Access to the slip from Howards Bay appears to be restricted to a relatively narrow, 300-ft-wide passage between a shallow embayment to the west exhibiting depths ranging from 4 to 20 ft and the CHS dock to the east. Once the Paper Calmenson Dock is

encountered at the approximate midpoint of the slip, the width tapers to approximately 250 ft, then further constricts to less than 200 ft at the headwaters. A minimum depth of 1 ft was detected along the western and eastern banks within the headwaters of the slip, as well as the northern and eastern limits of the CHS Dock. A maximum water depth of 41 ft was measured along the northwestern margin of the CHS Dock and again within a roughly circular bottom feature 45 ft northwest of the dock.

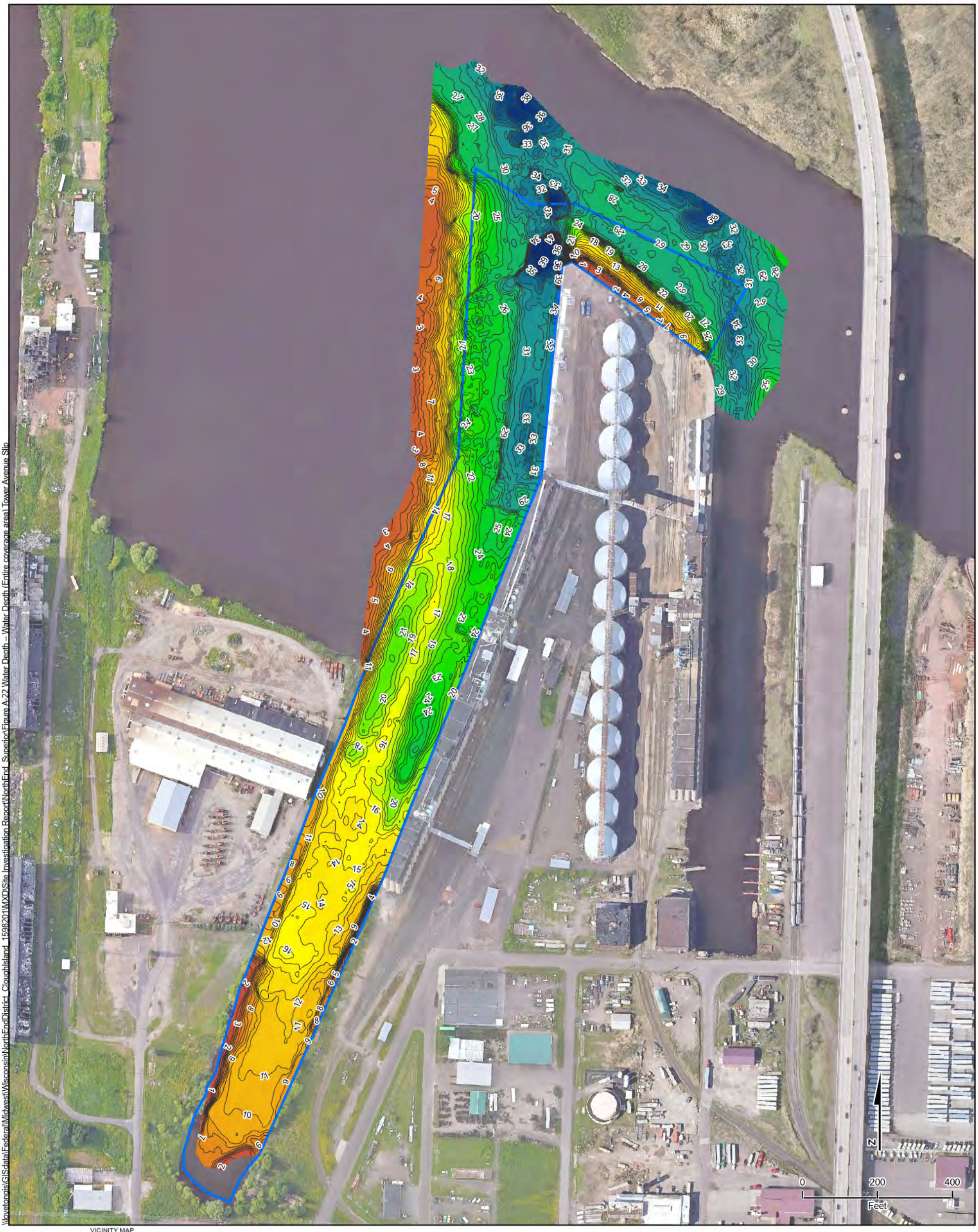
Sub-bottom profiling data were collected over 10 transects established within the Tower Avenue Slip survey area, each approximately 2,800 ft long and oriented parallel to the long axis of the slip. In general, the results for the Tower Avenue Slip were comparable to those derived for the General Mills Slip. Deposits of fine-grained material (silts) of varying thickness were detected at the sediment-water interface throughout the survey area. These lower density silts resided over mixed intervals of sand, silt and clay that comprise a layer of sediment that has been periodically disturbed by dredging, vessel movements, and other industrial activities within the slip. Due to the shallow water depths in the southwestern extents of the survey area, several artifacts (acoustic multiples) were captured in the acoustic record along with the desired sonar returns. These acoustic multiples limited the value of the sub-bottom data collected in the shallows by obscuring any backscatter deeper than 10 ft below the sediment-water interface.

The west wall of the Tower Avenue slip retains the fill material used to create the current Paper Calmenson Dock during its original construction in the late 1800s. It was imaged using both the MBES system and the side-scan sonar over a distance of approximately 850 ft. In general, the wall surface residing under the waterline and behind the pilings appears intact, while sections of the wall above the waterline display a considerable amount of deterioration and spalling over its length. The east wall of the Tower Avenue slip retains the fill material deposited in the late 1880s and used to create the structure now known as the CHS Dock. The entire east wall is comprised of steel sheet pile that was driven into the Tower Bay sediments. The entire east wall is comprised of steel sheet pile, and with one exception, appeared to be intact and in good condition. The southeast wall of the Tower Avenue slip retains the fill material used to the create the base of the CHS Dock where it tied into the original Tower Bay shoreline. In contrast to the east wall, the southeast wall was comprised of concrete and timber. Similar to the west wall in the Oil Barge Dock Slip, the southeast wall in the Tower Avenue Slip appears to consist of a deteriorating concrete cap that was cast over the compacted fill material originally used to cover the freshwater marshland. Besides the obvious deterioration of the concrete cap between Stations 0+00 and 1+50, there were also some indications of fill material loss into the slip, suggesting existing or prior breaches in the wall. Between Stations 1+50 and 2+40 the concrete cap displayed less evidence of deterioration and the support structure under the waterline appeared to be intact. From Station 2+40 to the limits of sonar coverage the concrete cap and structural components below the waterline appeared relatively intact.

Additional investigation of stability by means of divers or ROV and potential mitigation measures may be recommended in certain areas along the Tower Bay walls during future evaluations of potential remedial actions in this area.

LIST OF FIGURES (continued)

ATTACHMENTS



\\lovetonois\GIS\data\Federal\Midwest\Wisconsin\NorthEndDistrict_CloughIsland_1598201\MXD\Site Investigation Report\NorthEnd_Superior\Figure A-22 Water Depth – Water Depth (Entire coverage area) Tower Avenue Slip

VICINITY MAP

Legend

- Water Depth Contour (Feet)
- Sediment Characterization and Survey Area (39.65 ac)

Water Depth (Feet)

42
0

Figure A-22
Water Depth (Entire coverage area)
Tower Avenue Slip
North End District and Clough Island
Superior, Wisconsin

Map Date: 6/3/2021
Source: Google Earth 05/2017
Projection: NAD 1983 State Plane
Wisconsin North US Foot

Notes:
Ordinary High Water (OHW) = 603.1 (IGLD85 Feet)
Low Water Datum (LWD) = 601.1 (IGLD85 Feet)

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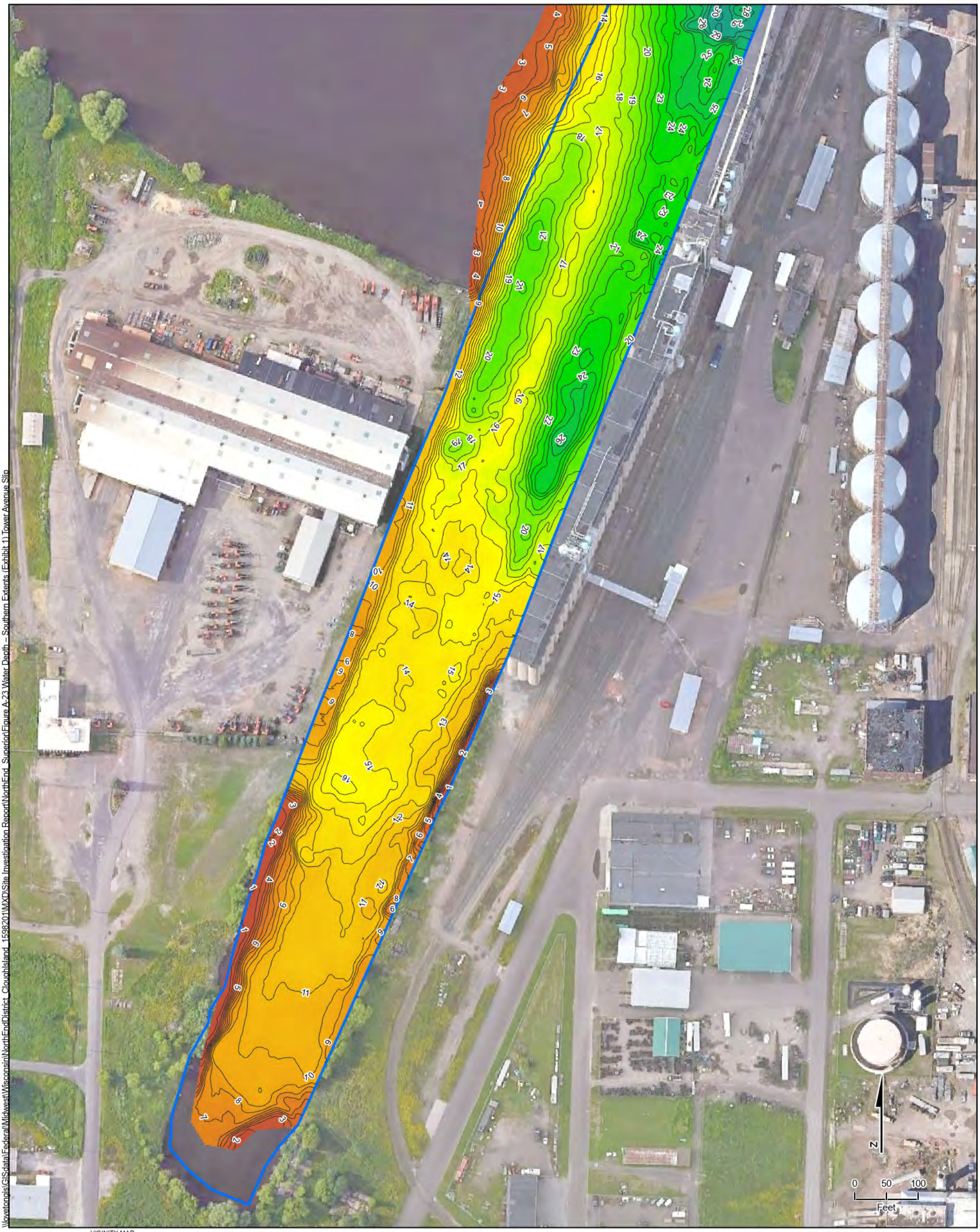

\\lovetongis\GISdata\Federal\Midwest\Wisconsin\NorthEndDistrict_CloughIsland_1598201\MXD\Site Investigation Report\NorthEnd_SuperiorFigure A-23 Water Depth – Southern Extents (Exhibit 1) Tower Avenue Slip

VICINITY MAP

Legend

Water Depth Contour (Feet)

Sediment Characterization and Survey Area (39.65 ac)

Water Depth (Feet)

42

0

Figure A-23
Water Depth Southern Extents (Exhibit 1)
Tower Avenue Slip
North End District and Clough Island
Superior, Wisconsin

Map Date: 6/3/2021
Source: Google Earth 05/2017
Projection: NAD 1983 State Plane Wisconsin North US Foot

Notes:
Ordinary High Water (OHW) = 603.1 (IGLD85 Feet)
Low Water Datum (LWD) = 601.1 (IGLD85 Feet)

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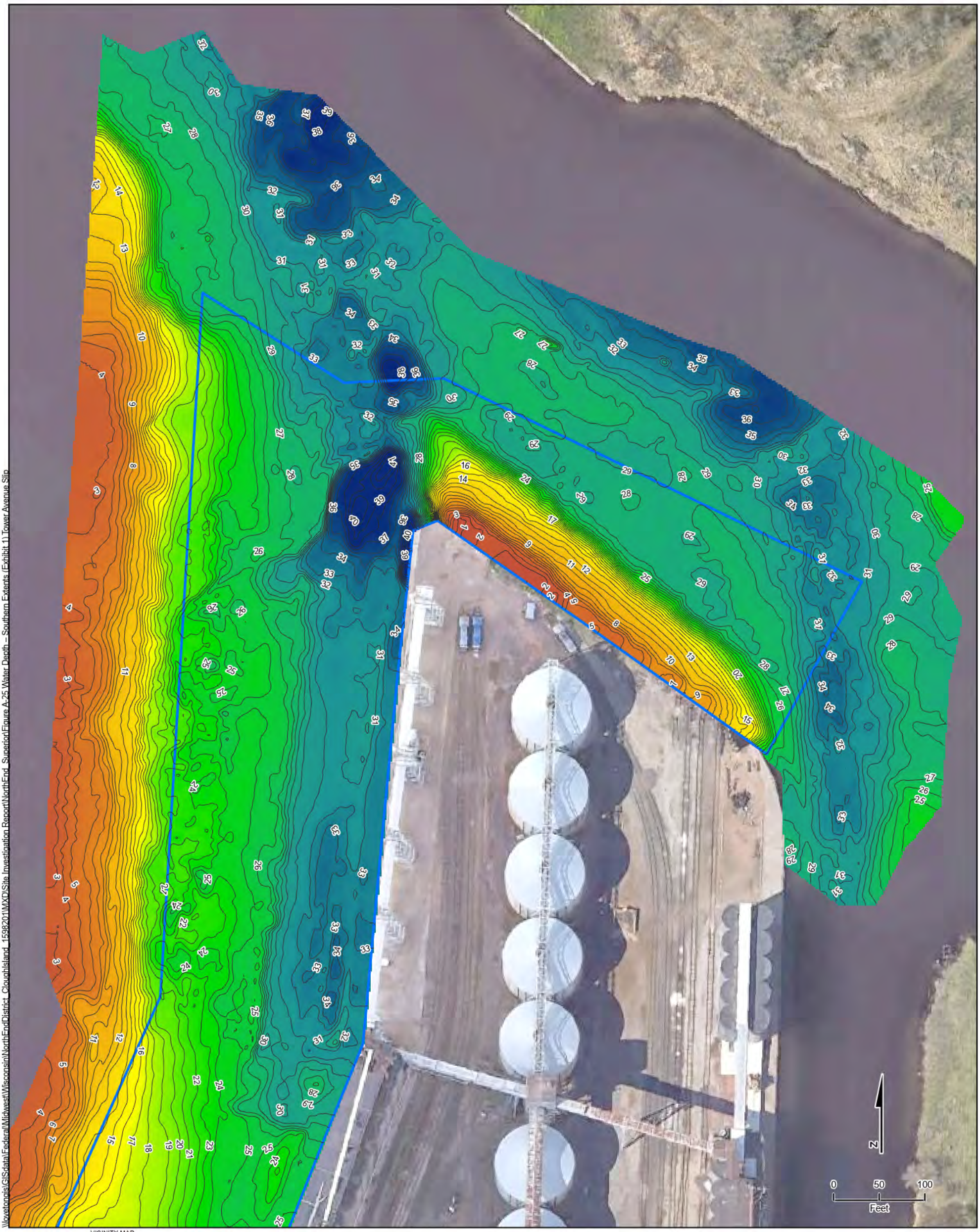
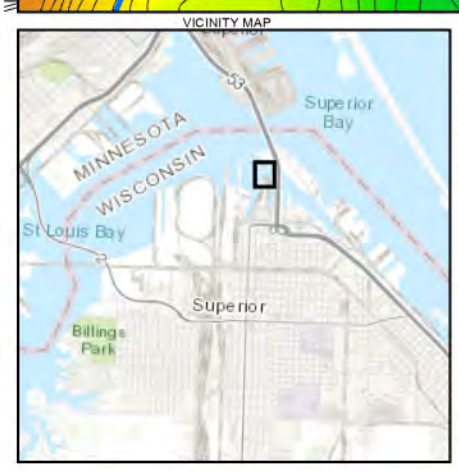
Figure A-24. Photograph of a large outfall actively discharging turbid water into the southwestern corner of the Tower Avenue Slip



\\lovetonpis\GIS\data\Federal\Midwest\Wisconsin\NorthEndDistrict_CloughIsland_1598201\MXD\Site Investigation Report\NorthEnd_SuperiorFigure A-25 Water Depth – Southern Extents (Exhibit 1) Tower Avenue Slip

VICINITY MAP



Legend

- Water Depth Contour (Feet)
- Sediment Characterization and Survey Area (39.65 ac)

Water Depth (Feet)

42
0

Figure A-25
Water Depth Northern Extents (Exhibit 2)
Tower Avenue Slip
North End District and Clough Island
Superior, Wisconsin

Map Date: 6/3/2021
Source: Google Earth 05/2017
Projection: NAD 1983 State Plane
Wisconsin North US Foot

Notes:
Ordinary High Water (OHW) = 603.1 (IGLD85 Feet)
Low Water Datum (LWD) = 601.1 (IGLD85 Feet)

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\\lovetongis\GISdata\Federal\Midwest\Wisconsin\NorthEndDistrict_CloughIsland_1598201\MXD\Site Investigation Report\NorthEnd_SuperiorFigure A-26 Lakebed Elevation Tower Avenue Slip

VICINITY MAP

Legend

Elevation Contour (IGLD85 Feet)

Sediment Characterization and Survey Area (39.65 ac)

Elevation (IGLD85 Feet)

600.5

559

Figure A-26
Lakebed Elevation
Tower Avenue Slip
North End District and Clough Island
Superior, Wisconsin

Map Date: 6/3/2021
Source: Google Earth 05/2017
Projection: NAD 1983 State Plane Wisconsin North US Foot

Notes:
Ordinary High Water (OHW) = 603.1 (IGLD85 Feet)
Low Water Datum (LWD) = 601.1 (IGLD85 Feet)

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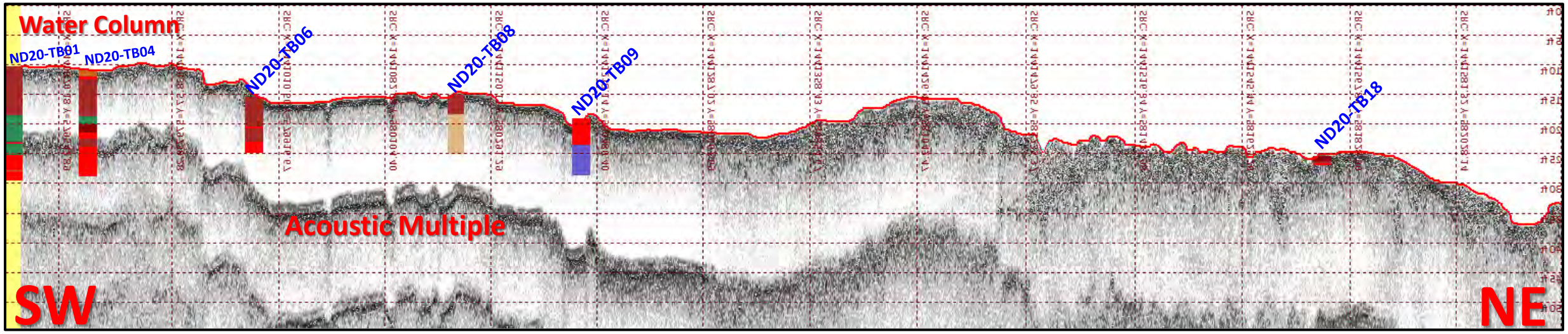
Tower Avenue Slip - West



Sand
Sandy Silt
Silty Organics
Silt
Silty Clay
Clay

Figure A-27. Acoustic sub bottom profile of the sediment column along the western margin of the Tower Avenue Slip. The acoustic image was reversed to allow presentation of survey transect from southwest (left) to northeast (right) orientation consistent with adjacent survey lines to improve inter-comparability. Fine-grained material (silts) of varying thickness were detected at the sediment-water interface overlying mixed intervals of sand, silt and clay that have been periodically disturbed by industrial activities within the slip and appear mottled in the acoustic image. Detailed core logs for Locations ND20-TB01 through TB18 are presented in Appendices B and C.

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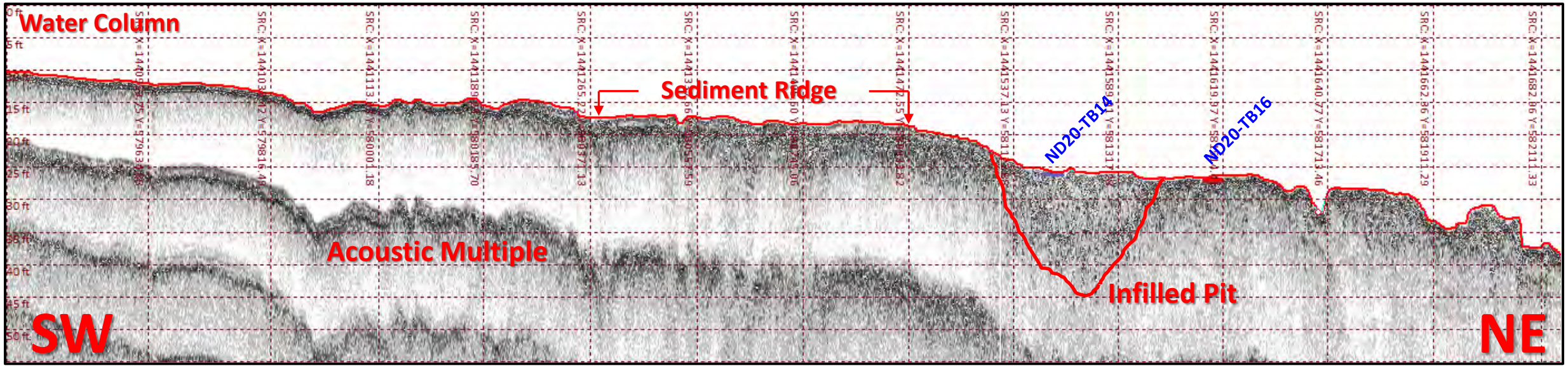
Tower Avenue Slip - Centerline



Sand
Sandy Silt
Silty Organics
Silt
Silty Clay
Clay

Figure A-28. Acoustic sub bottom profile of the sediment column along the centerline of the Tower Avenue Slip displaying a modest ridge of displaced sediment associated with the movement of the M/V *Ryerson* represented as 2 to 3 ft-thick layer of low-density material residing at the sediment-water interface. In addition, the profiler was able to identify an infilled pit approximately 500 ft from the mouth of the slip. Detailed core logs for Locations ND20-TB14 and TB16 are presented in Appendices B and C.

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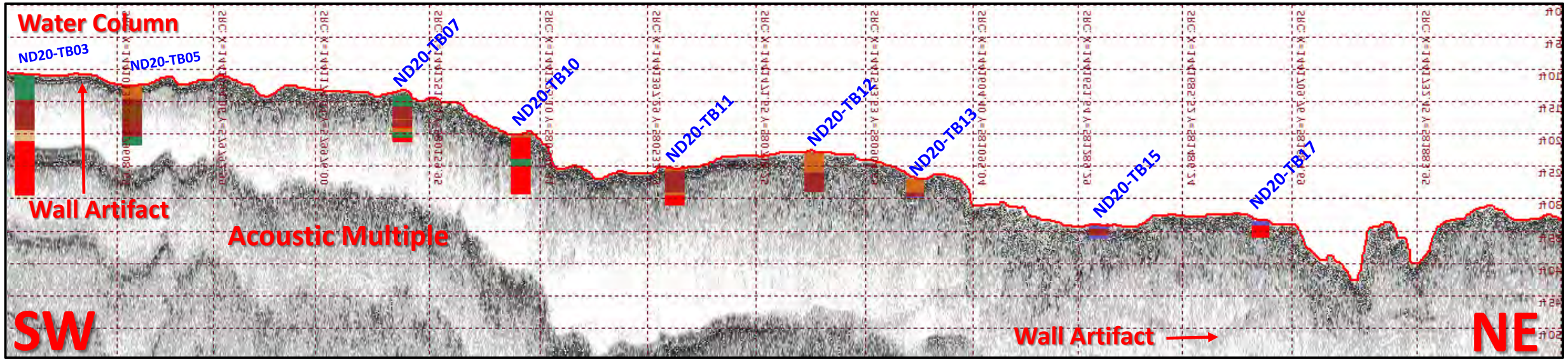
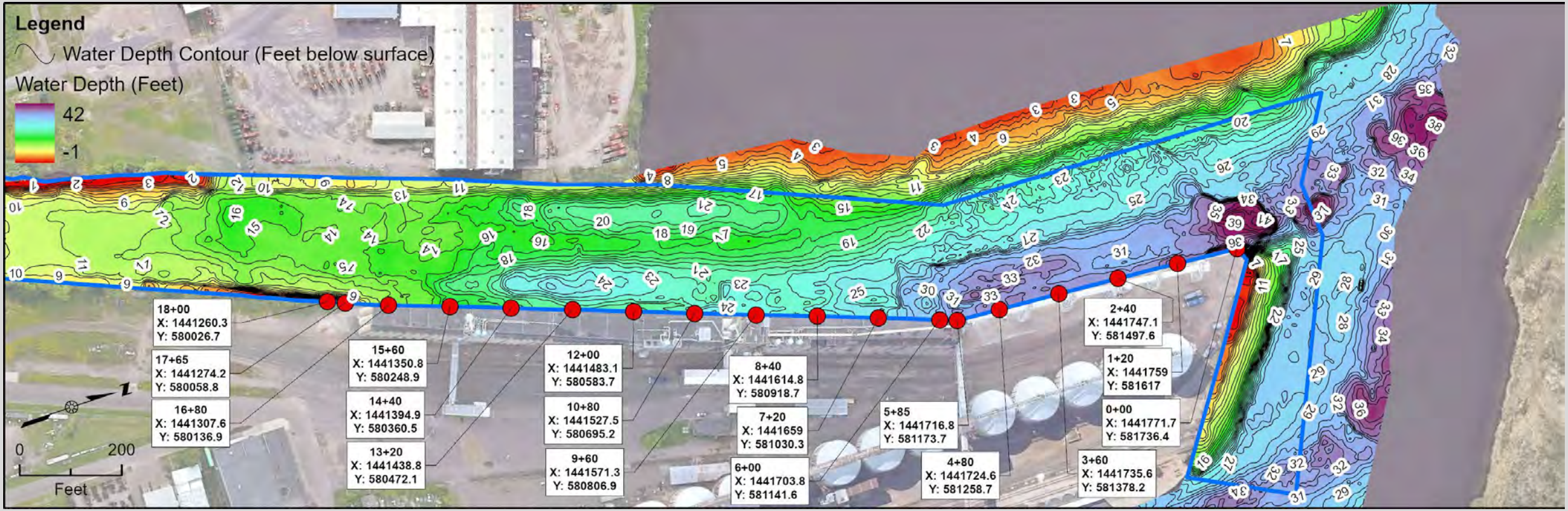
Tower Avenue Slip - East



Sand
Sandy Silt
Silty Organics
Silt
Silty Clay
Clay

Figure A-29. Acoustic sub bottom profile of the sediment column along the eastern margin of the Tower Avenue Slip displaying a considerable disturbance of the upper sediment column at the northeast end of the transect. The acoustic image was reversed to allow presentation of survey transect from southwest (left) to northeast (right) orientation consistent with adjacent survey lines to improve inter-comparability. Sediment cores collected along this transect displayed intervals of silts and clays of various thickness in the surface sediments overlying sand deposits at depth. Detailed core logs for Locations ND20-TB03 through TB17 are presented in Appendices B and C.

TOWER AVENUE EAST



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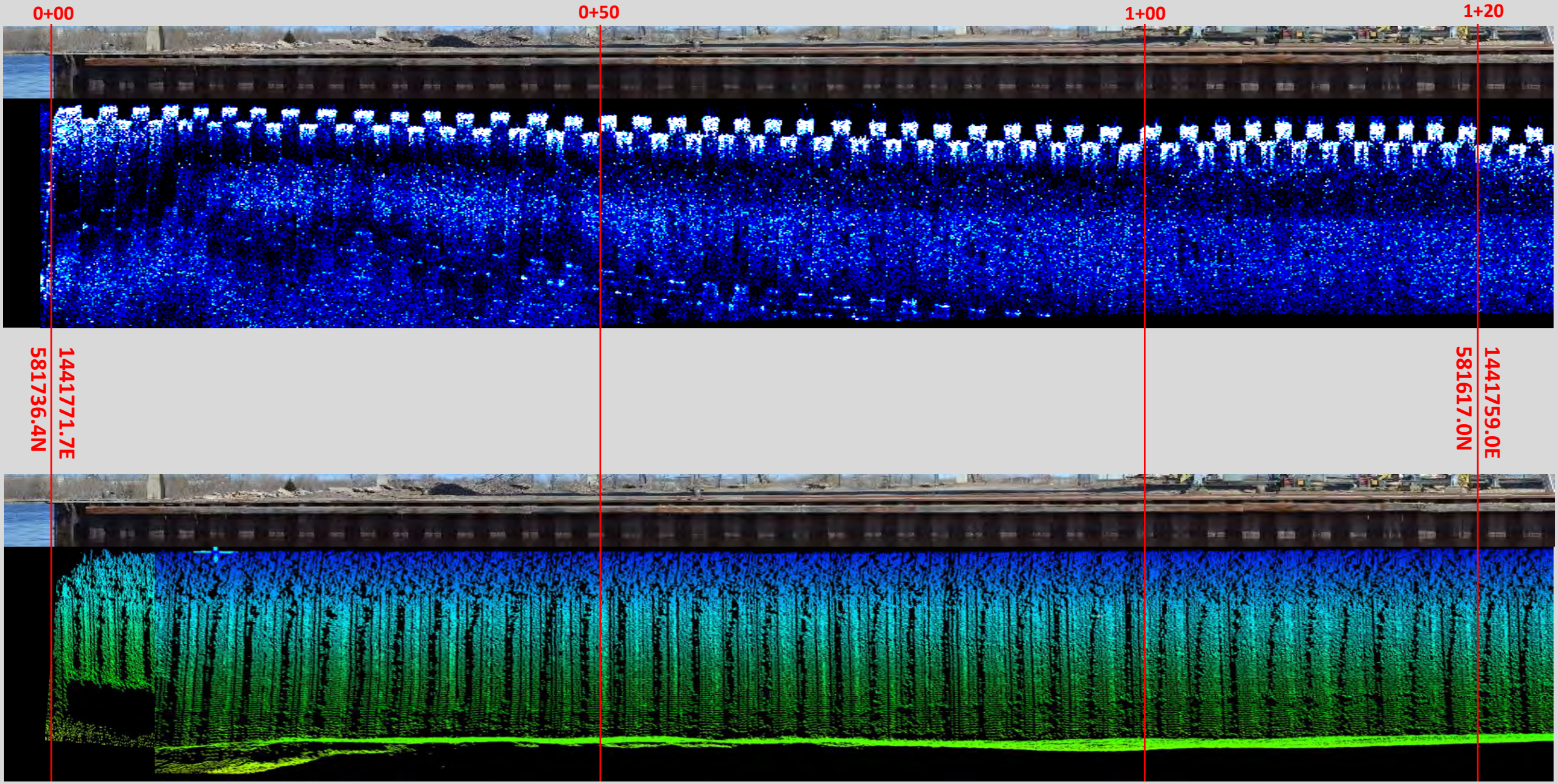
TOWER AVENUE EAST - 1



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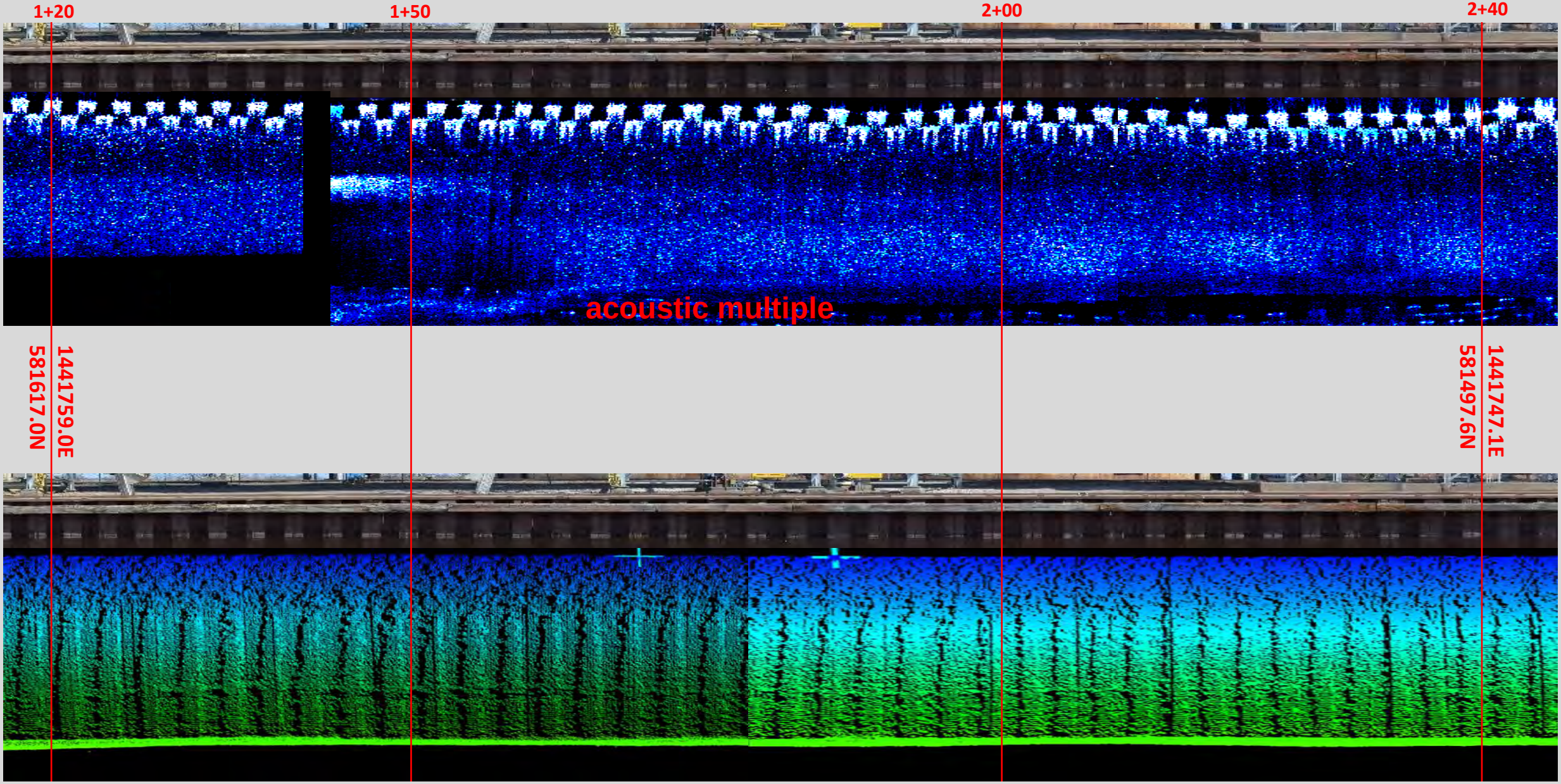
TOWER AVENUE EAST - 2



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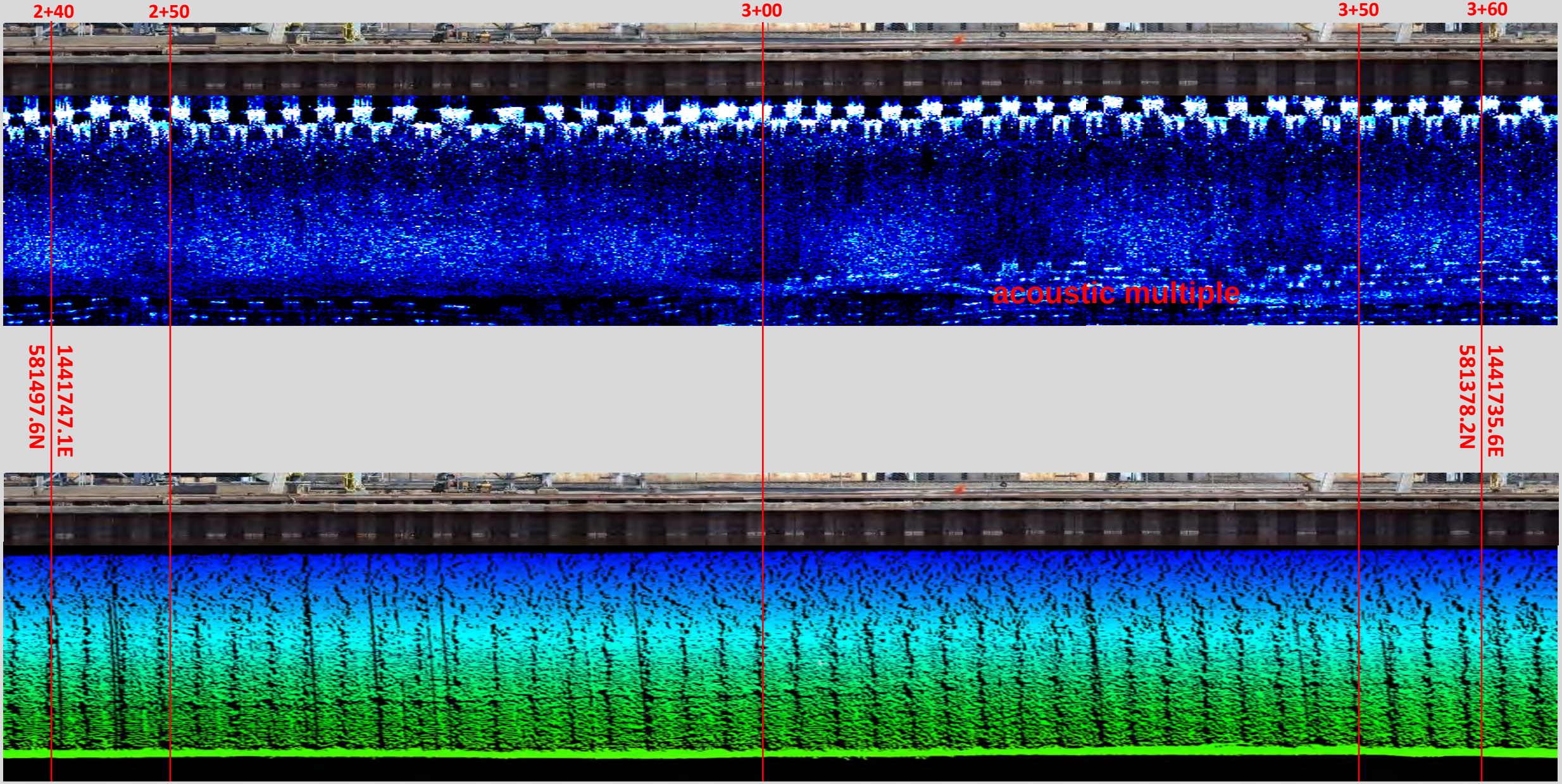
TOWER AVENUE EAST - 3



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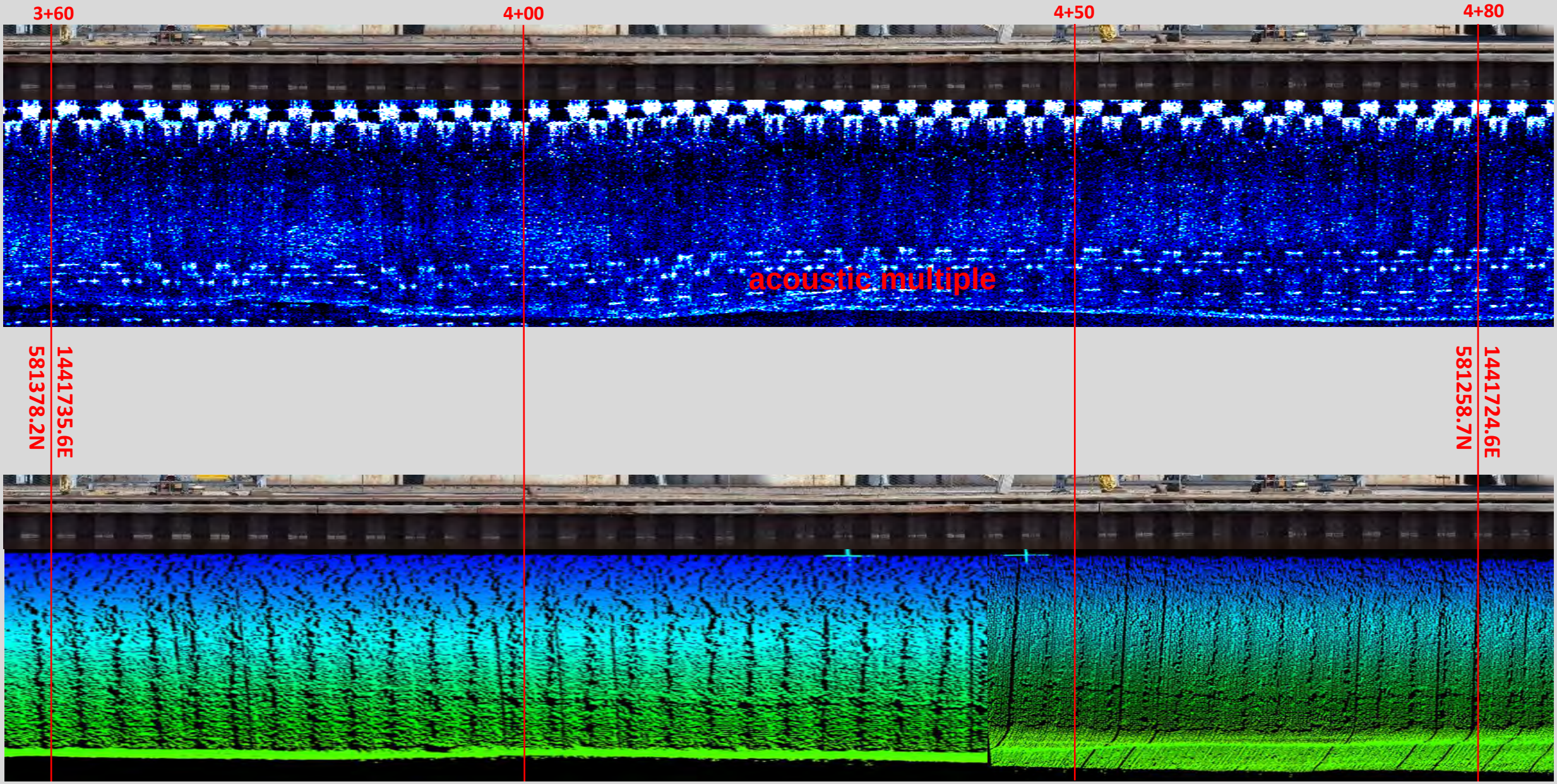
TOWER AVENUE EAST - 4



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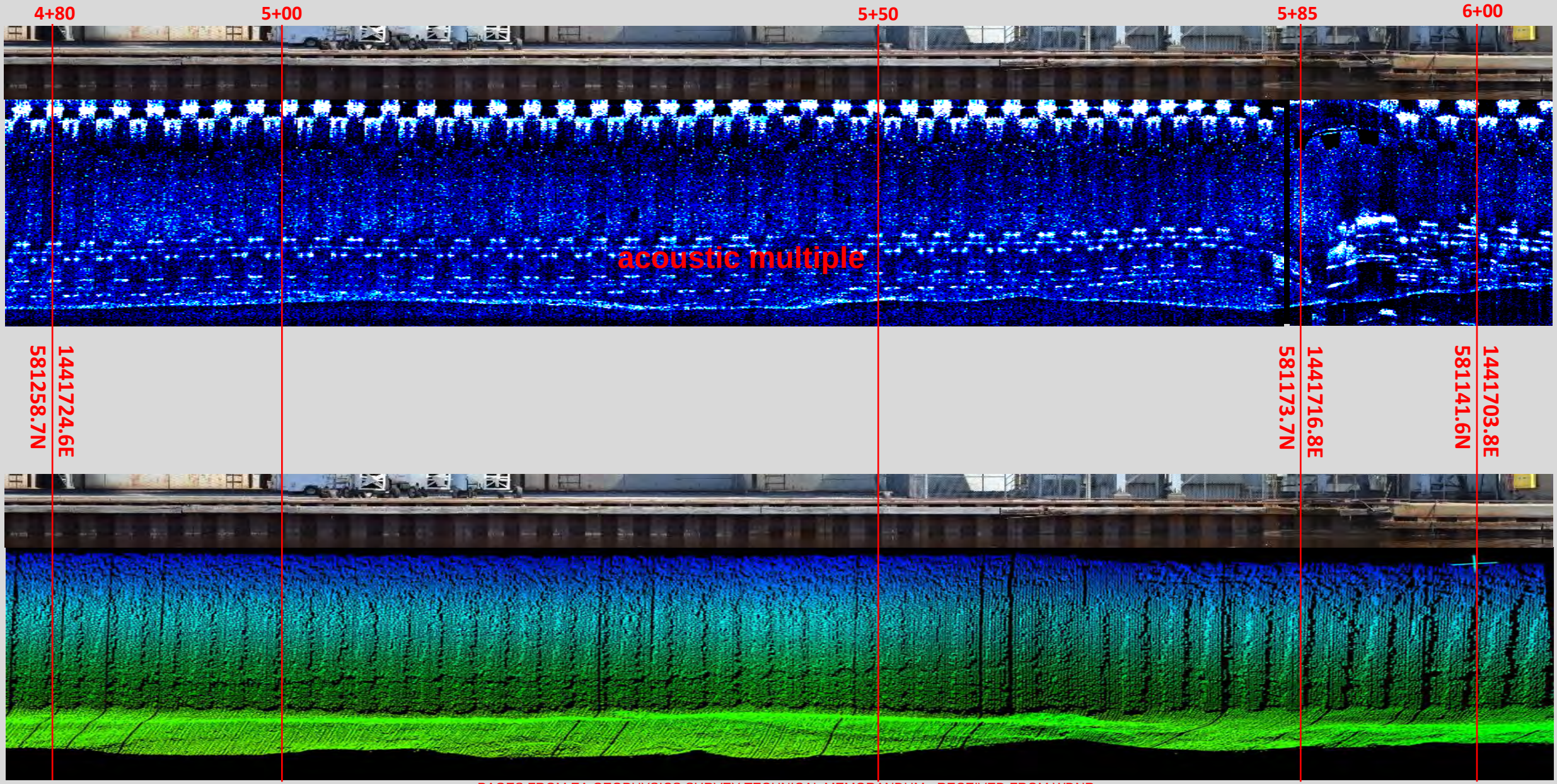
TOWER AVENUE EAST - 5



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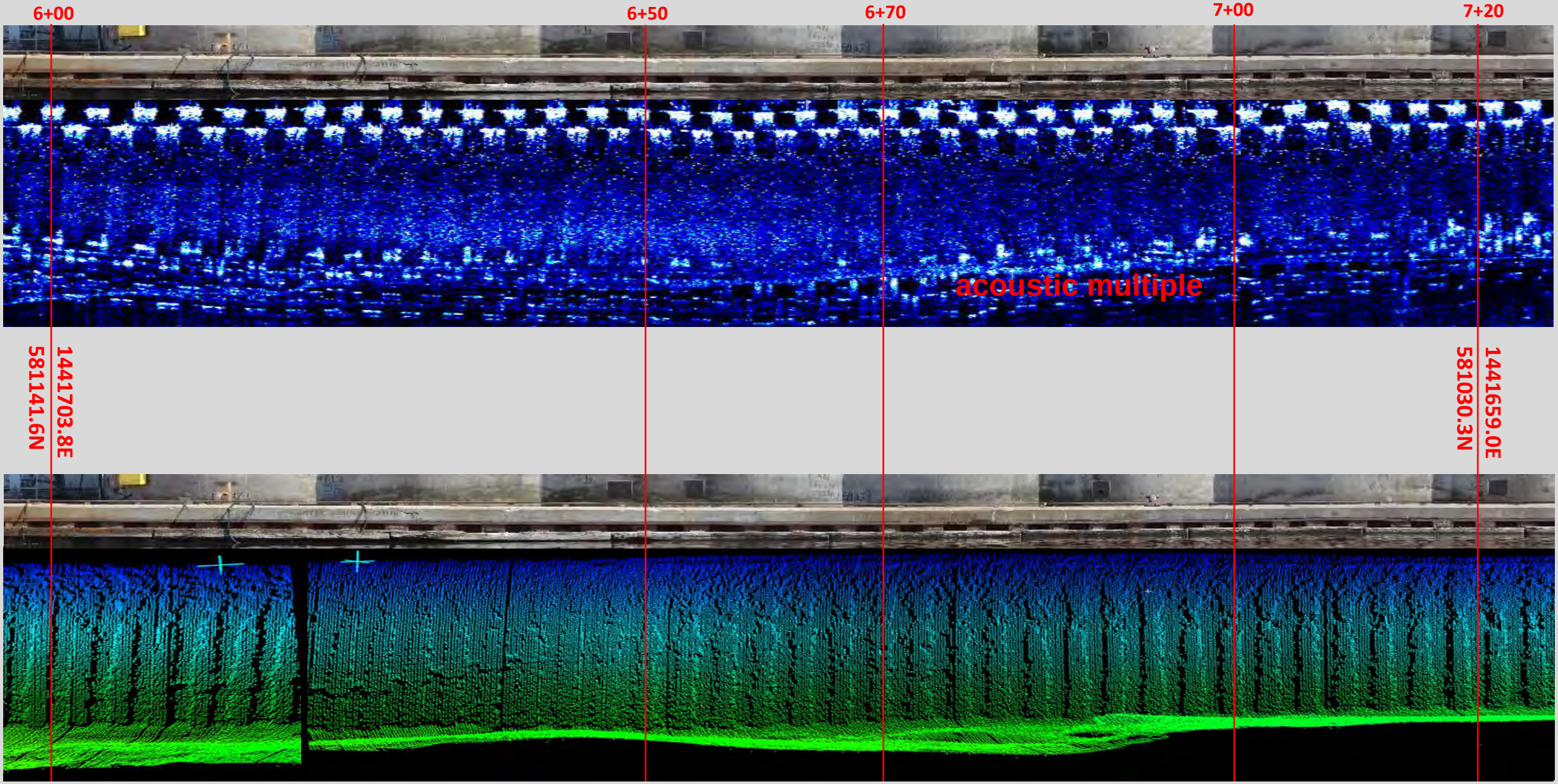
TOWER AVENUE EAST - 6



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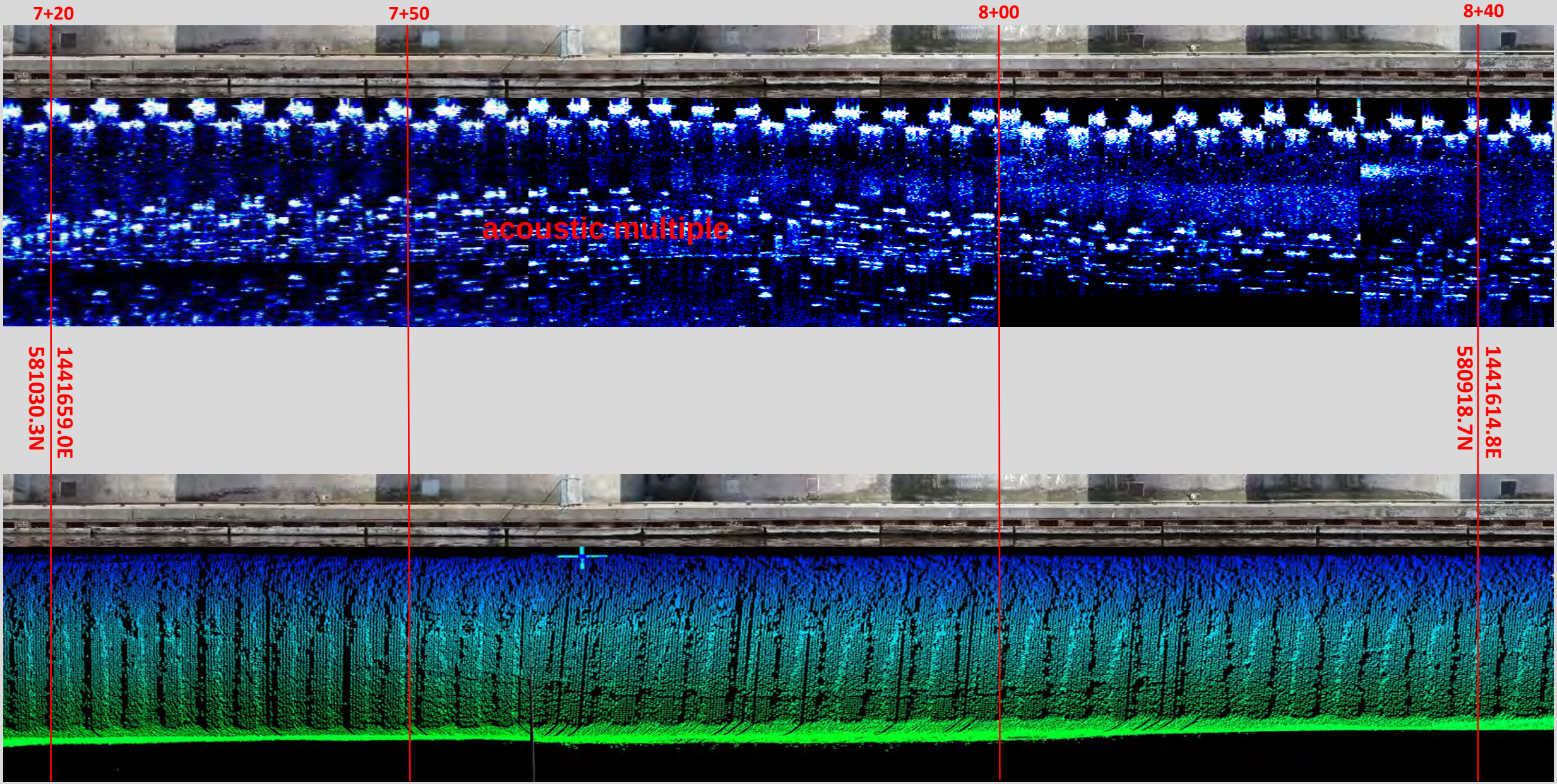
TOWER AVENUE EAST - 7



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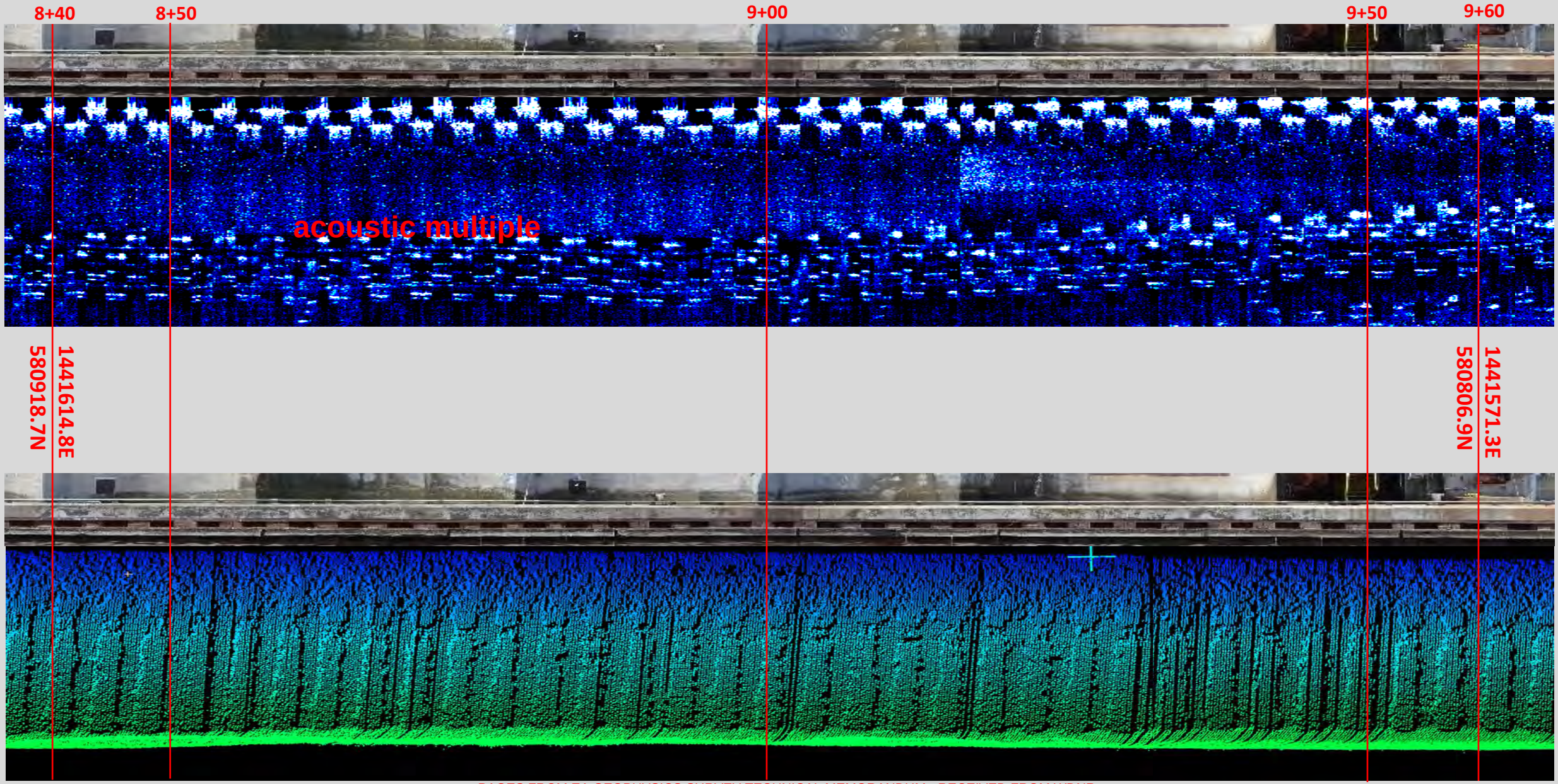
TOWER AVENUE EAST - 8



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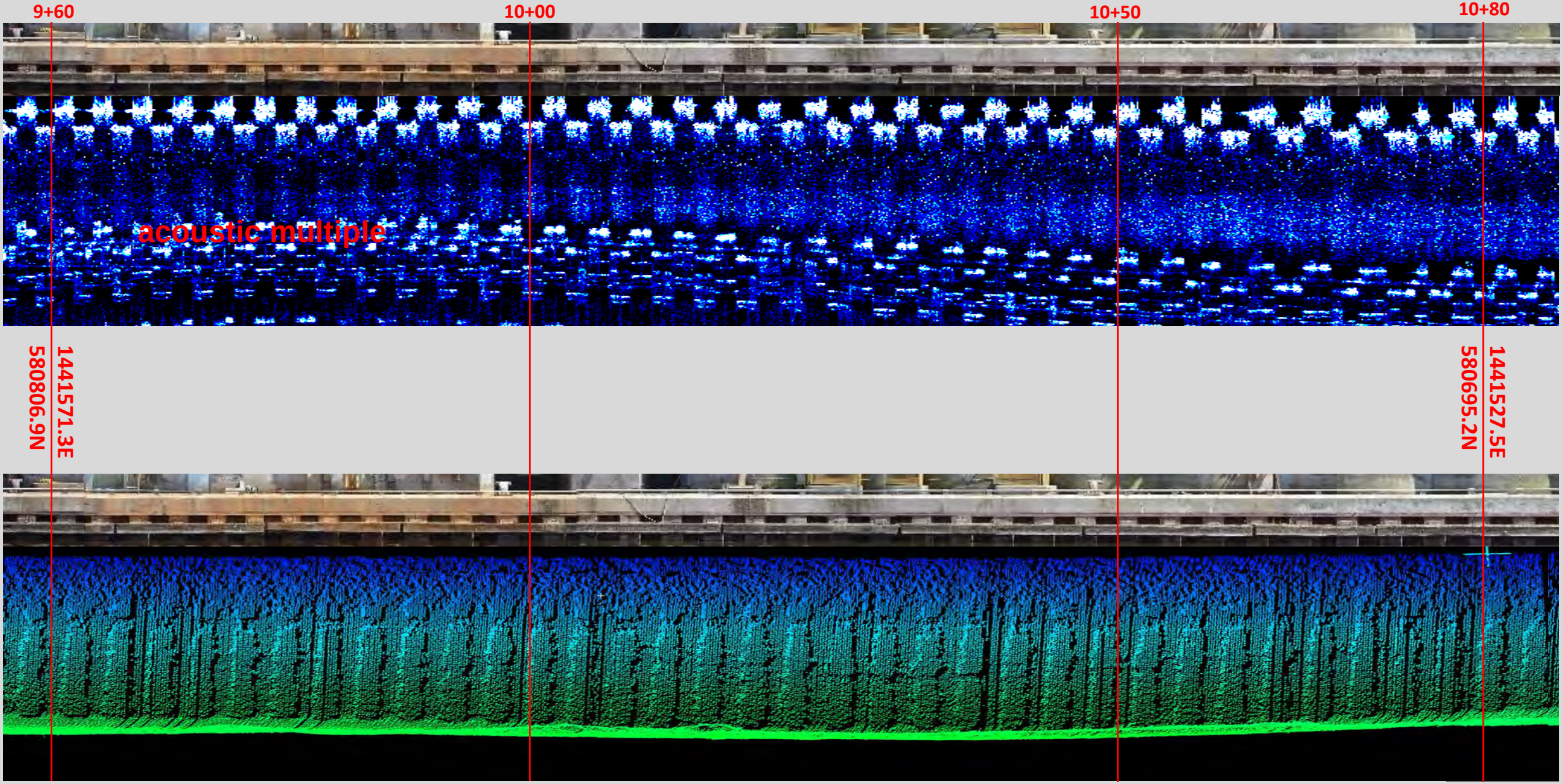
TOWER AVENUE EAST - 9



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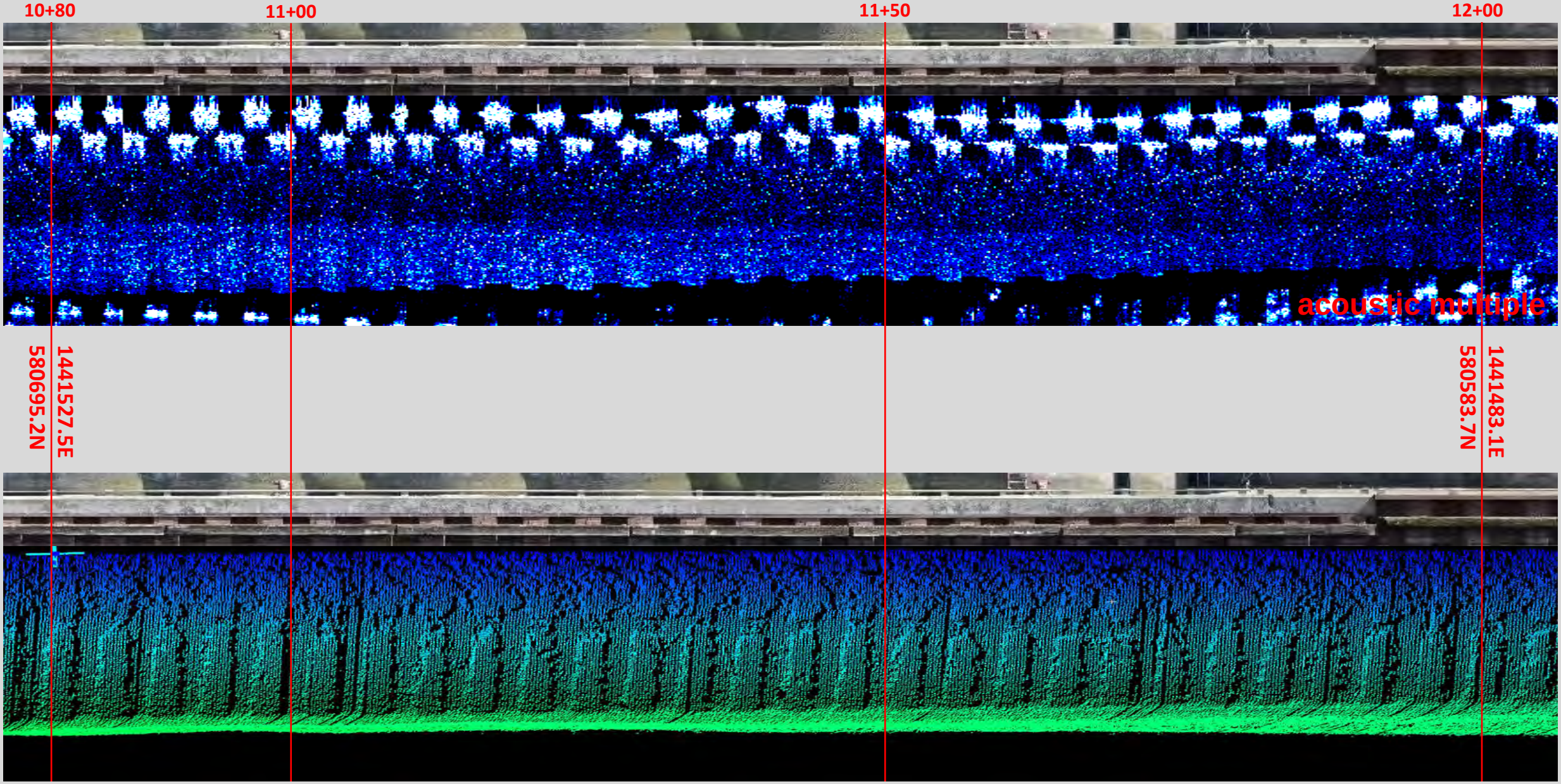
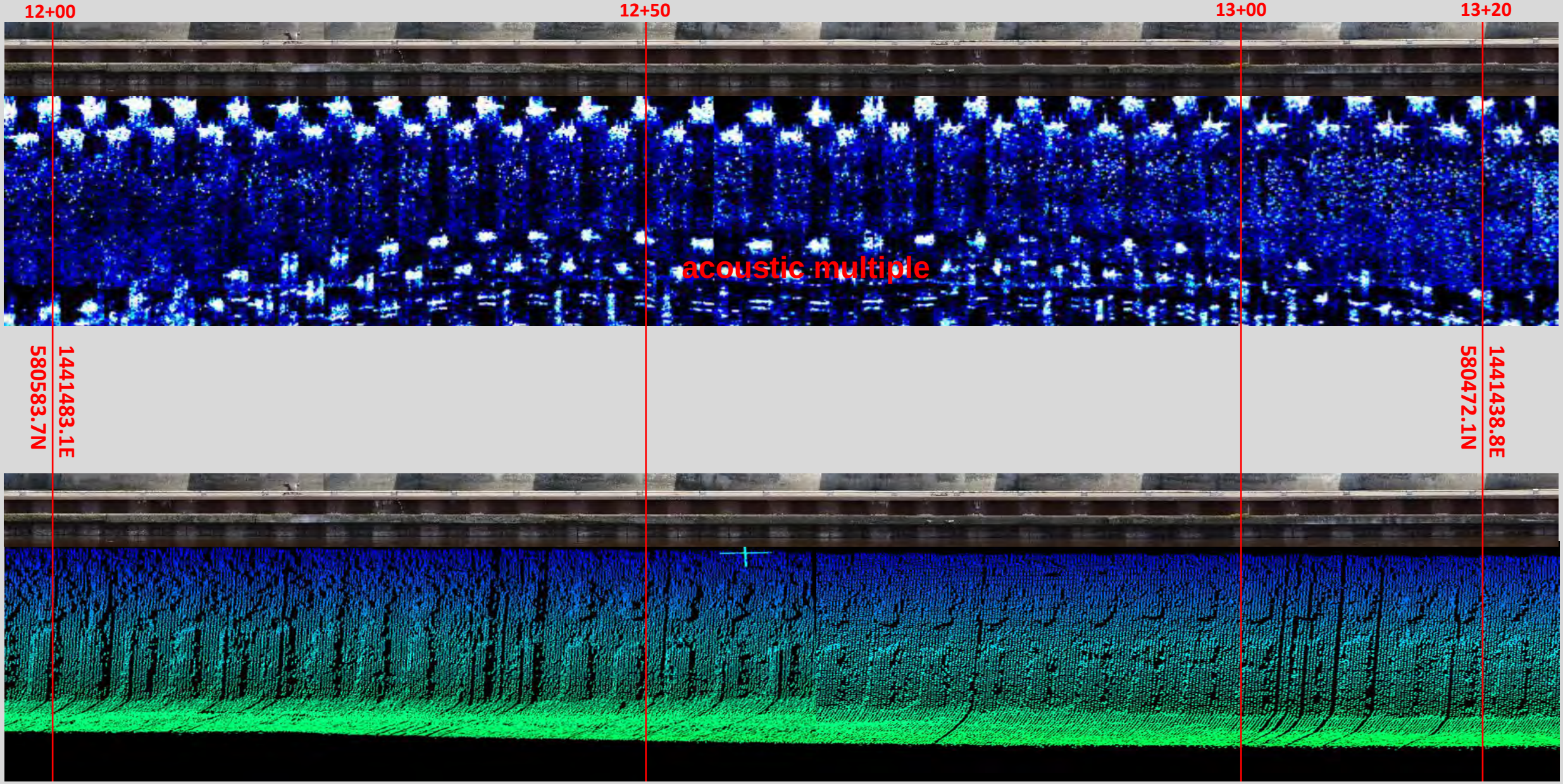
TOWER AVENUE EAST - 10



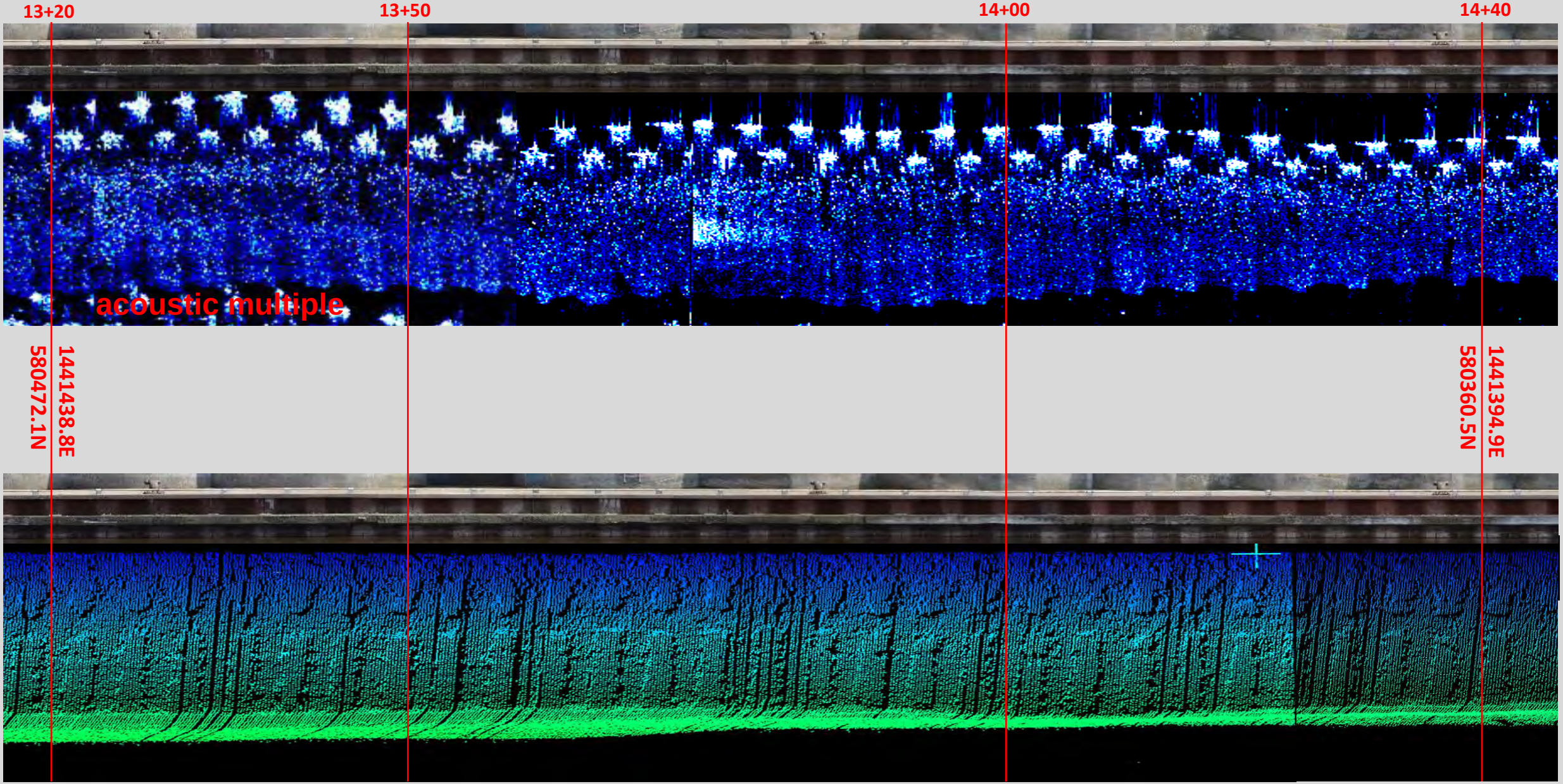
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE EAST - 11



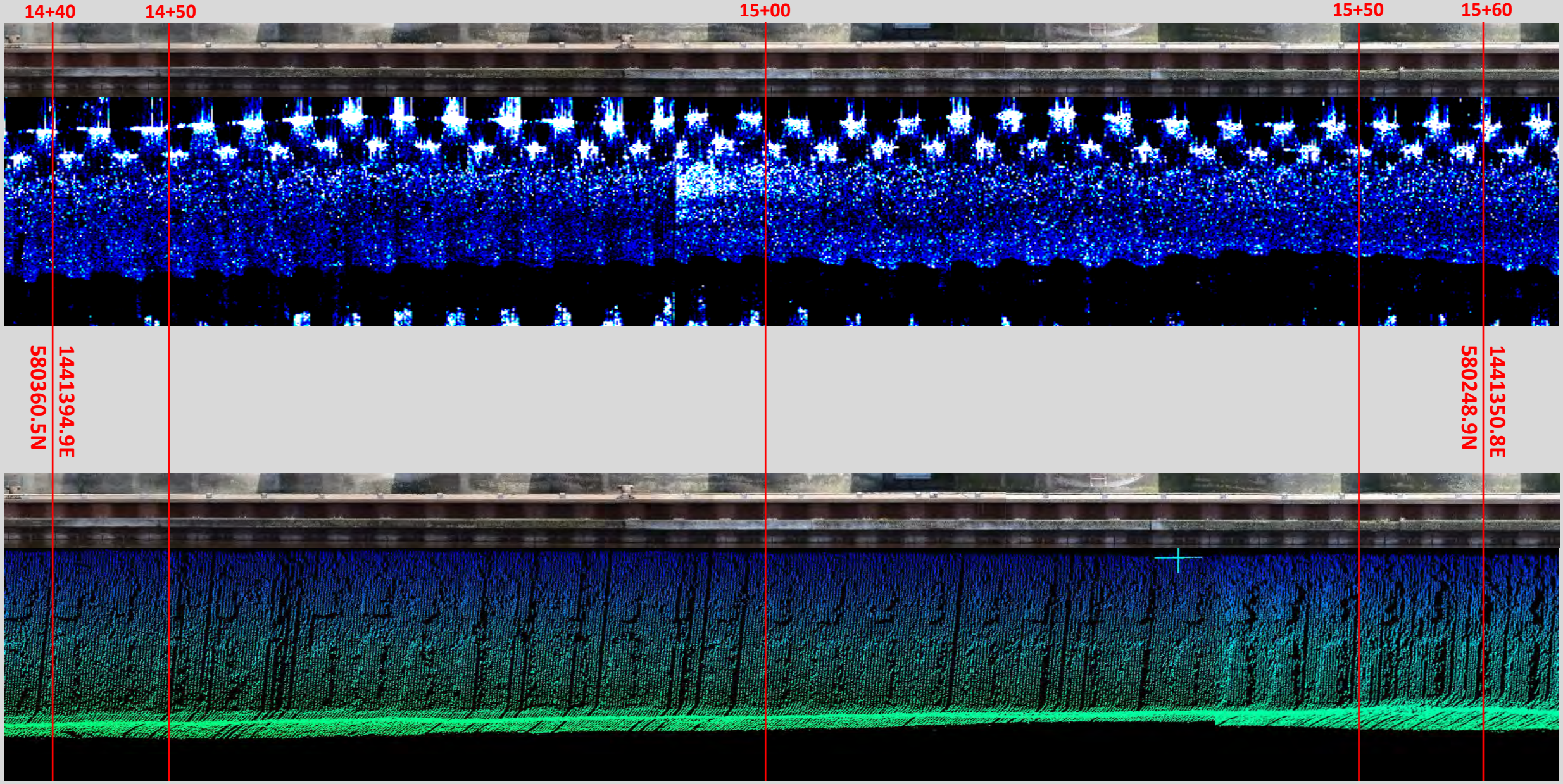
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE EAST - 12



PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

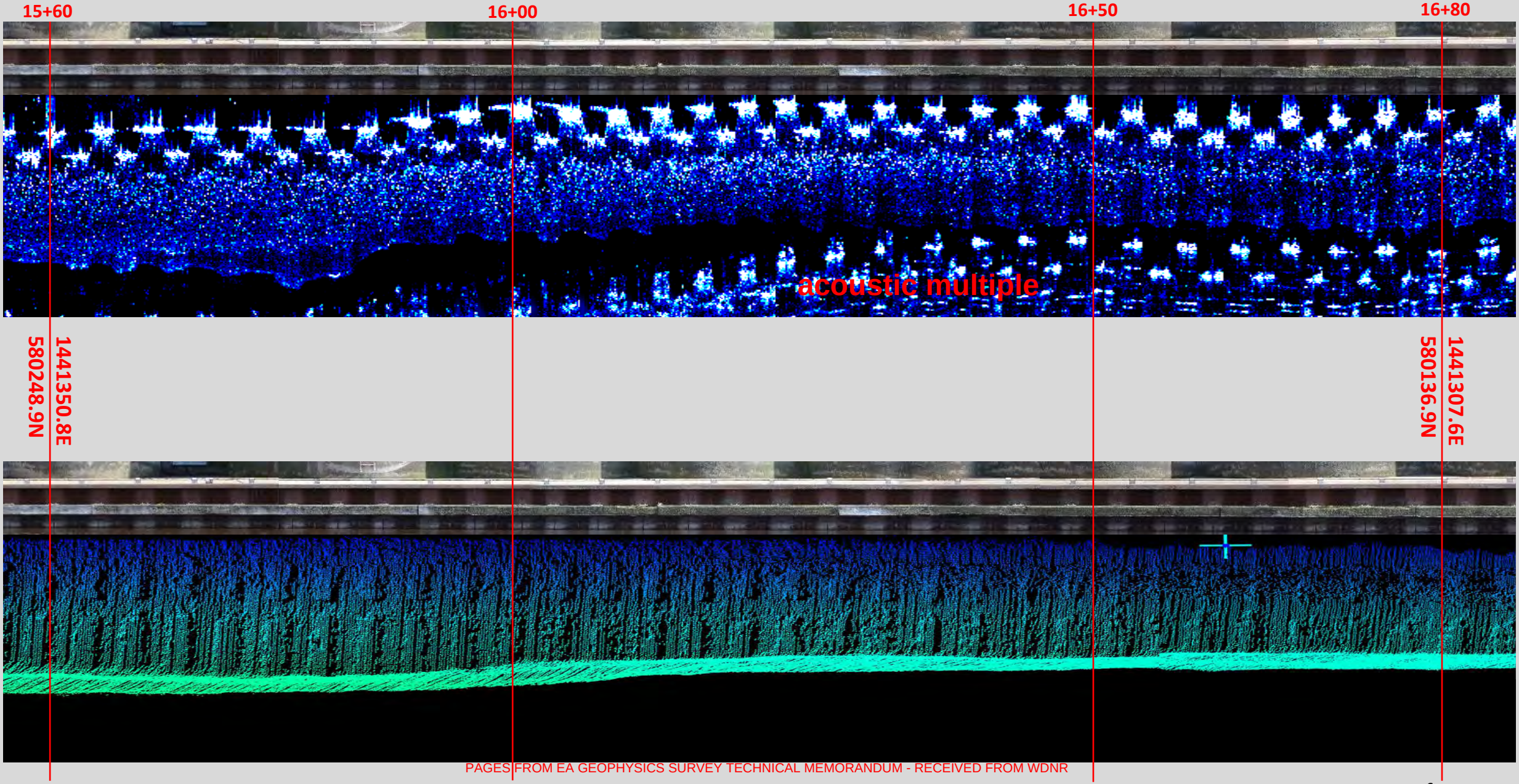
TOWER AVENUE EAST - 13



PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

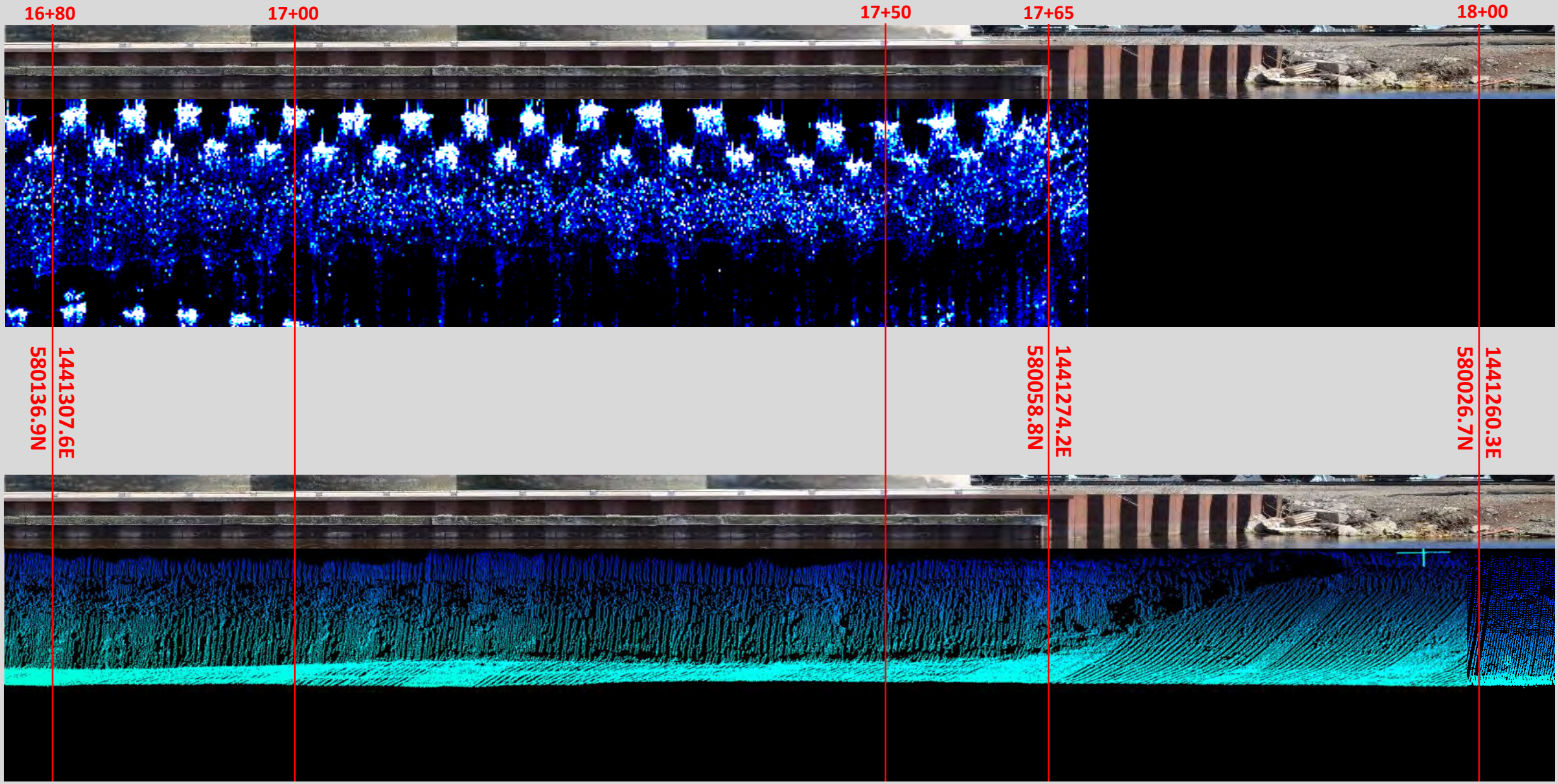
10 feet

TOWER AVENUE EAST - 14



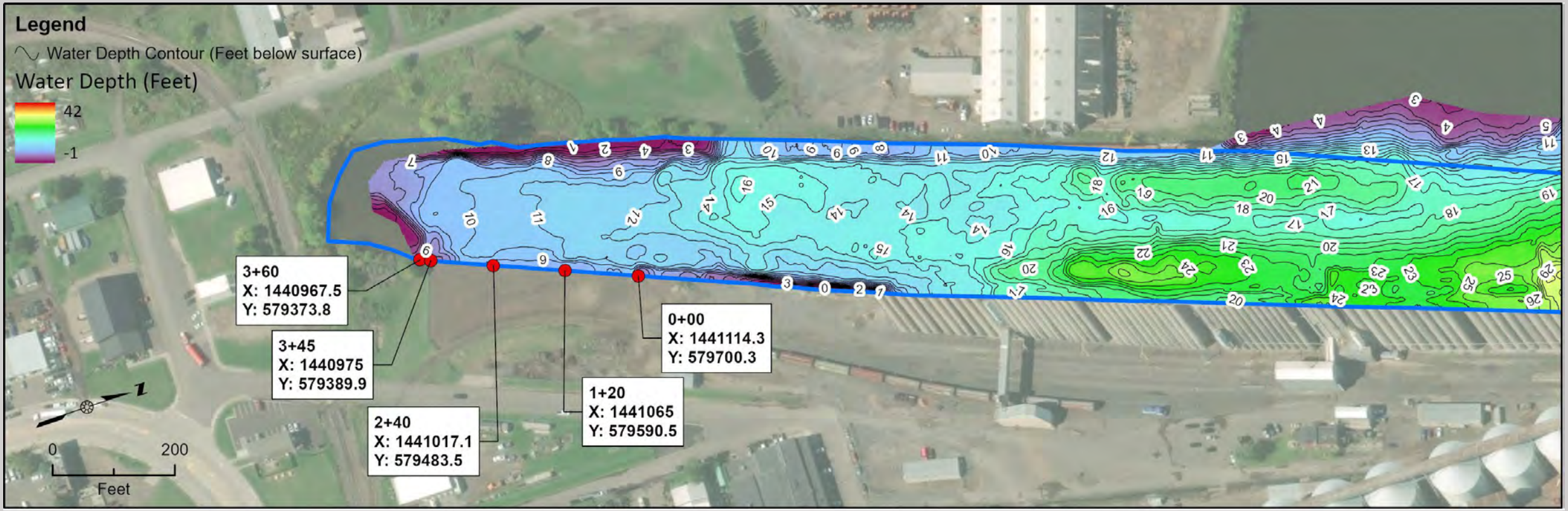
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE EAST - 15



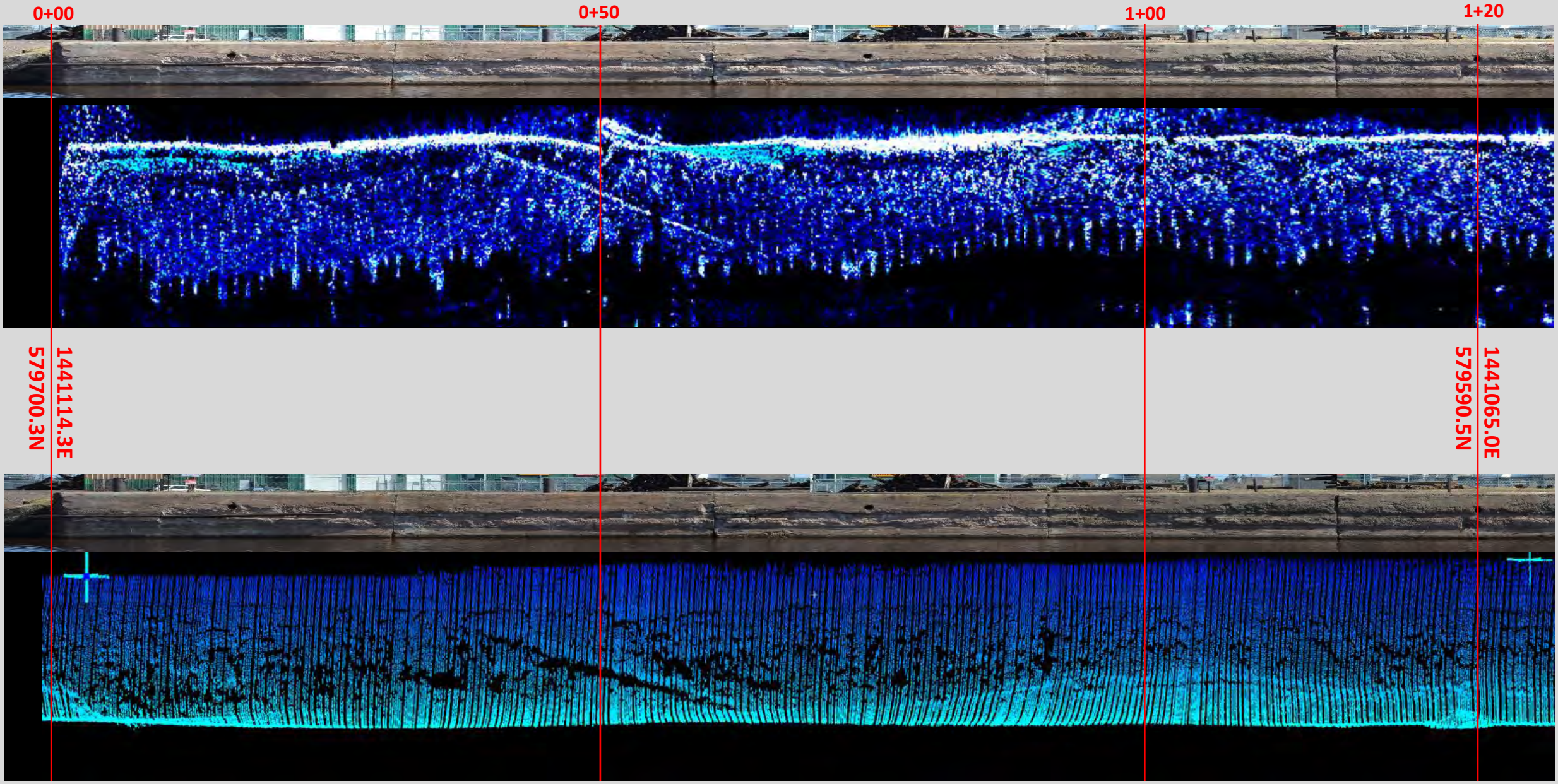
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE SOUTHEAST



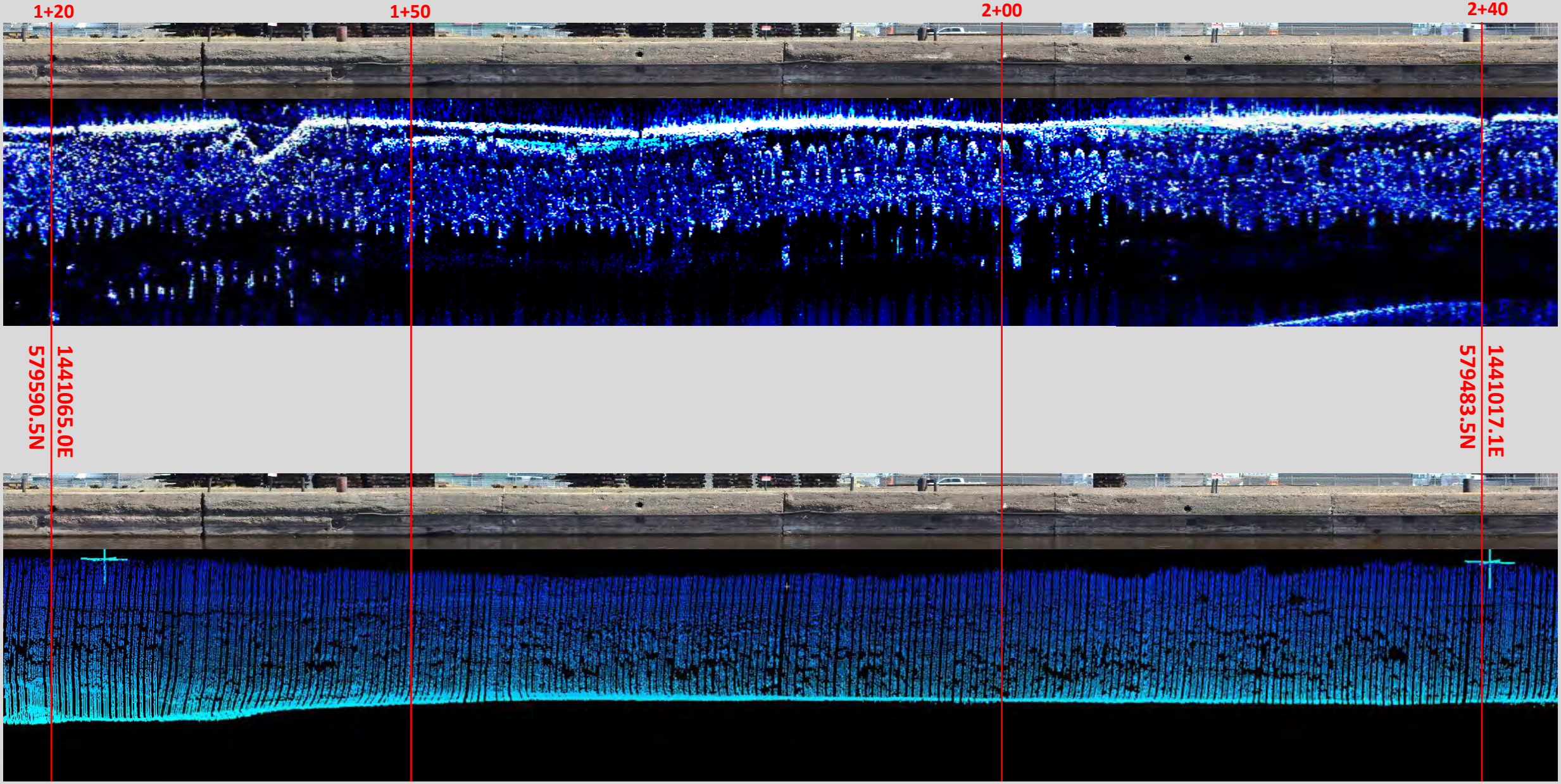
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE SOUTHEAST - 1



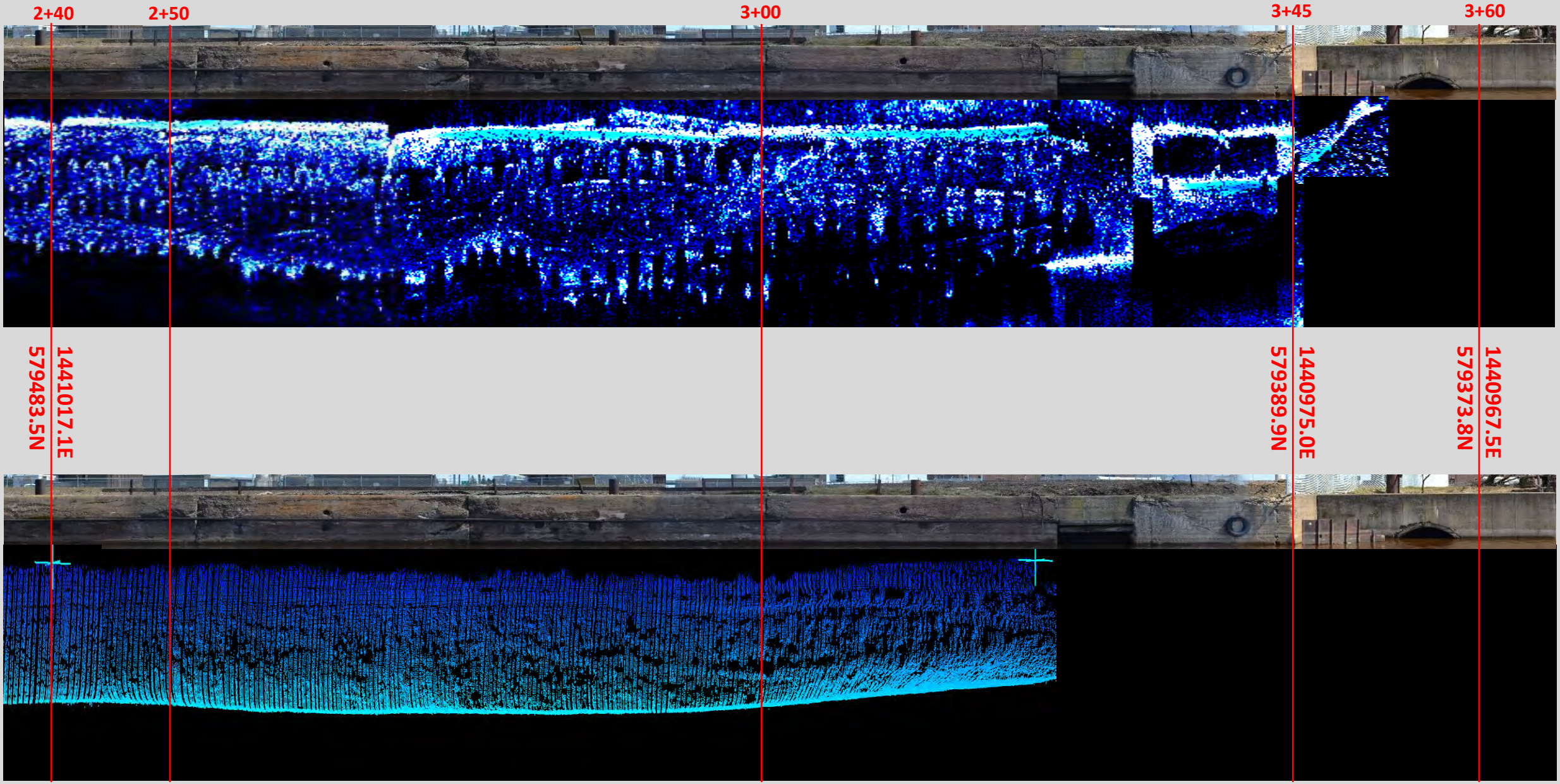
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE SOUTHEAST - 2



PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

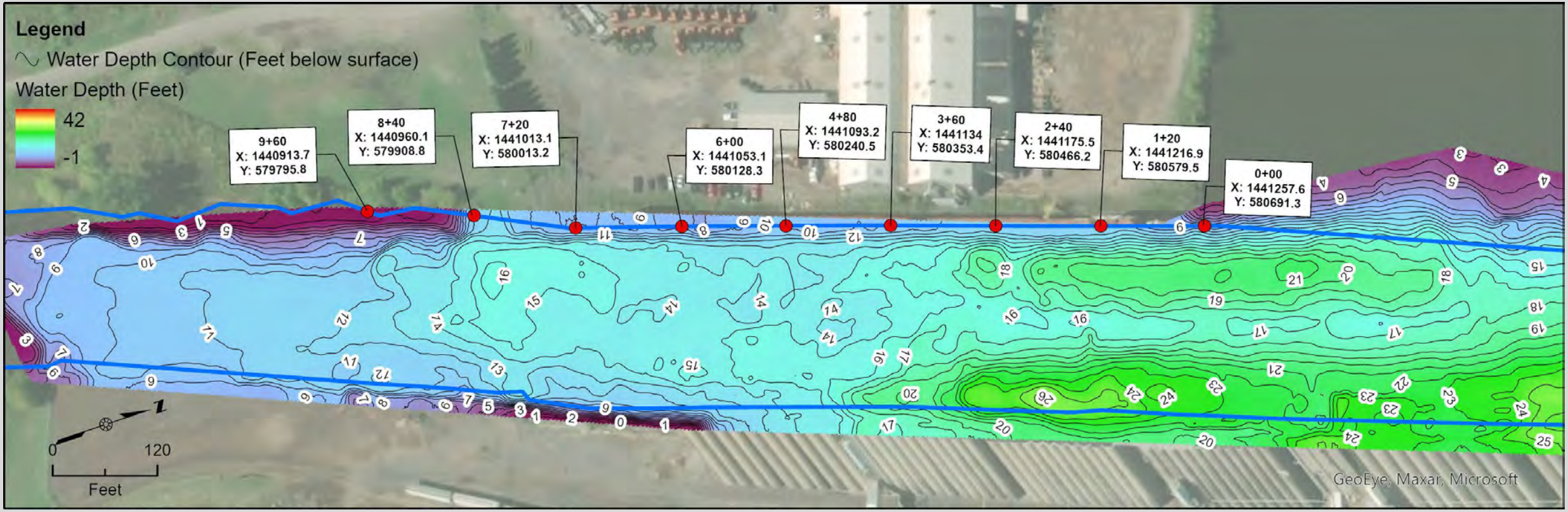
TOWER AVENUE SOUTHEAST - 3



PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

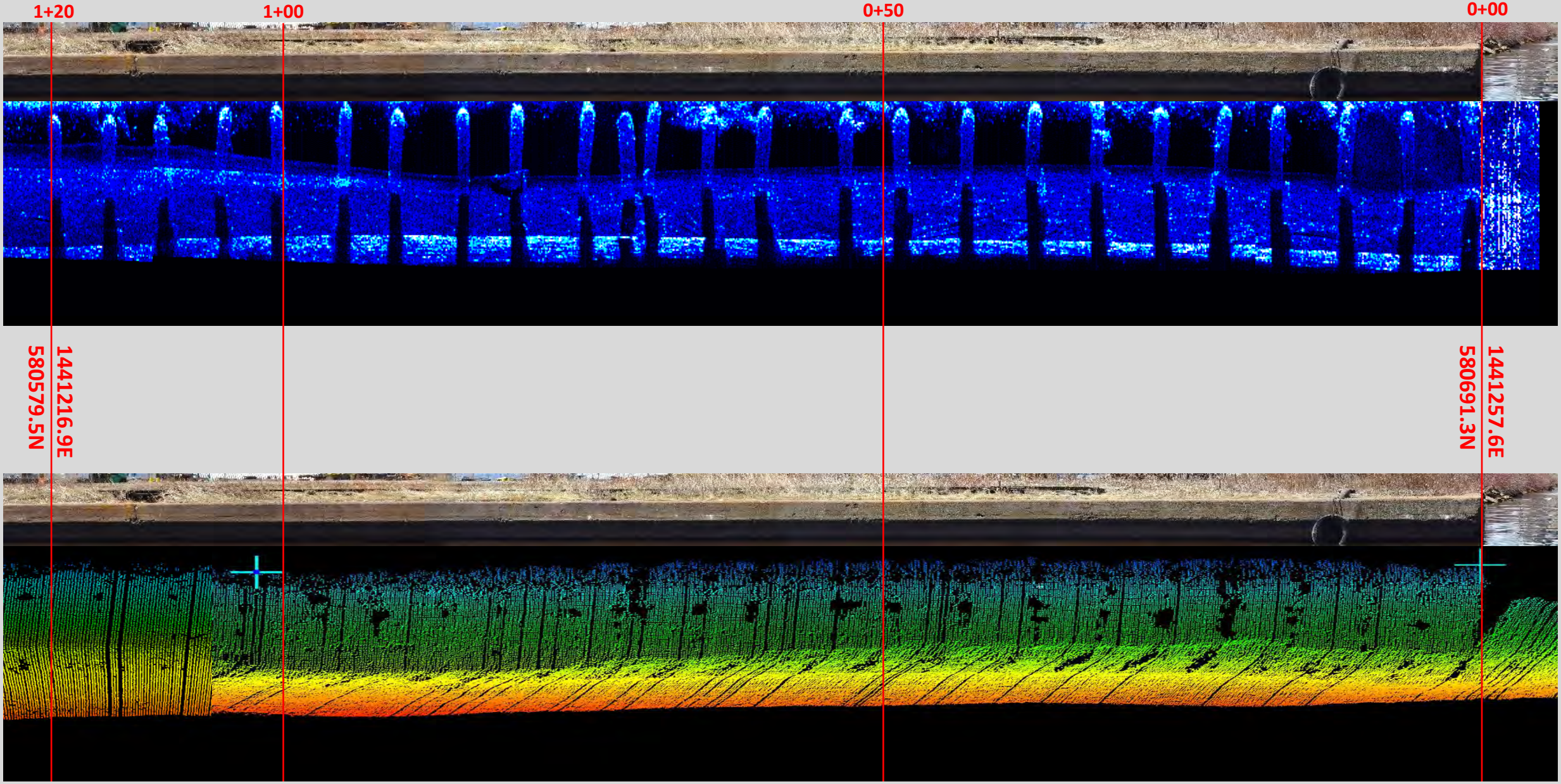
10 feet

TOWER AVENUE WEST



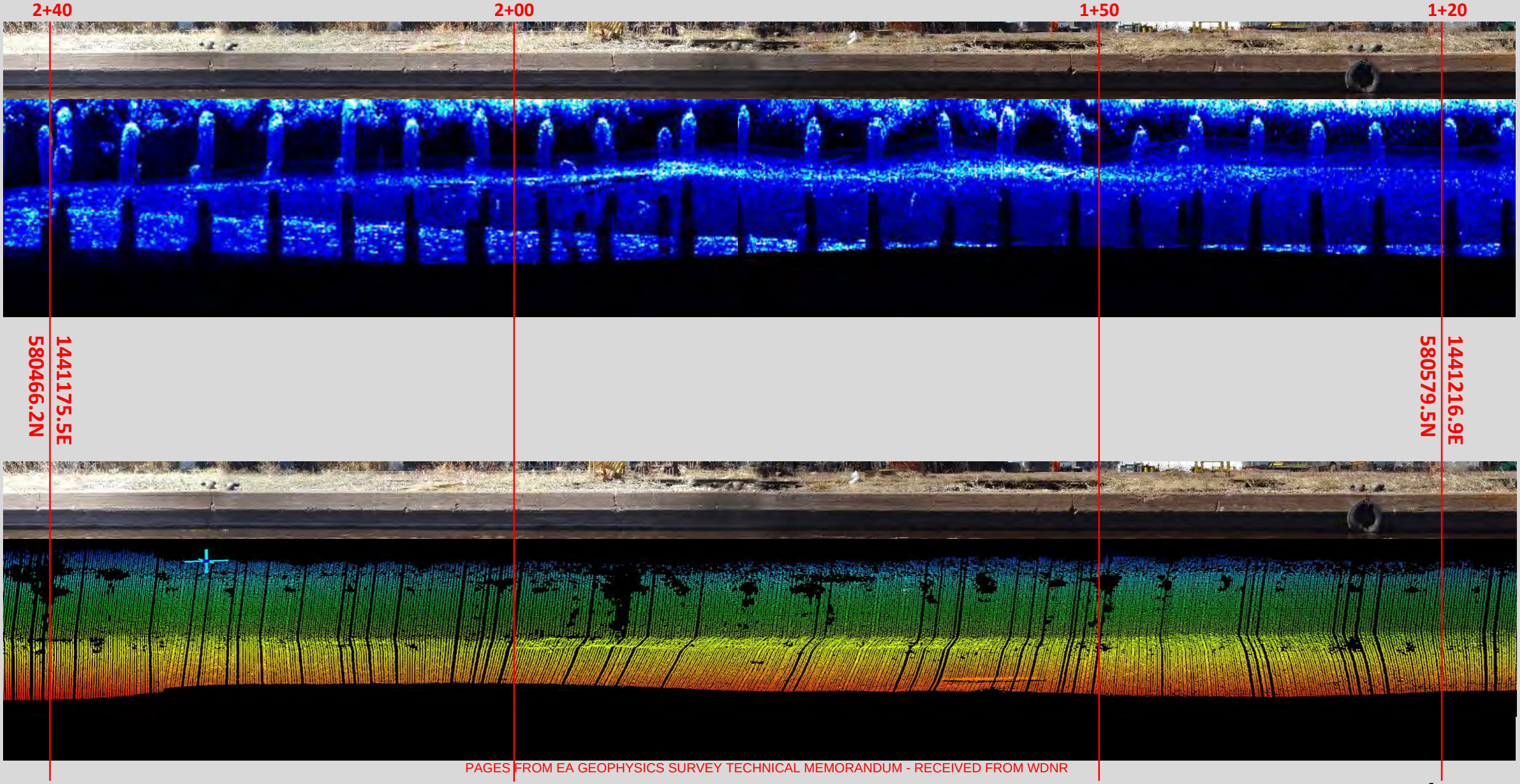
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE WEST - 1



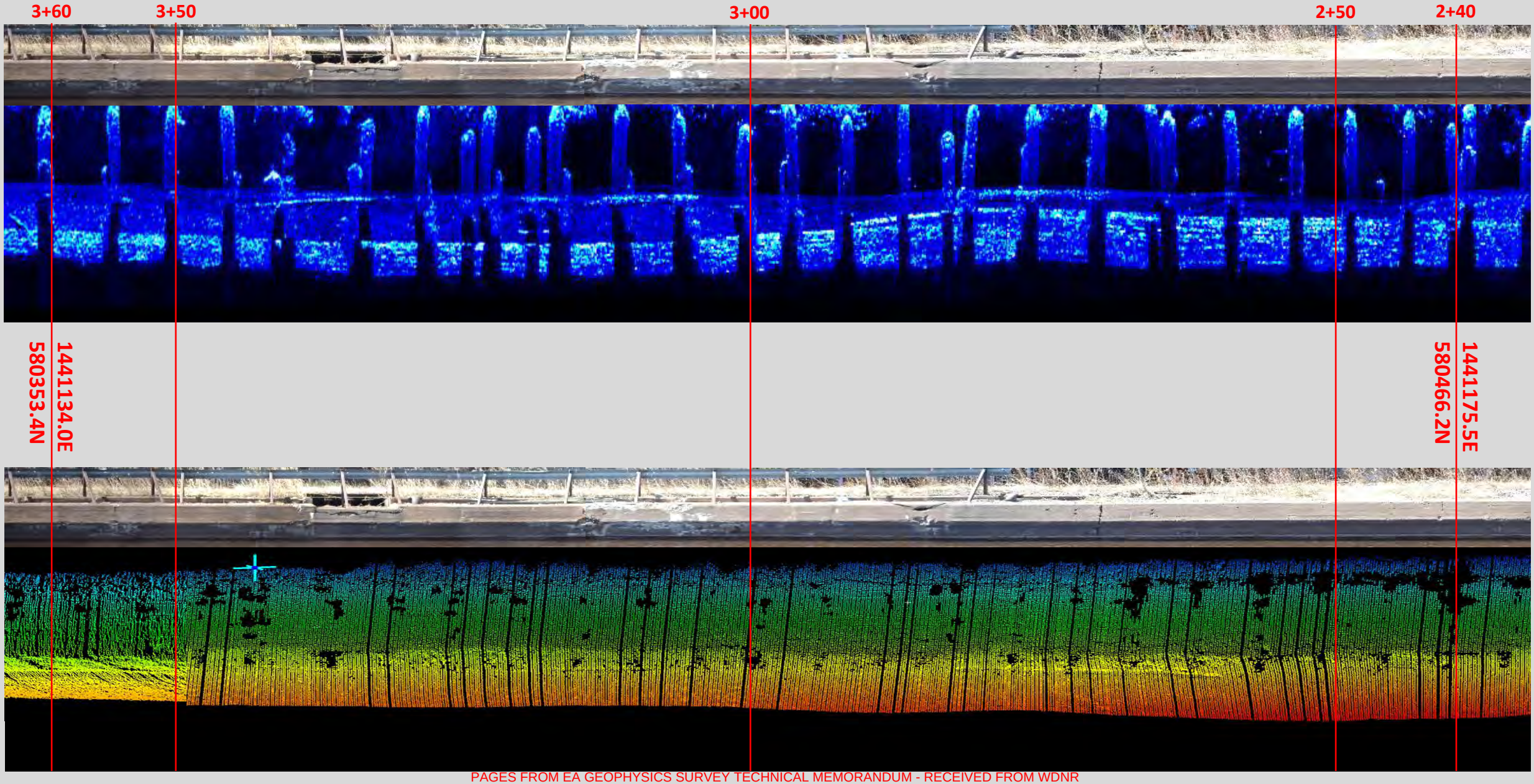
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE WEST - 2



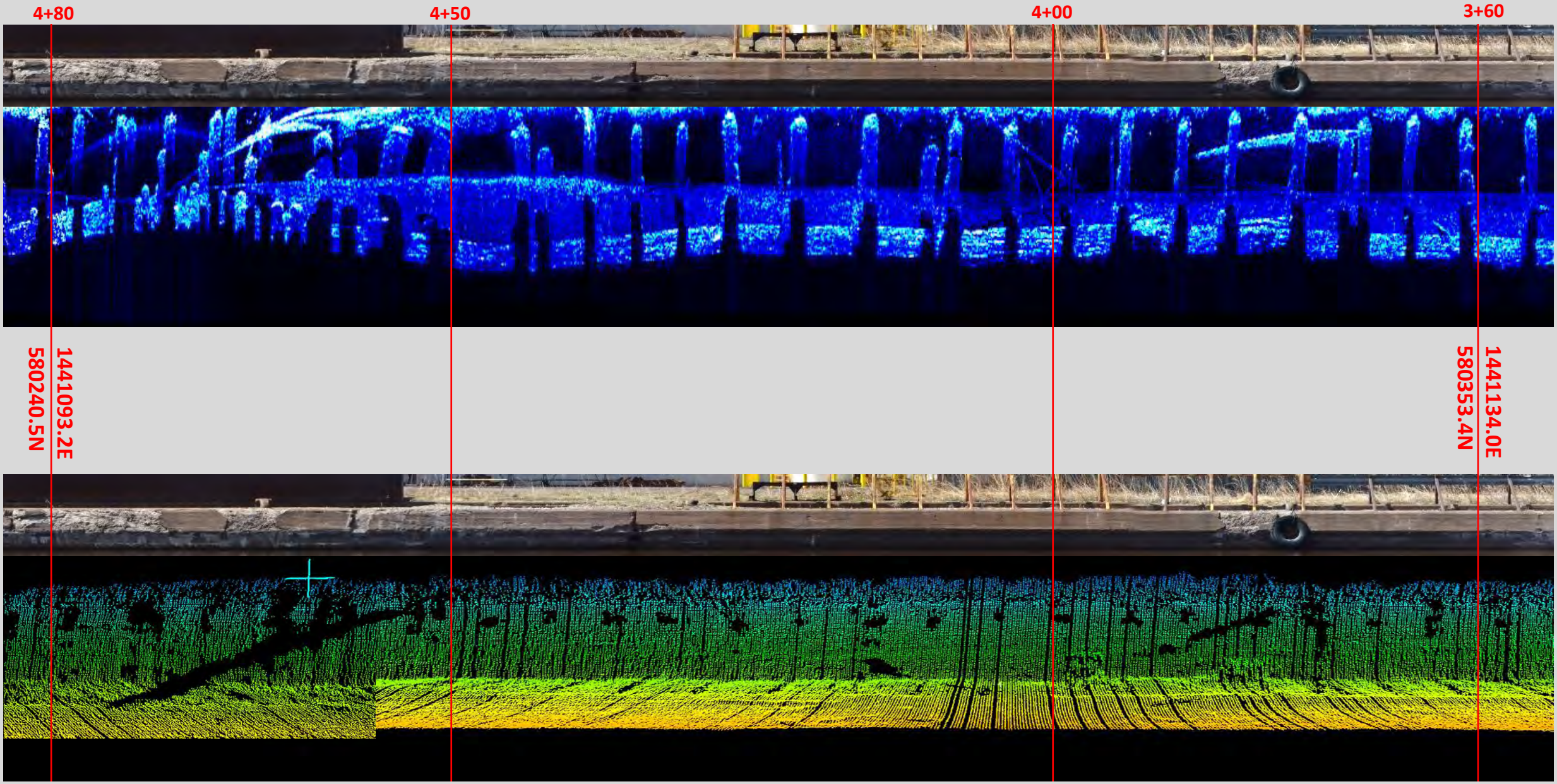
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE WEST - 3



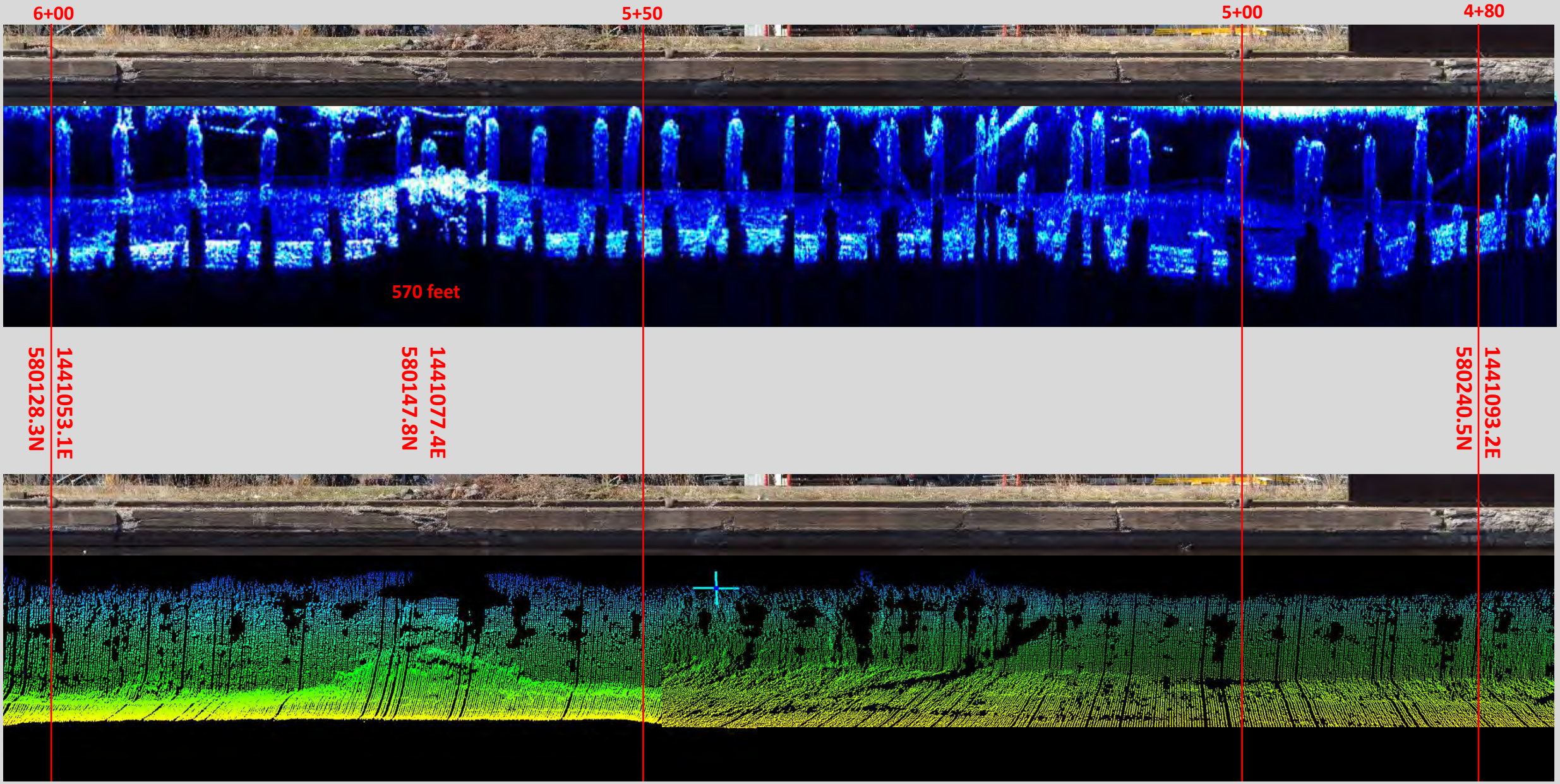
PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE WEST - 4



PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

TOWER AVENUE WEST - 5



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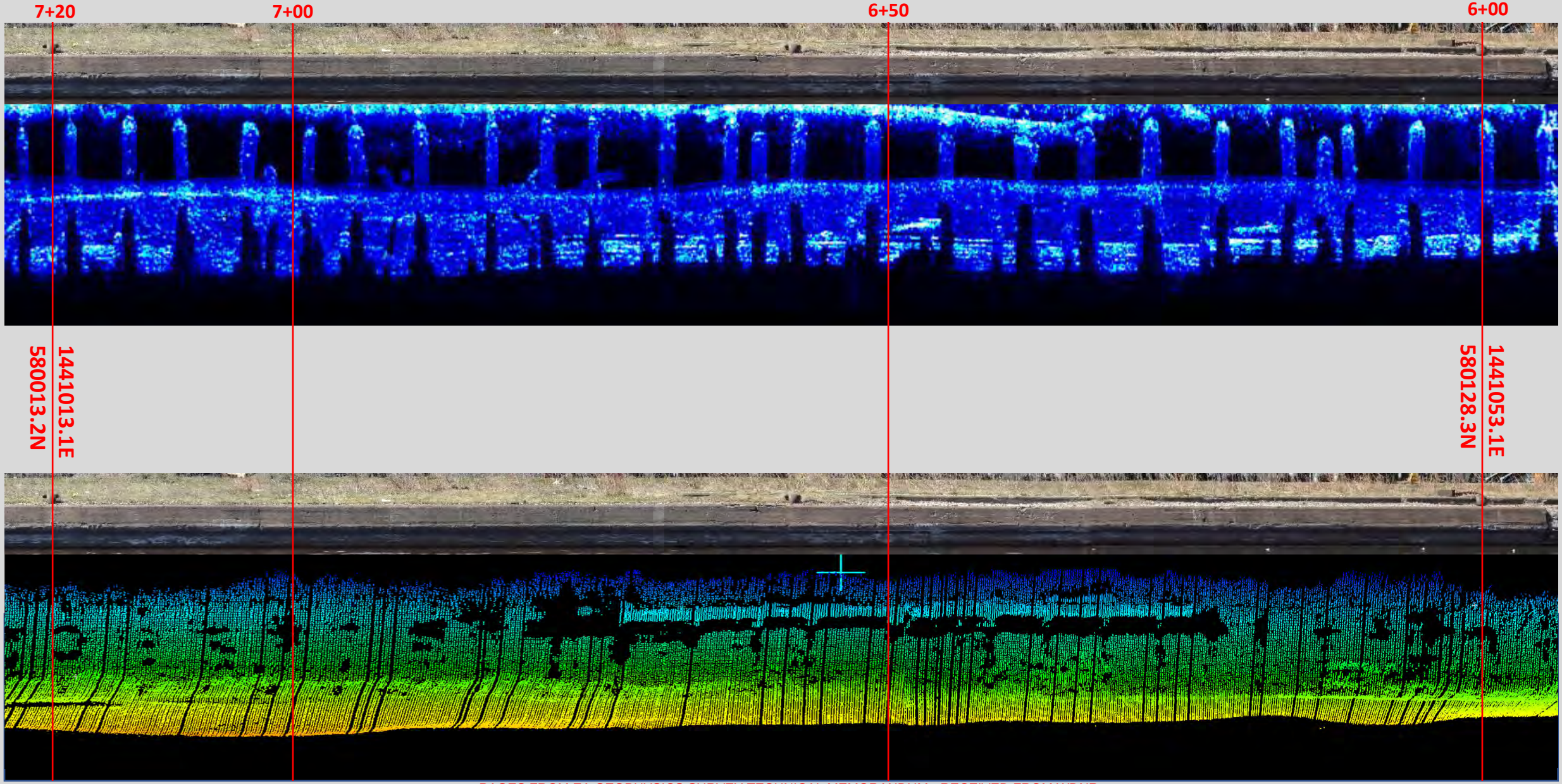
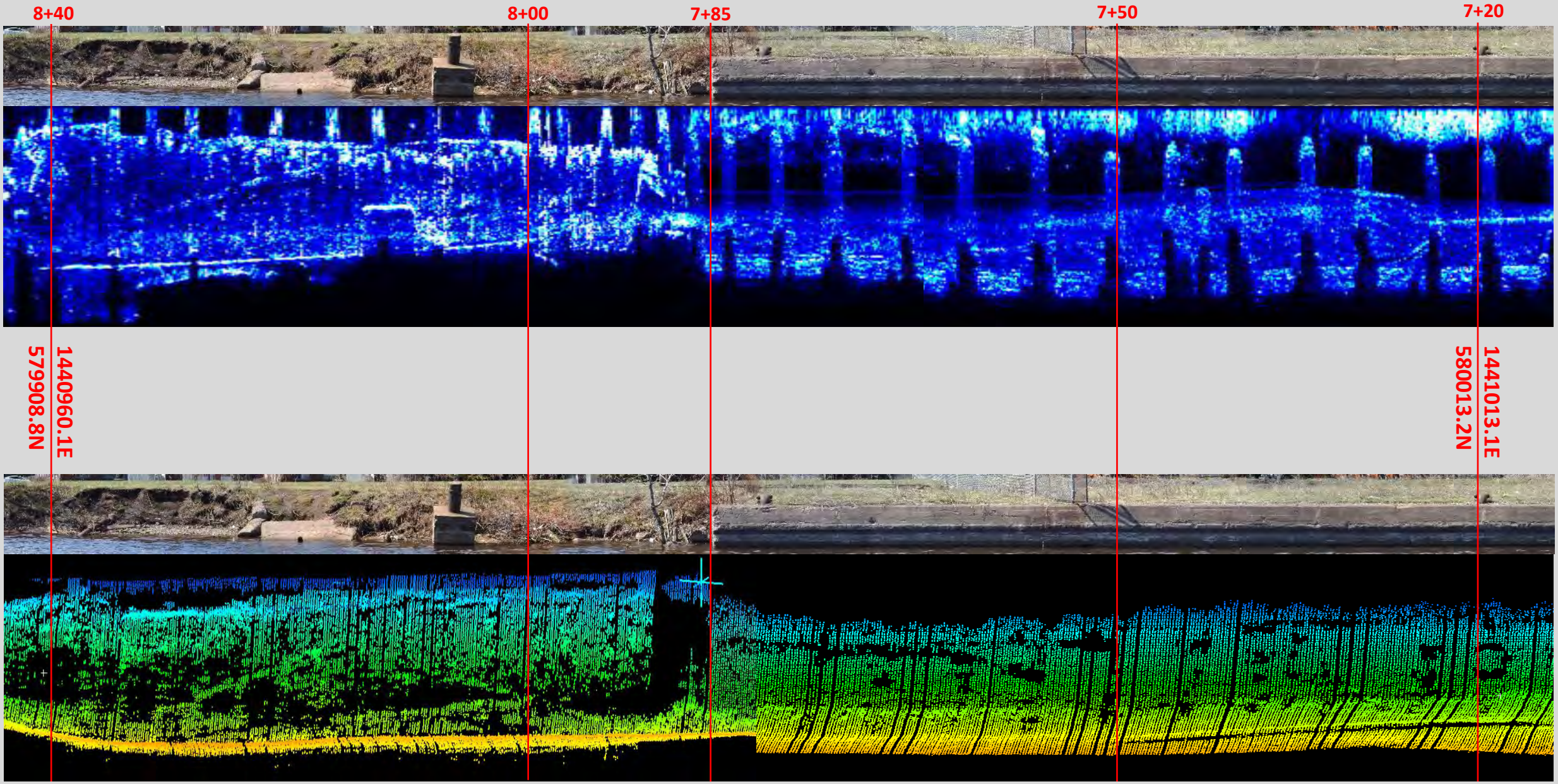
TOWER AVENUE WEST - 6



PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

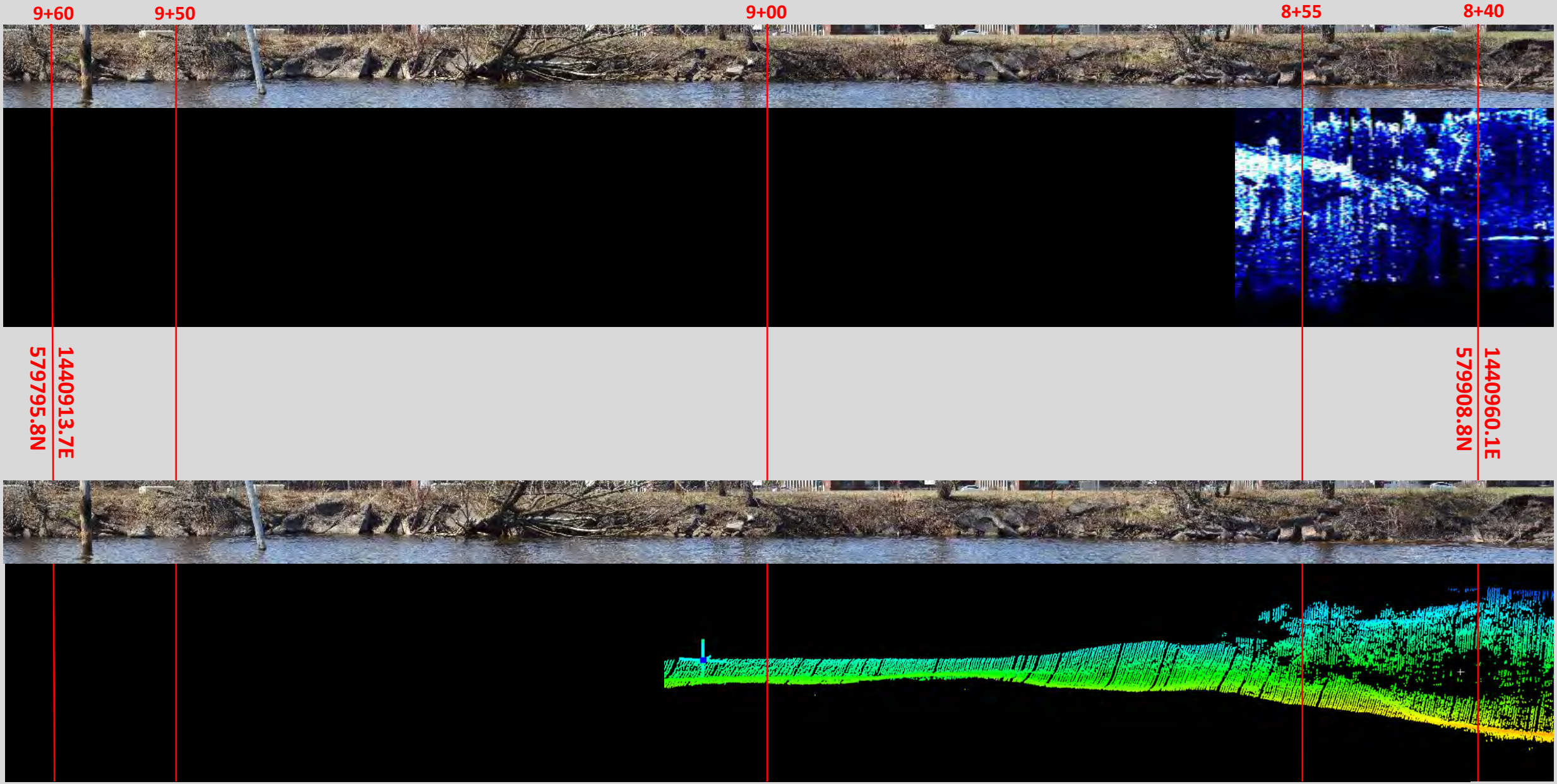
TOWER AVENUE WEST - 7



PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

10 feet

TOWER AVENUE WEST - 8



PAGES FROM EA GEOPHYSICS SURVEY TECHNICAL MEMORANDUM - RECEIVED FROM WDNR

Appendix C.3

2022 Sediment Sampling Logs and Index Test Results

AECOM	OWNER: **Wisconsin Department of Natural Resources**	LOG OF BORING NUMBER: **2022-GT-TA-01**
	PROJECT NAME: **Superior Slips WDNR**	ARCHITECT-ENGINEER: **AECOM**

SITE LOCATION: **Tower Avenue Slip, Superior, WI**

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}	PHOTO-IONIZATION DETECTOR READING (PPM)	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} (1 2 3 4 5) / PLASTIC LIMIT % / WATER CONTENT % / LIQUID LIMIT % (10 20 30 40 50) / STANDARD PENETRATION BLOWS/(FT) (10 20 30 40 50)
SURFACE ELEVATION							
0.0	0.0-3.0	VC		Sandy Organic Silt - brown, wet - coal and plant roots - hydrocarbon odour - very soft		<0.1	
1.0							
2.0							
3.0							
4.0	3.0-4.5	VC			44	<0.1	91.8
				4.7			
5.0				Well Graded Sand - brown, wet - hydrocarbon odour, no staining - loose			
	4.5-6.0	VC		5.1	53	<0.1	79.1
6.0				Sandy Organic Silt - brown, wet - peaty odour, no staining - soft		<0.1	
7.0	6.0-8.0	VC					
8.0				8.0 Refusal at 8.0 feet Bottom of borehole at 8.0 feet			

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING: **46.73795**	BORING STARTED: **7/25/22**	AECOM OFFICE: **Milwaukee, WI**	
EASTING: **-92.10333**	BORING COMPLETED: **7/25/22**	ENTERED BY: **MLB**	SHEET NO.: **1** OF: **1**
WL: **0.0**	RIG/FOREMAN: **Russfelder P3/DG / Affiliated**	APP'D BY:	AECOM JOB NO.:

AECOM LOG 60685299_TA SLIP.GPJ FS_DATATEMPLATE.GDT 11/15/22

AECOM	OWNER: **Wisconsin Department of Natural Resources**	LOG OF BORING NUMBER: **2022-GT-TA-02**
	PROJECT NAME: **Superior Slips WDNR**	ARCHITECT-ENGINEER: **AECOM**

SITE LOCATION: **Tower Avenue Slip, Superior, WI**

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}	PHOTO-IONIZATION DETECTOR READING (PPM)	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} (1 2 3 4 5) / PLASTIC LIMIT % / WATER CONTENT % / LIQUID LIMIT % (10 20 30 40 50) / STANDARD PENETRATION BLOWS/(FT) (10 20 30 40 50)
SURFACE ELEVATION							
1.0	0.0-1.5	VC		Sandy Organic Clay - brown, wet - no odour, no staining - very soft		<0.1	
2.0	1.5-3.0	VC			64	<0.1	●
3.0				3.1			
				Well Graded Sand (SW) - light brown, wet - hydrocarbon odour, no staining - dense			
4.0				3.8 Silt (ML) - light brown, wet - no odour, no staining - cohesive, medium stiff			
5.0	3.0-7.3	VC				<0.1	
6.0							
7.0							
7.3				7.3 Refusal at 8.0 feet Bottom of borehole at 8.0 feet			

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING: **46.7398**	BORING STARTED: **7/25/22**	AECOM OFFICE: **Milwaukee, WI**	
EASTING: **-92.10235**	BORING COMPLETED: **7/25/22**	ENTERED BY: **MLB**	SHEET NO.: **1** OF: **1**
WL: **0.0**	RIG/FOREMAN: **Russfelder P3/DG / Affiliated**	APP'D BY:	AECOM JOB NO.:

AECOM LOG 60685299_TA SLIP.GPJ FS_DATATEMPLATE.GDT 11/15/22

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

SAMPLE SUMMARY

Project: 60685299 T.6 SUPERIOR SLIPS
Pace Project No.: 40249166

Lab ID	Sample ID	Matrix	Date Collected	Date Received
40249166001	2022-GT-OB-01(2-3.5)	Solid	07/26/22 14:00	08/02/22 10:20
40249166002	2022-GT-OB-01(5-6.5)	Solid	07/26/22 14:00	08/02/22 10:20
40249166003	2022-GT-OB-02(5-6.5)	Solid	07/26/22 14:15	08/02/22 10:20
40249166004	2022-GT-GM-01(4-5.3)	Solid	07/28/22 08:00	08/02/22 10:20
40249166005	2022-GT-GM-02(2-3.5)	Solid	07/28/22 07:45	08/02/22 10:20
40249166006	2022-GT-GM-02(5-6)	Solid	07/28/22 07:45	08/02/22 10:20
40249166007	2022-GT-CS-01(0.5-2)	Solid	07/28/22 17:30	08/02/22 10:20
40249166008	2022-GT-CS-02(1.2-2.8)	Solid	07/28/22 17:15	08/02/22 10:20
40249166009	2022-GT-TA-01(3-4.5)	Solid	07/30/22 12:30	08/02/22 10:20
40249166010	2022-GT-TA-01(4.5-6)	Solid	07/30/22 12:30	08/02/22 10:20
40249166011	2022-GT-TA-02(1.5-3)	Solid	07/30/22 12:15	08/02/22 10:20

Pace Analytical Services, LLC
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Green Bay, WI 54302
(920)469-2436

SUMMARY OF DETECTION

Project: 60685299 T.6 SUPERIOR SLIPS
Pace Project No.: 40249166

Lab Sample ID / Method	Client Sample ID / Parameters	Result	Units	Report Limit	Analyzed	Qualifiers
40249166008	**2022-GT-CS-02(1.2-2.8)**					
ASTM D6913/D7928	Sieve #40	95.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #60	63.2	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #100	22.8	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #140	10.4	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #200	5.4	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 1 Passing	2.7	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 2 Passing	2.7	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 3 Passing	2.7	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 4 Passing	2.7	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 5 Passing	1.9	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 6 Passing	1.9	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 7 Passing	1.9	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 8 Passing	1.6	%		08/05/22 19:41	
Lloyd Kahn	Total Organic Carbon	6010	mg/kg	799	08/09/22 05:32	
40249166009	**2022-GT-TA-01(3-4.5)**					
ASTM D2974-87	Percent Moisture	41.1	%	0.10	08/04/22 12:01	
ASTM D6913/D7928	Sieve 3.0"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 2.0"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 1.5"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 1.0"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 0.75"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 0.375"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #4	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #10	98.7	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #20	90.6	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #40	78.2	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #60	68.1	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #100	61.8	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #140	59.3	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #200	57.4	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 1 Passing	32.9	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 2 Passing	29.4	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 3 Passing	29.4	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 4 Passing	22.4	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 5 Passing	20.6	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 6 Passing	17.1	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 7 Passing	11.8	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 8 Passing	7.8	%		08/05/22 19:41	
Lloyd Kahn	Total Organic Carbon	91200	mg/kg	3970	08/09/22 05:38	
40249166010	**2022-GT-TA-01(4.5-6)**					
ASTM D2974-87	Percent Moisture	28.8	%	0.10	08/04/22 12:01	
ASTM D6913/D7928	Sieve 3.0"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 2.0"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 1.5"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 1.0"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 0.75"	100.0	%		08/05/22 19:41	

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
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Green Bay, WI 54302
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SUMMARY OF DETECTION

Project: 60685299 T.6 SUPERIOR SLIPS
Pace Project No.: 40249166

Lab Sample ID / Method	Client Sample ID / Parameters	Result	Units	Report Limit	Analyzed	Qualifiers
40249166010	**2022-GT-TA-01(4.5-6)**					
ASTM D6913/D7928	Sieve 0.375"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #4	97.3	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #10	94.5	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #20	87.9	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #40	75.4	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #60	60.6	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #100	48.8	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #140	45.1	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #200	41.2	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 1 Passing	29.4	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 2 Passing	22.2	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 3 Passing	16.8	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 4 Passing	13.7	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 5 Passing	11.9	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 6 Passing	11.9	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 7 Passing	8.3	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 8 Passing	6.1	%		08/05/22 19:41	
Lloyd Kahn	Total Organic Carbon	12500	mg/kg	1670	08/09/22 05:44	
40249166011	**2022-GT-TA-02(1.5-3)**					
ASTM D2974-87	Percent Moisture	52.3	%	0.10	08/04/22 12:01	
ASTM D6913/D7928	Sieve 3.0"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 2.0"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 1.5"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 1.0"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 0.75"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve 0.375"	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #4	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #10	100.0	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #20	99.9	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #40	99.6	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #60	98.8	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #100	96.4	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #140	94.4	%		08/05/22 19:41	
ASTM D6913/D7928	Sieve #200	89.6	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 1 Passing	68.5	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 2 Passing	56.9	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 3 Passing	53.1	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 4 Passing	47.3	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 5 Passing	41.6	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 6 Passing	35.8	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 7 Passing	30.1	%		08/05/22 19:41	
ASTM D6913/D7928	Hydrometer 8 Passing	21.9	%		08/05/22 19:41	
Lloyd Kahn	Total Organic Carbon	35500	mg/kg	2630	08/09/22 05:49	

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

ANALYTICAL RESULTS

Project: 60685299 T.6 SUPERIOR SLIPS
Pace Project No.: 40249166

Sample: 2022-GT-TA-01(3-4.5) **Lab ID: 40249166009** Collected: 07/30/22 12:30 Received: 08/02/22 10:20 Matrix: Solid

Results reported on a "dry weight" basis and are adjusted for percent moisture, sample size and any dilutions.

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
Percent Moisture	Analytical Method: ASTM D2974-87 Pace Analytical Services - Green Bay								
Percent Moisture	**41.1**	%	0.10	0.10	1		08/04/22 12:01		
ASTM D6913D7928 GrainsizeHydro	Analytical Method: ASTM D6913/D7928 Pace Analytical Services - Green Bay								
Sieve 3.0"	**100.0**	%			1		08/05/22 19:41		
Sieve 2.0"	**100.0**	%			1		08/05/22 19:41		
Sieve 1.5"	**100.0**	%			1		08/05/22 19:41		
Sieve 1.0"	**100.0**	%			1		08/05/22 19:41		
Sieve 0.75"	**100.0**	%			1		08/05/22 19:41		
Sieve 0.375"	**100.0**	%			1		08/05/22 19:41		
Sieve #4	**100.0**	%			1		08/05/22 19:41		
Sieve #10	**98.7**	%			1		08/05/22 19:41		
Sieve #20	**90.6**	%			1		08/05/22 19:41		
Sieve #40	**78.2**	%			1		08/05/22 19:41		
Sieve #60	**68.1**	%			1		08/05/22 19:41		
Sieve #100	**61.8**	%			1		08/05/22 19:41		
Sieve #140	**59.3**	%			1		08/05/22 19:41		
Sieve #200	**57.4**	%			1		08/05/22 19:41		
Hydrometer 1 Passing	**32.9**	%			1		08/05/22 19:41		
Hydrometer 2 Passing	**29.4**	%			1		08/05/22 19:41		
Hydrometer 3 Passing	**29.4**	%			1		08/05/22 19:41		
Hydrometer 4 Passing	**22.4**	%			1		08/05/22 19:41		
Hydrometer 5 Passing	**20.6**	%			1		08/05/22 19:41		
Hydrometer 6 Passing	**17.1**	%			1		08/05/22 19:41		
Hydrometer 7 Passing	**11.8**	%			1		08/05/22 19:41		
Hydrometer 8 Passing	**7.8**	%			1		08/05/22 19:41		
TOC via Lloyd Kahn	Analytical Method: Lloyd Kahn Pace Analytical Services - Green Bay								
Total Organic Carbon	**91200**	mg/kg	3970	2010	1		08/09/22 05:38	7440-44-0	

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

ANALYTICAL RESULTS

Project: 60685299 T.6 SUPERIOR SLIPS
Pace Project No.: 40249166

Sample: 2022-GT-TA-01(4.5-6) **Lab ID: 40249166010** Collected: 07/30/22 12:30 Received: 08/02/22 10:20 Matrix: Solid

Results reported on a "dry weight" basis and are adjusted for percent moisture, sample size and any dilutions.

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
Percent Moisture	Analytical Method: ASTM D2974-87 Pace Analytical Services - Green Bay								
Percent Moisture	**28.8**	%	0.10	0.10	1		08/04/22 12:01		
ASTM D6913D7928 GrainsizeHydro	Analytical Method: ASTM D6913/D7928 Pace Analytical Services - Green Bay								
Sieve 3.0"	**100.0**	%			1		08/05/22 19:41		
Sieve 2.0"	**100.0**	%			1		08/05/22 19:41		
Sieve 1.5"	**100.0**	%			1		08/05/22 19:41		
Sieve 1.0"	**100.0**	%			1		08/05/22 19:41		
Sieve 0.75"	**100.0**	%			1		08/05/22 19:41		
Sieve 0.375"	**100.0**	%			1		08/05/22 19:41		
Sieve #4	**97.3**	%			1		08/05/22 19:41		
Sieve #10	**94.5**	%			1		08/05/22 19:41		
Sieve #20	**87.9**	%			1		08/05/22 19:41		
Sieve #40	**75.4**	%			1		08/05/22 19:41		
Sieve #60	**60.6**	%			1		08/05/22 19:41		
Sieve #100	**48.8**	%			1		08/05/22 19:41		
Sieve #140	**45.1**	%			1		08/05/22 19:41		
Sieve #200	**41.2**	%			1		08/05/22 19:41		
Hydrometer 1 Passing	**29.4**	%			1		08/05/22 19:41		
Hydrometer 2 Passing	**22.2**	%			1		08/05/22 19:41		
Hydrometer 3 Passing	**16.8**	%			1		08/05/22 19:41		
Hydrometer 4 Passing	**13.7**	%			1		08/05/22 19:41		
Hydrometer 5 Passing	**11.9**	%			1		08/05/22 19:41		
Hydrometer 6 Passing	**11.9**	%			1		08/05/22 19:41		
Hydrometer 7 Passing	**8.3**	%			1		08/05/22 19:41		
Hydrometer 8 Passing	**6.1**	%			1		08/05/22 19:41		
TOC via Lloyd Kahn	Analytical Method: Lloyd Kahn Pace Analytical Services - Green Bay								
Total Organic Carbon	**12500**	mg/kg	1670	842	1		08/09/22 05:44	7440-44-0	

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

ANALYTICAL RESULTS

Project: 60685299 T.6 SUPERIOR SLIPS
Pace Project No.: 40249166

Sample: 2022-GT-TA-02(1.5-3) **Lab ID: 40249166011** Collected: 07/30/22 12:15 Received: 08/02/22 10:20 Matrix: Solid

Results reported on a "dry weight" basis and are adjusted for percent moisture, sample size and any dilutions.

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
Percent Moisture	Analytical Method: ASTM D2974-87 Pace Analytical Services - Green Bay								
Percent Moisture	**52.3**	%	0.10	0.10	1		08/04/22 12:01		
ASTM D6913D7928 GrainsizeHydro	Analytical Method: ASTM D6913/D7928 Pace Analytical Services - Green Bay								
Sieve 3.0"	**100.0**	%			1		08/05/22 19:41		
Sieve 2.0"	**100.0**	%			1		08/05/22 19:41		
Sieve 1.5"	**100.0**	%			1		08/05/22 19:41		
Sieve 1.0"	**100.0**	%			1		08/05/22 19:41		
Sieve 0.75"	**100.0**	%			1		08/05/22 19:41		
Sieve 0.375"	**100.0**	%			1		08/05/22 19:41		
Sieve #4	**100.0**	%			1		08/05/22 19:41		
Sieve #10	**100.0**	%			1		08/05/22 19:41		
Sieve #20	**99.9**	%			1		08/05/22 19:41		
Sieve #40	**99.6**	%			1		08/05/22 19:41		
Sieve #60	**98.8**	%			1		08/05/22 19:41		
Sieve #100	**96.4**	%			1		08/05/22 19:41		
Sieve #140	**94.4**	%			1		08/05/22 19:41		
Sieve #200	**89.6**	%			1		08/05/22 19:41		
Hydrometer 1 Passing	**68.5**	%			1		08/05/22 19:41		
Hydrometer 2 Passing	**56.9**	%			1		08/05/22 19:41		
Hydrometer 3 Passing	**53.1**	%			1		08/05/22 19:41		
Hydrometer 4 Passing	**47.3**	%			1		08/05/22 19:41		
Hydrometer 5 Passing	**41.6**	%			1		08/05/22 19:41		
Hydrometer 6 Passing	**35.8**	%			1		08/05/22 19:41		
Hydrometer 7 Passing	**30.1**	%			1		08/05/22 19:41		
Hydrometer 8 Passing	**21.9**	%			1		08/05/22 19:41		
TOC via Lloyd Kahn	Analytical Method: Lloyd Kahn Pace Analytical Services - Green Bay								
Total Organic Carbon	**35500**	mg/kg	2630	1330	1		08/09/22 05:49	7440-44-0	

REPORT OF LABORATORY ANALYSIS

TETRA TECH

DRY DENSITY AND MOISTURE CONTENT OF SHELBY TUBE SAMPLES - CALIPER METHOD

(WORKSHEET ONLY)

Client:	Pace Analytical		
Project:	No. 40249166 (60685299 Superior Slips)		
Tested By:	RJP		
Prepared By:	Robert J Peeters	**Date Tested:**	August 16-18, 2022
Reviewed By:		**Date Reviewed:**	

Date Sampled:	7/30/22
Sample No.	40249166-009
Location:	2022-GT-TA-01
Depth:	3.0'-4.5'

Ww = Weight in Air-Wet (gms)
h = Average Height of Sample (inches)
d = Average Diameter of Sample (inches)
WD = Dry Weight of Sample (gms)
DW = Wet Density of Soil
V = Volume

Formula = $\frac{3.1416\ (r^2)\ h}{1728}$ = V

Formula = $\frac{Ww}{453.5924}$

Diameter	Height
2.730	14.000
2.730	14.000
2.730	14.000
2.730	14.000
2.730	14.000
Ave. Height	14.000
Ave. Diameter	2.730
Vol. Of Sample	0.04742
Area of Sample	5.8535

Wet Weight of Soil	gm	1822.0
Dry Weight of Soil	gm	950.0
Loss	gm	872.0
Water Content	%	91.8
Wet Weight of Perm Sample	gm	1822.0
Wet Soil in Pounds	lbs.	4.0168
Divided By Volume	pcf	84.7
Water Content	%	91.8
Dry Density	pcf	44.2

After Perm-Wet	gm	
After Perm-Dry	gm	
Loss	gm	
Water Content	%	
Dry Density	pcf	

Visual: SANDY ORGANIC SILT, black

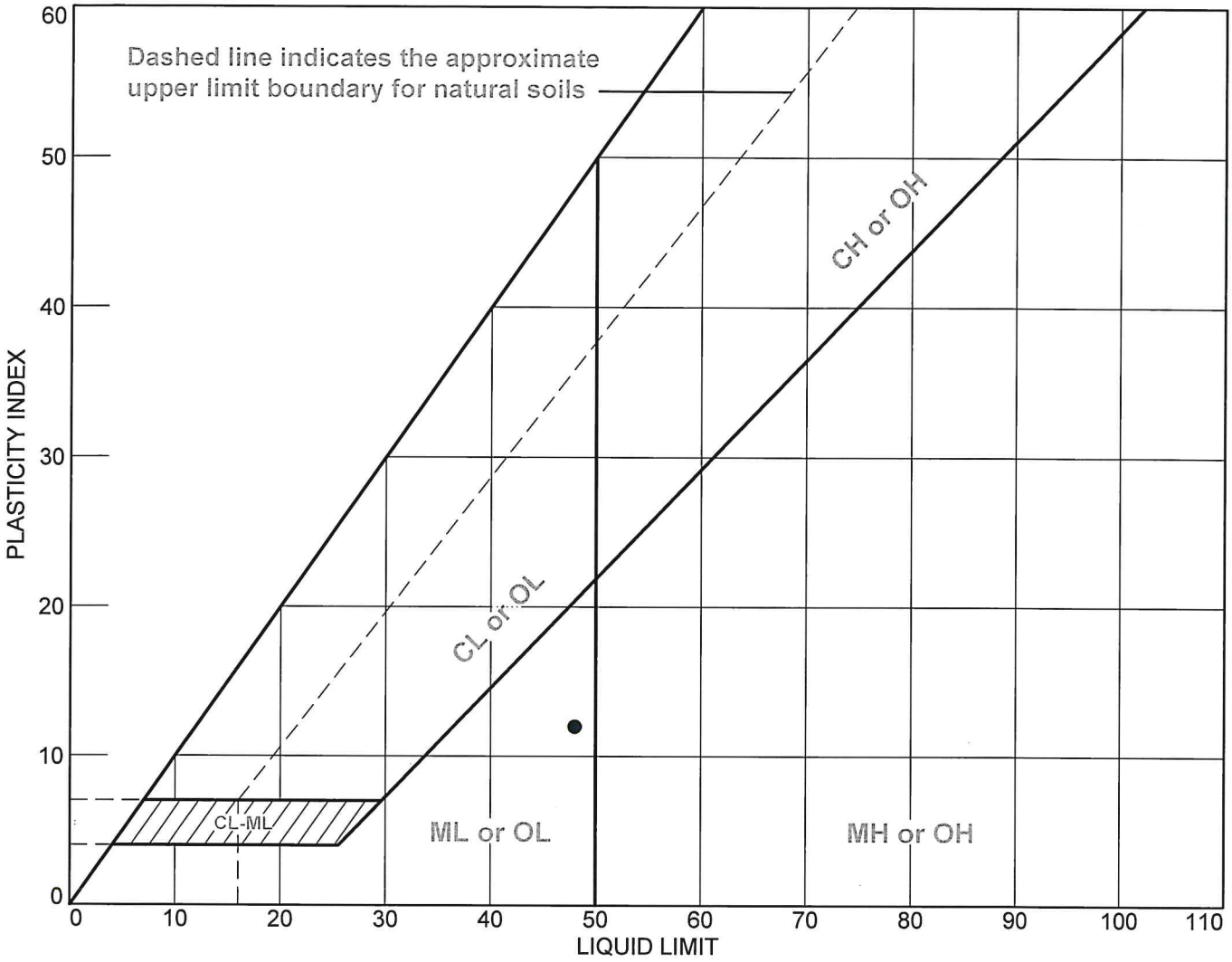
Munsell Color: 10YR 2/1

Lab Equipment:

Scale ID:	DS #5
Micrometer ID:	Lab S6

REVIEWED BY:	Robert R Rouse
DATE REVIEWED:	8/25/22

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Borings	2022-GT-TA-01 (009)	3.0'-4.5'	91.9	36	48	12	

Tetra Tech
2679 Continental Drive
Green Bay, WI 54311

Client: Pace Analytical
Project: 40249166 Superior Slips
Project No.:

Figure

Tested By: MLW **Checked By:** RJP

TETRA TECH

DRY DENSITY AND MOISTURE CONTENT OF SHELBY TUBE SAMPLES - CALIPER METHOD

(WORKSHEET ONLY)

Client:	Pace Analytical
Project:	No. 40249166 (60685299 Superior Slips)
Tested By:	RJP
Prepared By:	Robert J Peeters
Reviewed By:	
Date Tested:	August 16-18, 2022
Date Reviewed:	

Date Sampled:	7/30/22
Sample No.	40249166-010
Location:	2022-GT-TA-01
Depth:	4.5'-6.0'

Ww = Weight in Air-Wet (gms)
h = Average Height of Sample (inches)
d = Average Diameter of Sample (inches)
WD = Dry Weight of Sample (gms)
DW = Wet Density of Soil
V = Volume

Formula = $\frac{3.1416\ (r^2)\ h}{1728}$ = V

Formula = $\frac{Ww}{453.5924}$

Diameter	Height
2.740	14.000
2.740	14.000
2.740	14.000
2.740	14.000
2.740	14.000
Ave. Height	14.000
Ave. Diameter	2.740
Vol. Of Sample	0.04777
Area of Sample	5.8965

Wet Weight of Soil	gm	2065.0
Dry Weight of Soil	gm	1153.0
Loss	gm	912.0
Water Content	%	79.1
Wet Weight of Perm Sample	gm	2065.0
Wet Soil in Pounds	lbs.	4.5525
Divided By Volume	pcf	95.3
Water Content	%	79.1
Dry Density	pcf	53.2

After Perm-Wet	gm	
After Perm-Dry	gm	
Loss	gm	
Water Content	%	
Dry Density	pcf	

Visual: SILTY SAND W/ORGANIC FINES, fine to medium grained, some fuel odor, a little gravel, black

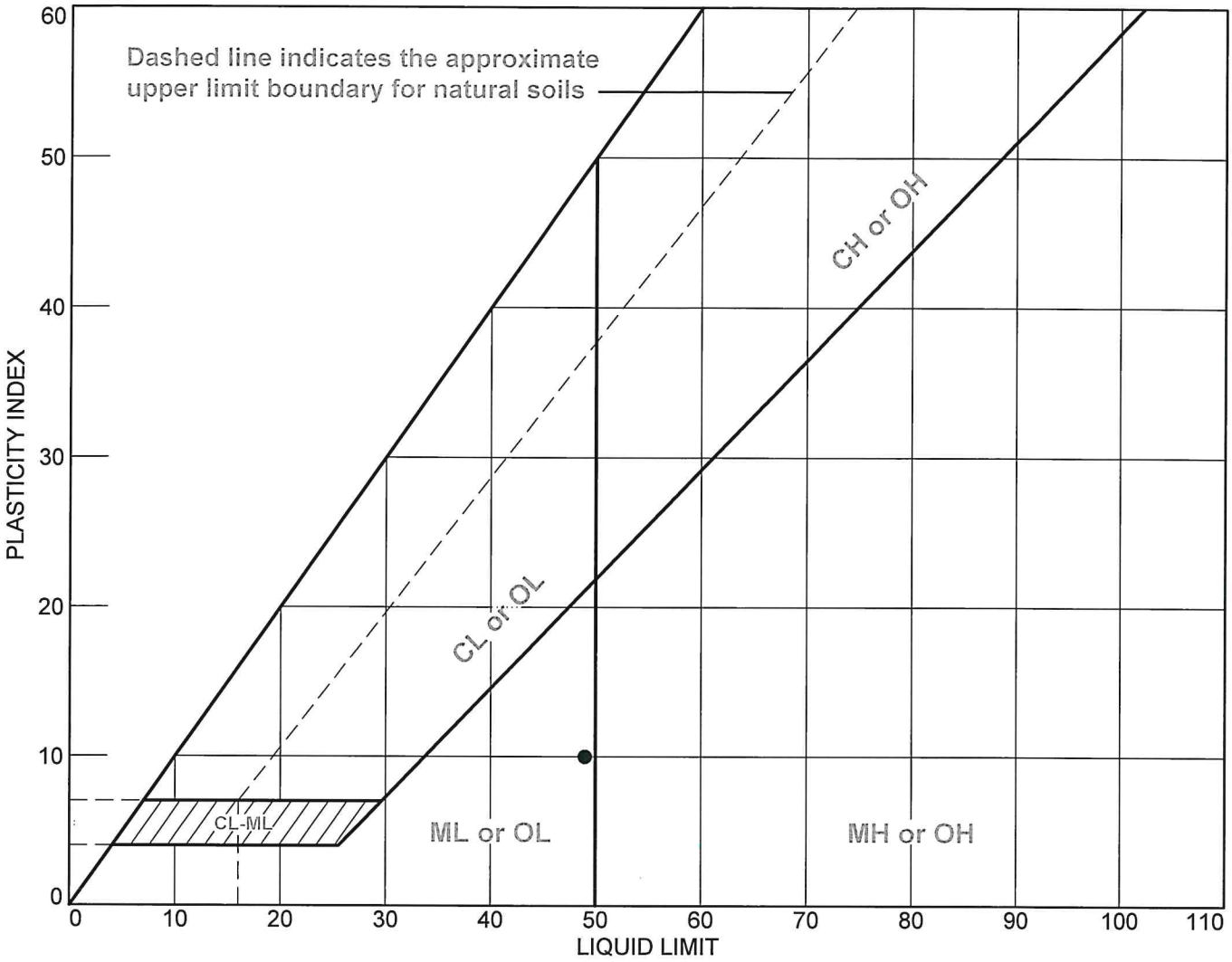
Munsell Color: 10YR 2/1 Black

Lab Equipment:

Scale ID:	DS #5
Micrometer ID:	Lab S6

REVIEWED BY:	Robert R Rouse
DATE REVIEWED:	8/25/22

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Borings	2022-GT-TA-01 (010)	4.5'-6.0'	79.0	39	49	10	

Tetra Tech
2679 Continental Drive
Green Bay, WI 54311

Client: Pace Analytical
Project: 40249166 Superior Slips
Project No.:

Figure

Tested By: MLW **Checked By:** RJP

TETRA TECH

DRY DENSITY AND MOISTURE CONTENT OF SHELBY TUBE SAMPLES - CALIPER METHOD

(WORKSHEET ONLY)

Client:	Pace Analytical		
Project:	No. 40249166 (60685299 Superior Slips)		
Tested By:	RJP		
Prepared By:	Robert J Peeters	**Date Tested:**	August 16-18, 2022
Reviewed By:		**Date Reviewed:**	

Date Sampled:	7/30/22
Sample No.	40249166-011
Location:	2022-GT-TA-02
Depth:	1.5'-3.0'

Ww = Weight in Air-Wet (gms)
h = Average Height of Sample (inches)
d = Average Diameter of Sample (inches)
WD = Dry Weight of Sample (gms)
DW = Wet Density of Soil
V = Volume

Formula = $\frac{3.1416\ (r^2)\ h}{1728}$ = V

Formula = $\frac{Ww}{453.5924}$

Diameter	Height
2.740	17.000
2.740	17.000
2.740	17.000
2.740	17.000
2.740	17.000
Ave. Height	17.000
Ave. Diameter	2.740
Vol. Of Sample	0.05801
Area of Sample	5.8965

Wet Weight of Soil	gm	2653.0
Dry Weight of Soil	gm	1686.0
Loss	gm	967.0
Water Content	%	57.4
Wet Weight of Perm Sample	gm	2653.0
Wet Soil in Pounds	lbs.	5.8489
Divided By Volume	pcf	100.8
Water Content	%	57.4
Dry Density	pcf	64.1

After Perm-Wet	gm	
After Perm-Dry	gm	
Loss	gm	
Water Content	%	
Dry Density	pcf	

Visual: LEAN CLAY W/SAND, some organic fines, dark brown

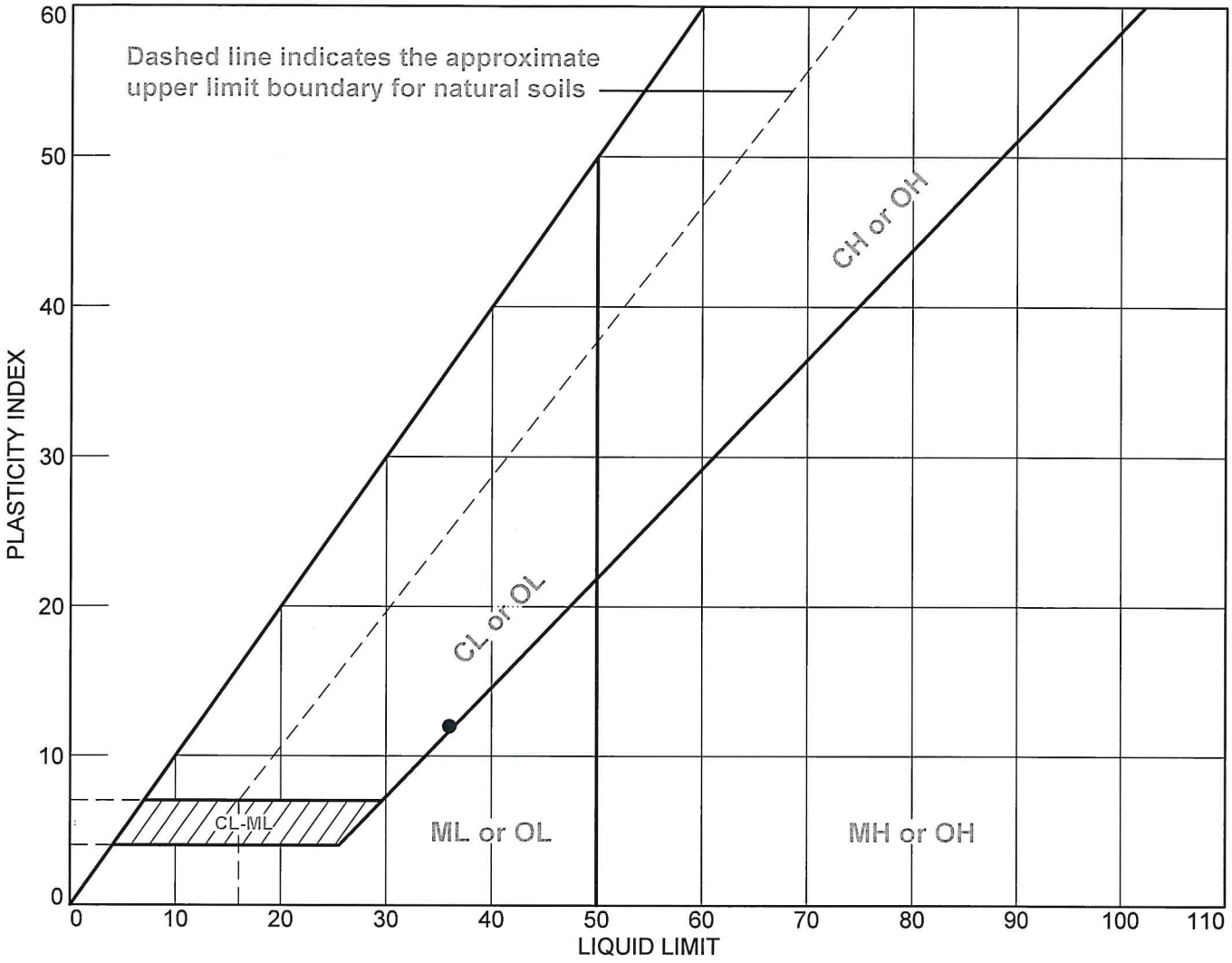
Munsell Color: 10YR 3/3

Lab Equipment:

Scale ID:	DS #5
Micrometer ID:	Lab S6

REVIEWED BY:	Robert R Peters
DATE REVIEWED:	8/25/22

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Borings	2022-GT-TA-02 (011)	1.5'-3.0'	57.3	24	36	12	

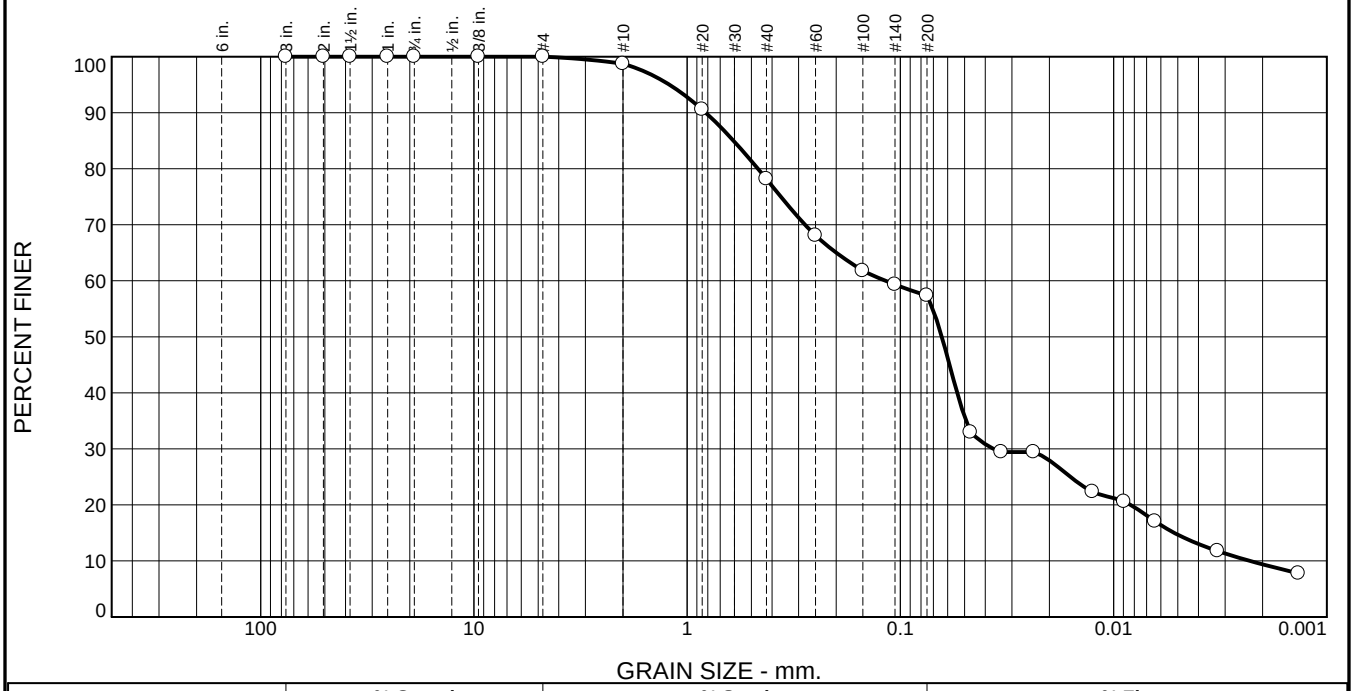
Tetra Tech
2679 Continental Drive
Green Bay, WI 54311

Client: Pace Analytical
Project: 40249166 Superior Slips

Project No.: **Figure**

Tested By: MLW **Checked By:** RJP

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.3	20.5	20.8	42.7	14.7

TEST RESULTS (D7928 mod - With Hydrometer)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	100.0		
0.75"	100.0		
0.375"	100.0		
#4	100.0		
#10	98.7		
#20	90.6		
#40	78.2		
#60	68.1		
#100	61.8		
#140	59.3		
#200	57.4		
0.0469 mm.	32.9		
0.0336 mm.	29.4		
0.0237 mm.	29.4		
0.0126 mm.	22.4		
0.0089 mm.	20.6		
0.0064 mm.	17.1		
0.0033 mm.	11.8		
0.0014 mm.	7.8		

* (no specification provided)

Material Description

manual description: standing water, silt, grainy, compact; sharp rocks/shards; gasoline odor

geosystems description: sandy silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.8183 D_{85}= 0.6062 D_{60}= 0.1173
D_{50}= 0.0639 D_{30}= 0.0366 D_{15}= 0.0052
D_{10}= 0.0023 C_u= 51.20 C_c= 4.98

Remarks

Batch 47397, HBN 422694; coarse sieved 8/9/22, fine sieved 8/11/22; test assisted by LTT

Date Received: 8/2/22 **Date Tested:** 8/9/22

Tested By: Madeline Rohde and

Checked By: Donavon Sieloff

Title: Supervisor

Location: 2022-GT-TA-01(3-4.5)
Sample Number: 40249166-009

Date Sampled: 7/30/22

Pace Analytical Services, Inc.

Green Bay, WI

Client: AECOM, Inc. - Milwaukee
Project: 60685299 T.6 SUPERIOR SLIPS

Project No: 40249166 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

8/12/2022

Client: AECOM, Inc. - Milwaukee
Project: 60685299 T.6 SUPERIOR SLIPS
Project Number: 40249166
Location: 2022-GT-TA-01(3-4.5)
Sample Number: 40249166-009
Material Description: manual description: standing water, silt, grainy, compact; sharp rocks/shards; gasoline odor
geosystems description: sandy silt
Sample Date: 7/30/22
Date Received: 8/2/22 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Grain Size Test Method: D7928 mod - With Hydrometer
Testing Remarks: Batch 47397, HBN 422694; coarse sieved 8/9/22, fine sieved 8/11/22; test assisted by LTT
Tested By: Madeline Rohde and **Test Date:** 8/9/22
Checked By: Donavon Sieloff **Title:** Supervisor

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
747.43	500.99	3"	0.00	0.00	100.0
		2"	0.00	0.00	100.0
		1.5"	0.00	0.00	100.0
		1"	0.00	0.00	100.0
		0.75"	0.00	0.00	100.0
		0.375"	0.00	0.00	100.0
		#4	0.00	0.00	100.0
		#10	3.11	0.00	98.7
55.93	0.00	#20	4.63	0.00	90.6
		#40	7.02	0.00	78.2
		#60	5.71	0.00	68.1
		#100	3.58	0.00	61.8
		#140	1.38	0.00	59.3
		#200	1.12	0.00	57.4

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 98.7
Weight of hydrometer sample =55.93
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -4
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	23.0	22.0	18.7	0.0132	22.0	12.7	0.0469	32.9
2.00	23.0	20.0	16.7	0.0132	20.0	13.0	0.0336	29.4
4.00	23.0	20.0	16.7	0.0132	20.0	13.0	0.0237	29.4
15.00	23.0	16.0	12.7	0.0132	16.0	13.7	0.0126	22.4
30.00	23.0	15.0	11.7	0.0132	15.0	13.8	0.0089	20.6
60.00	23.0	13.0	9.7	0.0132	13.0	14.2	0.0064	17.1
240.00	23.0	10.0	6.7	0.0132	10.0	14.7	0.0033	11.8
1440.00	22.0	8.0	4.4	0.0133	8.0	15.0	0.0014	7.8

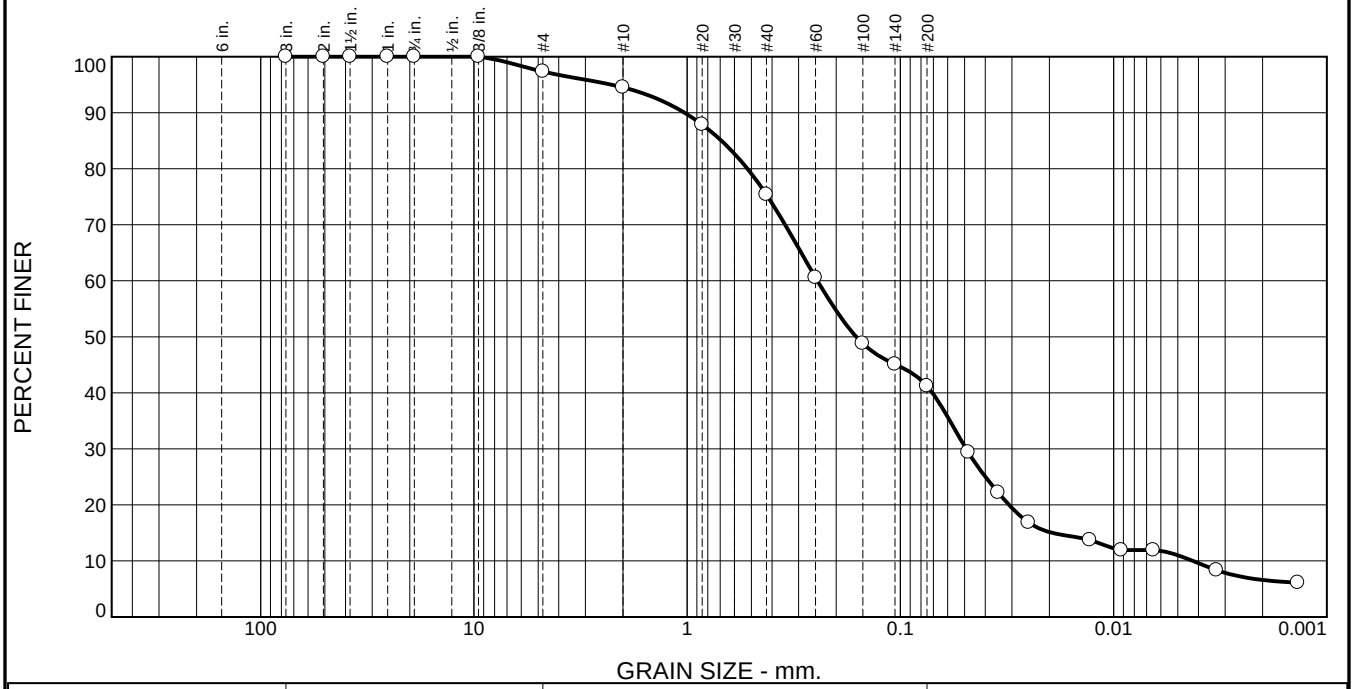
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	1.3	20.5	20.8	42.6	42.7	14.7	57.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0023	0.0052	0.0083	0.0366	0.0541	0.0639	0.1173	0.4658	0.6062	0.8183	1.2126

Fineness Modulus	C_u	C_c
0.88	51.20	4.98

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.7	2.8	19.1	34.2	30.2	11.0

TEST RESULTS (D7928 mod - With Hydrometer)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	100.0		
0.75"	100.0		
0.375"	100.0		
#4	97.3		
#10	94.5		
#20	87.9		
#40	75.4		
#60	60.6		
#100	48.8		
#140	45.1		
#200	41.2		
0.0480 mm.	29.4		
0.0348 mm.	22.2		
0.0251 mm.	16.8		
0.0129 mm.	13.7		
0.0092 mm.	11.9		
0.0065 mm.	11.9		
0.0033 mm.	8.3		
0.0014 mm.	6.1		

* (no specification provided)

Material Description

manual description: moist, silt, grainy, compact; large woodchip, roots, pebbles; gasoline odor

geosystems description: silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 1.0283 D_{85}= 0.6904 D_{60}= 0.2449
D_{50}= 0.1611 D_{30}= 0.0492 D_{15}= 0.0194
D_{10}= 0.0042 C_u= 57.66 C_c= 2.32

Remarks

Batch 47397, HBN 422694; coarse sieved 8/9/22, fine sieved 8/11/22; ethanol (#281100) used on sample to dissipate foam during hydrometer test; test assisted by LTT

Date Received: 8/2/22 **Date Tested:** 8/9/22

Tested By: Madeline Rohde and

Checked By: Donavon Sieloff

Title: Supervisor

Location: 2022-GT-TA-01(4.5-6)
Sample Number: 40249166-010

Date Sampled: 7/30/22

Pace Analytical Services, Inc.

Green Bay, WI

Client: AECOM, Inc. - Milwaukee
Project: 60685299 T.6 SUPERIOR SLIPS

Project No: 40249166 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

8/12/2022

Client: AECOM, Inc. - Milwaukee
Project: 60685299 T.6 SUPERIOR SLIPS
Project Number: 40249166
Location: 2022-GT-TA-01(4.5-6)
Sample Number: 40249166-010
Material Description: manual description: moist, silt, grainy, compact; large woodchip, roots, pebbles; gasoline odor
geosystems description: silty sand
Sample Date: 7/30/22
Date Received: 8/2/22 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SM **AASHTO Classification:** A-4(0)
Grain Size Test Method: D7928 mod - With Hydrometer
Testing Remarks: Batch 47397, HBN 422694; coarse sieved 8/9/22, fine sieved 8/11/22; ethanol (#281100) used on sample to dissipate foam during hydrometer test; test assisted by LTT
Tested By: Madeline Rohde and **Test Date:** 8/9/22
Checked By: Donavon Sieloff **Title:** Supervisor

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
803.35	620.60	3"	0.00	0.00	100.0
		2"	0.00	0.00	100.0
		1.5"	0.00	0.00	100.0
		1"	0.00	0.00	100.0
		0.75"	0.00	0.00	100.0
		0.375"	0.00	0.00	100.0
		#4	4.86	0.00	97.3
		#10	5.16	0.00	94.5
52.80	0.00	#20	3.71	0.00	87.9
		#40	6.98	0.00	75.4
		#60	8.27	0.00	60.6
		#100	6.58	0.00	48.8
		#140	2.07	0.00	45.1
		#200	2.17	0.00	41.2

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 94.5
Weight of hydrometer sample =52.80
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -4
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	22.0	20.0	16.4	0.0133	20.0	13.0	0.0480	29.4
2.00	22.0	16.0	12.4	0.0133	16.0	13.7	0.0348	22.2
4.00	22.0	13.0	9.4	0.0133	13.0	14.2	0.0251	16.8
15.00	23.0	11.0	7.7	0.0132	11.0	14.5	0.0129	13.7
30.00	23.0	10.0	6.7	0.0132	10.0	14.7	0.0092	11.9
60.00	23.0	10.0	6.7	0.0132	10.0	14.7	0.0065	11.9
240.00	23.0	8.0	4.7	0.0132	8.0	15.0	0.0033	8.3
1440.00	22.0	7.0	3.4	0.0133	7.0	15.1	0.0014	6.1

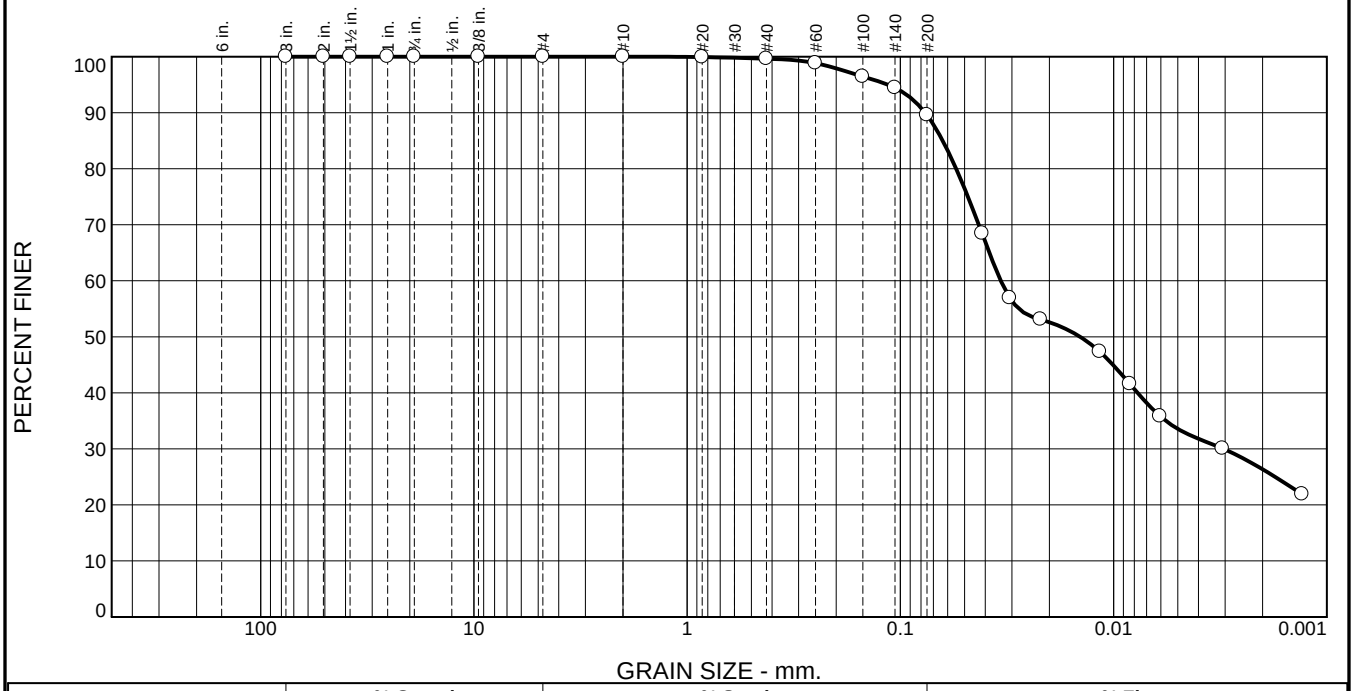
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	2.7	2.7	2.8	19.1	34.2	56.1	30.2	11.0	41.2

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0042	0.0194	0.0309	0.0492	0.0708	0.1611	0.2449	0.5216	0.6904	1.0283	2.2644

Fineness Modulus	C_u	C_c
1.19	57.66	2.32

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.4	10.0	56.0	33.6

TEST RESULTS (D7928 mod - With Hydrometer)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	100.0		
0.75"	100.0		
0.375"	100.0		
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.6		
#60	98.8		
#100	96.4		
#140	94.4		
#200	89.6		
0.0414 mm.	68.5		
0.0307 mm.	56.9		
0.0220 mm.	53.1		
0.0116 mm.	47.3		
0.0084 mm.	41.6		
0.0060 mm.	35.8		
0.0031 mm.	30.1		
0.0013 mm.	21.9		

* (no specification provided)

Material Description

manual description: standing water, silt, somewhat compact; roots, dried clay

geosystems description: silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.0765 D_{85}= 0.0633 D_{60}= 0.0338
D_{50}= 0.0143 D_{30}= 0.0031 D_{15}=
D_{10}= C_u= C_c=

Remarks

Batch 47397, HBN 422694; coarse sieved 8/9/22, fine sieved 8/11/22; ethanol (#281100) used on sample to dissipate foam during hydrometer test; test assisted by LTT

Date Received: 8/2/22 **Date Tested:** 8/9/22

Tested By: Madeline Rohde and

Checked By: Donavon Sieloff

Title: Supervisor

Location: 2022-GT-TA-02(1.5-3) **Date Sampled:** 7/30/22
Sample Number: 40249166-011

Pace Analytical Services, Inc.

Green Bay, WI

Client: AECOM, Inc. - Milwaukee
Project: 60685299 T.6 SUPERIOR SLIPS

Project No: 40249166 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

8/12/2022

Client: AECOM, Inc. - Milwaukee
Project: 60685299 T.6 SUPERIOR SLIPS
Project Number: 40249166
Location: 2022-GT-TA-02(1.5-3)
Sample Number: 40249166-011
Material Description: manual description: standing water, silt, somewhat compact; roots, dried clay
geosystems description: silt
Sample Date: 7/30/22
Date Received: 8/2/22 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Grain Size Test Method: D7928 mod - With Hydrometer
Testing Remarks: Batch 47397, HBN 422694; coarse sieved 8/9/22, fine sieved 8/11/22; ethanol (#281100) used on sample to dissipate foam during hydrometer test; test assisted by LTT
Tested By: Madeline Rohde and **Test Date:** 8/9/22
Checked By: Donavon Sieloff **Title:** Supervisor

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
788.39	650.21	3"	0.00	0.00	100.0
		2"	0.00	0.00	100.0
		1.5"	0.00	0.00	100.0
		1"	0.00	0.00	100.0
		0.75"	0.00	0.00	100.0
		0.375"	0.00	0.00	100.0
		#4	0.00	0.00	100.0
		#10	0.00	0.00	100.0
52.09	0.00	#20	0.04	0.00	99.9
		#40	0.15	0.00	99.6
		#60	0.41	0.00	98.8
		#100	1.25	0.00	96.4
		#140	1.05	0.00	94.4
		#200	2.53	0.00	89.6

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =52.09
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -4
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	23.0	39.0	35.7	0.0132	39.0	9.9	0.0414	68.5
2.00	23.0	33.0	29.7	0.0132	33.0	10.9	0.0307	56.9
4.00	23.0	31.0	27.7	0.0132	31.0	11.2	0.0220	53.1
15.00	23.0	28.0	24.7	0.0132	28.0	11.7	0.0116	47.3
30.00	23.0	25.0	21.7	0.0132	25.0	12.2	0.0084	41.6
60.00	23.0	22.0	18.7	0.0132	22.0	12.7	0.0060	35.8
240.00	23.0	19.0	15.7	0.0132	19.0	13.2	0.0031	30.1
1440.00	22.0	15.0	11.4	0.0133	15.0	13.8	0.0013	21.9

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.4	10.0	10.4	56.0	33.6	89.6

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0031	0.0077	0.0143	0.0338	0.0548	0.0633	0.0765	0.1145

Fineness Modulus
0.04

aecom.com

Appendix D RCL Calculation Outputs

Site-specific

Fish Risk-Based Regional Screening Levels (RSL) for Fish

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	RfD (mg/kg-day)	RfD Ref	Ingestion SL TR=1E-06 (mg/kg)	Ingestion SL THQ=1 (mg/kg)	Screening Level (mg/kg)
Aroclor 1242	53469-21-9	No	Yes	Organics	2.00E+00	G	-		7.49E-03	-	7.49E-03 ca
Aroclor 1248	12672-29-6	No	Yes	Organics	2.00E+00	G	-		7.49E-03	-	7.49E-03 ca
Aroclor 1254	11097-69-1	No	Yes	Organics	2.00E+00	G	2.00E-05	I	7.49E-03	1.11E-01	7.49E-03 ca*
Aroclor 1260	11096-82-5	No	Yes	Organics	2.00E+00	G	-		7.49E-03	-	7.49E-03 ca
DDD, o,p'-	53-19-0	No	No	Organics	-		-		-	-	
DDE, p,p'-	72-55-9	No	Yes	Organics	3.40E-01	I	5.00E-04	A	4.40E-02	2.78E+00	4.40E-02 ca*
DDT	50-29-3	No	No	Organics	3.40E-01	I	5.00E-04	I	4.40E-02	2.78E+00	4.40E-02 ca*
Dieldrin	60-57-1	No	No	Organics	1.60E+01	I	5.00E-05	I	9.36E-04	2.78E-01	9.36E-04 ca
Methyl Mercury	22967-92-6	No	No	Inorganics	-		1.00E-04	I	-	5.56E-01	5.56E-01 nc

Output generated 17NOV2022:11:52:48

Variable	Fish Fish Default Value	Site-Specific Value
AT (averaging time)	365	365
BW_{res-a} (body weight) kg	80	80
ED_{res} (exposure duration) yr	26	26
EF_{res-a} (exposure frequency) days/yr	350	350
THQ (target hazard quotient) unitless	0.1	1
$IRFI_{res-a}$ (fish consumption rate - adult) mg/day		15000
LT (lifetime) yr	70	70
TR (target cancer risk) unitless	0.000001	0.000001

Output generated 17NOV2022:11:52:48

Appendix E ProUCL Outputs

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 11/11/2022 3:19:15 PM
From File	Tower Slip ProUCL Input_f.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Dibenzofuran (µg/kg)

General Statistics

Total Number of Observations	116	Number of Distinct Observations	85
		Number of Missing Observations	20
Number of Detects	87	Number of Non-Detects	29
Number of Distinct Detects	68	Number of Distinct Non-Detects	23
Minimum Detect	0.26	Minimum Non-Detect	20
Maximum Detect	2300	Maximum Non-Detect	6500
Variance Detects	224477	Percent Non-Detects	25%
Mean Detects	280.2	SD Detects	473.8
Median Detects	100	CV Detects	1.691
Skewness Detects	2.597	Kurtosis Detects	6.336
Mean of Logged Detects	4.421	SD of Logged Detects	1.884

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.595	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.316	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.11	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	233.5	KM Standard Error of Mean	41.98
90KM SD	433.6	95% KM (BCA) UCL	308.8
95% KM (t) UCL	303.1	95% KM (Percentile Bootstrap) UCL	305.4
95% KM (z) UCL	302.6	95% KM Bootstrap t UCL	321.1
90% KM Chebyshev UCL	359.5	95% KM Chebyshev UCL	416.5
97.5% KM Chebyshev UCL	495.7	99% KM Chebyshev UCL	651.2

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.135	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.817	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.166	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.101	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.52	k star (bias corrected MLE)	0.51
Theta hat (MLE)	539	Theta star (bias corrected MLE)	549.8
nu hat (MLE)	90.46	nu star (bias corrected)	88.67
Mean (detects)	280.2		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	216.2
Maximum	2300	Median	65
SD	424.9	CV	1.966
k hat (MLE)	0.31	k star (bias corrected MLE)	0.308
Theta hat (MLE)	696.8	Theta star (bias corrected MLE)	701.9
nu hat (MLE)	71.97	nu star (bias corrected)	71.44
Adjusted Level of Significance (β)	0.0479		
Approximate Chi Square Value (71.44, α)	52.98	Adjusted Chi Square Value (71.44, β)	52.78
95% Gamma Approximate UCL	291.5	95% Gamma Adjusted UCL	292.6

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	233.5	SD (KM)	433.6
Variance (KM)	188009	SE of Mean (KM)	41.98
k hat (KM)	0.29	k star (KM)	0.288
nu hat (KM)	67.29	nu star (KM)	66.88
theta hat (KM)	805.1	theta star (KM)	810
80% gamma percentile (KM)	354.5	90% gamma percentile (KM)	691.9
95% gamma percentile (KM)	1082	99% gamma percentile (KM)	2100

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (66.88, α)	49.06	Adjusted Chi Square Value (66.88, β)	48.87
95% KM Approximate Gamma UCL	318.3	95% KM Adjusted Gamma UCL	319.6

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.917	**Shapiro Wilk GOF Test**	
10% Shapiro Wilk P Value	6.8382E-6	Detected Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.116	**Lilliefors GOF Test**	
10% Lilliefors Critical Value	0.0871	Detected Data Not Lognormal at 10% Significance Level	

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	217.7	Mean in Log Scale	4.046
SD in Original Scale	424.1	SD in Log Scale	1.838
95% t UCL (assumes normality of ROS data)	283	95% Percentile Bootstrap UCL	284
95% BCA Bootstrap UCL	290.4	95% Bootstrap t UCL	296
95% H-UCL (Log ROS)	529		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.97	KM Geo Mean	52.98
KM SD (logged)	2.123	95% Critical H Value (KM-Log)	3.481
KM Standard Error of Mean (logged)	0.227	95% H-UCL (KM -Log)	1004
KM SD (logged)	2.123	95% Critical H Value (KM-Log)	3.481
KM Standard Error of Mean (logged)	0.227		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	380.4	Mean in Log Scale	4.518
SD in Original Scale	669.3	SD in Log Scale	1.973
95% t UCL (Assumes normality)	483.4	95% H-Stat UCL	1176

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL 303.1

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	135	Number of Distinct Observations	78
		Number of Missing Observations	1
Number of Detects	70	Number of Non-Detects	65
Number of Distinct Detects	39	Number of Distinct Non-Detects	42
Minimum Detect	0.29	Minimum Non-Detect	5.1
Maximum Detect	9.4	Maximum Non-Detect	14.8
Variance Detects	5.782	Percent Non-Detects	48.15%
Mean Detects	2	SD Detects	2.405
Median Detects	1.2	CV Detects	1.202
Skewness Detects	2.368	Kurtosis Detects	4.253
Mean of Logged Detects	0.292	SD of Logged Detects	0.793

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.566	**Normal GOF Test on Detected Observations Only**	
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.352	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.122	Detected Data Not Normal at 1% Significance Level	

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.69	KM Standard Error of Mean	0.189
90KM SD	1.939	95% KM (BCA) UCL	2.011
95% KM (t) UCL	2.003	95% KM (Percentile Bootstrap) UCL	2.006
95% KM (z) UCL	2	95% KM Bootstrap t UCL	2.094
90% KM Chebyshev UCL	2.257	95% KM Chebyshev UCL	2.513
97.5% KM Chebyshev UCL	2.87	99% KM Chebyshev UCL	3.57

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	6.302	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.771	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.271	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.109	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.391	k star (bias corrected MLE)	1.341
Theta hat (MLE)	1.438	Theta star (bias corrected MLE)	1.491
nu hat (MLE)	194.7	nu star (bias corrected)	187.7
Mean (detects)	2		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.29	Mean	1.629
Maximum	9.4	Median	1.174
SD	1.815	CV	1.115
k hat (MLE)	1.783	k star (bias corrected MLE)	1.748
Theta hat (MLE)	0.914	Theta star (bias corrected MLE)	0.932
nu hat (MLE)	481.3	nu star (bias corrected)	472
Adjusted Level of Significance (β)	0.0482		
Approximate Chi Square Value (471.96, α)	422.6	Adjusted Chi Square Value (471.96, β)	422.1
95% Gamma Approximate UCL	1.819	95% Gamma Adjusted UCL	1.821

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.69	SD (KM)	1.939
Variance (KM)	3.76	SE of Mean (KM)	0.189
k hat (KM)	0.759	k star (KM)	0.747
nu hat (KM)	205	nu star (KM)	201.7
theta hat (KM)	2.226	theta star (KM)	2.261
80% gamma percentile (KM)	2.77	90% gamma percentile (KM)	4.176
95% gamma percentile (KM)	5.617	99% gamma percentile (KM)	9.039

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (201.74, α)	169.9	Adjusted Chi Square Value (201.74, β)	169.6
95% KM Approximate Gamma UCL	2.006	95% KM Adjusted Gamma UCL	2.01

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.869	**Shapiro Wilk GOF Test**	
10% Shapiro Wilk P Value	3.7200E-8	Detected Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.197	**Lilliefors GOF Test**	
10% Lilliefors Critical Value	0.0969	Detected Data Not Lognormal at 10% Significance Level	

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.633	Mean in Log Scale	0.238
SD in Original Scale	1.782	SD in Log Scale	0.601
95% t UCL (assumes normality of ROS data)	1.887	95% Percentile Bootstrap UCL	1.904
95% BCA Bootstrap UCL	1.957	95% Bootstrap t UCL	1.953
95% H-UCL (Log ROS)	1.676		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.206	KM Geo Mean	1.229
KM SD (logged)	0.692	95% Critical H Value (KM-Log)	1.948
KM Standard Error of Mean (logged)	0.0749	95% H-UCL (KM -Log)	1.755
KM SD (logged)	0.692	95% Critical H Value (KM-Log)	1.948
KM Standard Error of Mean (logged)	0.0749		

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.977	Mean in Log Scale	0.805
SD in Original Scale	2.153	SD in Log Scale	0.802
95% t UCL (Assumes normality)	3.284	95% H-Stat UCL	3.551

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL 2.003

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	138	Number of Distinct Observations	67
		Number of Missing Observations	1
Minimum	2	Mean	5.483
Maximum	12	Median	5.15
SD	2.113	Std. Error of Mean	0.18
Coefficient of Variation	0.385	Skewness	0.644

Normal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk P Value	3.6775E-4	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.0869	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.0877	Data appear Normal at 1% Significance Level	

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.781	95% Adjusted-CLT UCL (Chen-1995)	5.789
		95% Modified-t UCL (Johnson-1978)	5.782

Gamma GOF Test

A-D Test Statistic	0.268	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0485	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0797	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.756	k star (bias corrected MLE)	6.614
Theta hat (MLE)	0.812	Theta star (bias corrected MLE)	0.829
nu hat (MLE)	1865	nu star (bias corrected)	1825
MLE Mean (bias corrected)	5.483	MLE Sd (bias corrected)	2.132
		Approximate Chi Square Value (0.05)	1727
Adjusted Level of Significance	0.0483	Adjusted Chi Square Value	1726

Assuming Gamma Distribution

95% Approximate Gamma UCL	5.795	95% Adjusted Gamma UCL	5.798

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.967	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0.036	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0671	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0694	Data appear Lognormal at 10% Significance Level

Data appear Approximate Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.693	Mean of logged Data	1.626
Maximum of Logged Data	2.485	SD of logged Data	0.399

Assuming Lognormal Distribution

95% H-UCL	5.846	90% Chebyshev (MVUE) UCL	6.081
95% Chebyshev (MVUE) UCL	6.344	97.5% Chebyshev (MVUE) UCL	6.709
99% Chebyshev (MVUE) UCL	7.426		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	5.779	95% BCA Bootstrap UCL	5.765
95% Standard Bootstrap UCL	5.775	95% Bootstrap-t UCL	5.781
95% Hall's Bootstrap UCL	5.779	95% Percentile Bootstrap UCL	5.771
90% Chebyshev(Mean, Sd) UCL	6.022	95% Chebyshev(Mean, Sd) UCL	6.267
97.5% Chebyshev(Mean, Sd) UCL	6.606	99% Chebyshev(Mean, Sd) UCL	7.273

Suggested UCL to Use

95% Student's-t UCL 5.781

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	135	Number of Distinct Observations	78
		Number of Missing Observations	1
Number of Detects	132	Number of Non-Detects	3
Number of Distinct Detects	77	Number of Distinct Non-Detects	2
Minimum Detect	0.13	Minimum Non-Detect	0.49
Maximum Detect	3.3	Maximum Non-Detect	0.53
Variance Detects	0.324	Percent Non-Detects	2.222%
Mean Detects	0.741	SD Detects	0.569
Median Detects	0.58	CV Detects	0.768
Skewness Detects	2.065	Kurtosis Detects	5.021
Mean of Logged Detects	-0.531	SD of Logged Detects	0.675

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.796	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.0896	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.732	KM Standard Error of Mean	0.0487
90KM SD	0.564	95% KM (BCA) UCL	0.812
95% KM (t) UCL	0.813	95% KM (Percentile Bootstrap) UCL	0.812
95% KM (z) UCL	0.812	95% KM Bootstrap t UCL	0.826
90% KM Chebyshev UCL	0.879	95% KM Chebyshev UCL	0.945
97.5% KM Chebyshev UCL	1.037	99% KM Chebyshev UCL	1.217

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.273	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.764	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0763	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0821	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.308	k star (bias corrected MLE)	2.261
Theta hat (MLE)	0.321	Theta star (bias corrected MLE)	0.328

nu hat (MLE)	609.4	nu star (bias corrected)	596.8
Mean (detects)	0.741		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.13	Mean	0.731
Maximum	3.3	Median	0.58
SD	0.567	CV	0.775
k hat (MLE)	2.28	k star (bias corrected MLE)	2.234
Theta hat (MLE)	0.321	Theta star (bias corrected MLE)	0.327
nu hat (MLE)	615.6	nu star (bias corrected)	603.3
Adjusted Level of Significance (β)	0.0482		
Approximate Chi Square Value (603.28, α)	547.3	Adjusted Chi Square Value (603.28, β)	546.7
95% Gamma Approximate UCL	0.806	95% Gamma Adjusted UCL	0.807

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.732	SD (KM)	0.564
Variance (KM)	0.318	SE of Mean (KM)	0.0487
k hat (KM)	1.688	k star (KM)	1.655
nu hat (KM)	455.7	nu star (KM)	446.9
theta hat (KM)	0.434	theta star (KM)	0.442
80% gamma percentile (KM)	1.121	90% gamma percentile (KM)	1.49
95% gamma percentile (KM)	1.846	99% gamma percentile (KM)	2.646

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (446.90, α)	398.9	Adjusted Chi Square Value (446.90, β)	398.4
95% KM Approximate Gamma UCL	0.82	95% KM Adjusted Gamma UCL	0.821

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.978	**Shapiro Wilk GOF Test**
10% Shapiro Wilk P Value	0.356	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0336	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.0709	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.732	Mean in Log Scale	-0.544
SD in Original Scale	0.566	SD in Log Scale	0.672
95% t UCL (assumes normality of ROS data)	0.813	95% Percentile Bootstrap UCL	0.817
95% BCA Bootstrap UCL	0.825	95% Bootstrap t UCL	0.823
95% H-UCL (Log ROS)	0.814		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.545	KM Geo Mean	0.58
KM SD (logged)	0.673	95% Critical H Value (KM-Log)	1.934

KM Standard Error of Mean (logged)	0.0583	95% H-UCL (KM -Log)	0.814
KM SD (logged)	0.673	95% Critical H Value (KM-Log)	1.934
KM Standard Error of Mean (logged)	0.0583		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.73	Mean in Log Scale	-0.55
SD in Original Scale	0.567	SD in Log Scale	0.678
95% t UCL (Assumes normality)	0.811	95% H-Stat UCL	0.814

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.82	95% GROS Approximate Gamma UCL	0.806

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	135	Number of Distinct Observations	118
		Number of Missing Observations	1
Minimum	9.4	Mean	31.46
Maximum	98.1	Median	30.6
SD	12.04	Std. Error of Mean	1.036
Coefficient of Variation	0.383	Skewness	1.091

Normal GOF Test

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk P Value	2.3548E-6	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.0521	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.0886	Data appear Normal at 1% Significance Level	

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	33.17	95% Adjusted-CLT UCL (Chen-1995)	33.26
		95% Modified-t UCL (Johnson-1978)	33.19

Gamma GOF Test

A-D Test Statistic	1.28	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0682	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0805	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.604	k star (bias corrected MLE)	6.463
Theta hat (MLE)	4.763	Theta star (bias corrected MLE)	4.867
nu hat (MLE)	1783	nu star (bias corrected)	1745
MLE Mean (bias corrected)	31.46	MLE Sd (bias corrected)	12.37
		Approximate Chi Square Value (0.05)	1649
Adjusted Level of Significance	0.0482	Adjusted Chi Square Value	1648

Assuming Gamma Distribution

95% Approximate Gamma UCL	33.29	95% Adjusted Gamma UCL	33.31

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.941	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk P Value	1.0066E-5	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.0932	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.0701	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.241	Mean of logged Data	3.371
Maximum of Logged Data	4.586	SD of logged Data	0.413

Assuming Lognormal Distribution

95% H-UCL	33.78	90% Chebyshev (MVUE) UCL	35.19
95% Chebyshev (MVUE) UCL	36.78	97.5% Chebyshev (MVUE) UCL	38.99
99% Chebyshev (MVUE) UCL	43.33		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	33.16	95% BCA Bootstrap UCL	33.14
95% Standard Bootstrap UCL	33.16	95% Bootstrap-t UCL	33.26
95% Hall's Bootstrap UCL	33.37	95% Percentile Bootstrap UCL	33.19
90% Chebyshev(Mean, Sd) UCL	34.56	95% Chebyshev(Mean, Sd) UCL	35.97
97.5% Chebyshev(Mean, Sd) UCL	37.93	99% Chebyshev(Mean, Sd) UCL	41.76

Suggested UCL to Use

95% Student's-t UCL 33.17

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	135	Number of Distinct Observations	108
		Number of Missing Observations	1
Minimum	8920	Mean	24766
Maximum	58700	Median	24200
SD	8792	Std. Error of Mean	756.7
Coefficient of Variation	0.355	Skewness	0.545

Normal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0.102	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.0684	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.0886	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	26020	95% Adjusted-CLT UCL (Chen-1995)	26049
		95% Modified-t UCL (Johnson-1978)	26025

Gamma GOF Test

A-D Test Statistic	0.494	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0614	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0805	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.647	k star (bias corrected MLE)	7.482
Theta hat (MLE)	3239	Theta star (bias corrected MLE)	3310
nu hat (MLE)	2065	nu star (bias corrected)	2020
MLE Mean (bias corrected)	24766	MLE Sd (bias corrected)	9054
		Approximate Chi Square Value (0.05)	1917
Adjusted Level of Significance	0.0482	Adjusted Chi Square Value	1916

Assuming Gamma Distribution

95% Approximate Gamma UCL	26102	95% Adjusted Gamma UCL	26117

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk P Value	0.00724	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.0825	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.0701	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.096	Mean of logged Data	10.05
Maximum of Logged Data	10.98	SD of logged Data	0.379

Assuming Lognormal Distribution

95% H-UCL	26367	90% Chebyshev (MVUE) UCL	27388
95% Chebyshev (MVUE) UCL	28526	97.5% Chebyshev (MVUE) UCL	30106
99% Chebyshev (MVUE) UCL	33210		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	26011	95% BCA Bootstrap UCL	25983
95% Standard Bootstrap UCL	26006	95% Bootstrap-t UCL	26002
95% Hall's Bootstrap UCL	26014	95% Percentile Bootstrap UCL	26042
90% Chebyshev(Mean, Sd) UCL	27036	95% Chebyshev(Mean, Sd) UCL	28065
97.5% Chebyshev(Mean, Sd) UCL	29492	99% Chebyshev(Mean, Sd) UCL	32295

Suggested UCL to Use

95% Student's-t UCL 26020

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	135	Number of Distinct Observations	125
		Number of Missing Observations	1
Minimum	97	Mean	488.2
Maximum	1190	Median	454
SD	242.3	Std. Error of Mean	20.85
Coefficient of Variation	0.496	Skewness	0.644

Normal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk P Value	5.3820E-5	Data Not Normal at 1% Significance Level	

Lilliefors Test Statistic	0.0806	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.0886	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	522.8	95% Adjusted-CLT UCL (Chen-1995)	523.8
		95% Modified-t UCL (Johnson-1978)	523

Gamma GOF Test

A-D Test Statistic	0.361	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.757	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0537	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0808	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.859	k star (bias corrected MLE)	3.778
Theta hat (MLE)	126.5	Theta star (bias corrected MLE)	129.2
nu hat (MLE)	1042	nu star (bias corrected)	1020
MLE Mean (bias corrected)	488.2	MLE Sd (bias corrected)	251.2
		Approximate Chi Square Value (0.05)	947
Adjusted Level of Significance	0.0482	Adjusted Chi Square Value	946.3

Assuming Gamma Distribution

95% Approximate Gamma UCL	525.9	95% Adjusted Gamma UCL	526.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0.00478	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0787	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0701	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.575	Mean of logged Data	6.056
Maximum of Logged Data	7.082	SD of logged Data	0.547

Assuming Lognormal Distribution

95% H-UCL	540.8	90% Chebyshev (MVUE) UCL	569.4
95% Chebyshev (MVUE) UCL	603.2	97.5% Chebyshev (MVUE) UCL	650.1
99% Chebyshev (MVUE) UCL	742.3		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	522.5	95% BCA Bootstrap UCL	519.3
95% Standard Bootstrap UCL	522.1	95% Bootstrap-t UCL	522.7

95% Hall's Bootstrap UCL	522.7	95% Percentile Bootstrap UCL	522.3
90% Chebyshev(Mean, Sd) UCL	550.8	95% Chebyshev(Mean, Sd) UCL	579.1
97.5% Chebyshev(Mean, Sd) UCL	618.4	99% Chebyshev(Mean, Sd) UCL	695.7

Suggested UCL to Use

95% Student's-t UCL 522.8

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aroclor 1242 (µg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	38
		Number of Missing Observations	55
Number of Detects	2	Number of Non-Detects	72
Number of Distinct Detects	2	Number of Distinct Non-Detects	37
Minimum Detect	11	Minimum Non-Detect	40
Maximum Detect	53	Maximum Non-Detect	96
Variance Detects	882	Percent Non-Detects	97.3%
Mean Detects	32	SD Detects	29.7
Median Detects	32	CV Detects	0.928
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	3.184	SD of Logged Detects	1.112

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	13.33	KM Standard Error of Mean	3.207
90KM SD	9.621	95% KM (BCA) UCL	N/A
95% KM (t) UCL	18.68	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	18.61	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	22.95	95% KM Chebyshev UCL	27.31
97.5% KM Chebyshev UCL	33.36	99% KM Chebyshev UCL	45.24

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	1.925	k star (bias corrected MLE)	N/A

Theta hat (MLE)	16.62	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	7.701	nu star (bias corrected)	N/A
Mean (detects)	32		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	13.33	SD (KM)	9.621
Variance (KM)	92.56	SE of Mean (KM)	3.207
k hat (KM)	1.921	k star (KM)	1.852
nu hat (KM)	284.3	nu star (KM)	274.1
theta hat (KM)	6.942	theta star (KM)	7.2
80% gamma percentile (KM)	20.14	90% gamma percentile (KM)	26.41
95% gamma percentile (KM)	32.41	99% gamma percentile (KM)	45.79

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0468
Approximate Chi Square Value (274.08, α)	236.7	Adjusted Chi Square Value (274.08, β)	236.1
95% KM Approximate Gamma UCL	15.44	95% KM Adjusted Gamma UCL	15.48

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	12.88	Mean in Log Scale	2.46
SD in Original Scale	6.778	SD in Log Scale	0.421
95% t UCL (assumes normality of ROS data)	14.2	95% Percentile Bootstrap UCL	14.36
95% BCA Bootstrap UCL	14.57	95% Bootstrap t UCL	14.66
95% H-UCL (Log ROS)	13.98		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.485	KM Geo Mean	12
KM SD (logged)	0.36	95% Critical H Value (KM-Log)	1.775
KM Standard Error of Mean (logged)	0.12	95% H-UCL (KM -Log)	13.8
KM SD (logged)	0.36	95% Critical H Value (KM-Log)	1.775
KM Standard Error of Mean (logged)	0.12		

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	30.7	Mean in Log Scale	3.401
SD in Original Scale	6.572	SD in Log Scale	0.221
95% t UCL (Assumes normality)	31.97	95% H-Stat UCL	32.13

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL 18.68

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aroclor 1248 (µg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	39
		Number of Missing Observations	55
Number of Detects	2	Number of Non-Detects	72
Number of Distinct Detects	2	Number of Distinct Non-Detects	37
Minimum Detect	43	Minimum Non-Detect	40
Maximum Detect	120	Maximum Non-Detect	96
Variance Detects	2965	Percent Non-Detects	97.3%
Mean Detects	81.5	SD Detects	54.45
Median Detects	81.5	CV Detects	0.668
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	4.274	SD of Logged Detects	0.726

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	42.56	KM Standard Error of Mean	2.1
90KM SD	9.185	95% KM (BCA) UCL	N/A
95% KM (t) UCL	46.06	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	46.01	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	48.86	95% KM Chebyshev UCL	51.71
97.5% KM Chebyshev UCL	55.68	99% KM Chebyshev UCL	63.46

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	4.119	k star (bias corrected MLE)	N/A
Theta hat (MLE)	19.78	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	16.48	nu star (bias corrected)	N/A
Mean (detects)	81.5		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	42.56	SD (KM)	9.185
Variance (KM)	84.37	SE of Mean (KM)	2.1
k hat (KM)	21.47	k star (KM)	20.61
nu hat (KM)	3178	nu star (KM)	3050
theta hat (KM)	1.982	theta star (KM)	2.065

80% gamma percentile (KM)	50.18	90% gamma percentile (KM)	54.93
95% gamma percentile (KM)	59.06	99% gamma percentile (KM)	67.35

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0468
Approximate Chi Square Value (N/A, α)	2923	Adjusted Chi Square Value (N/A, β)	2920
95% KM Approximate Gamma UCL	44.41	95% KM Adjusted Gamma UCL	44.45

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	31.98	Mean in Log Scale	3.408
SD in Original Scale	13.41	SD in Log Scale	0.319
95% t UCL (assumes normality of ROS data)	34.58	95% Percentile Bootstrap UCL	34.73
95% BCA Bootstrap UCL	35.21	95% Bootstrap t UCL	35.7
95% H-UCL (Log ROS)	33.95		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.739	KM Geo Mean	42.07
KM SD (logged)	0.128	95% Critical H Value (KM-Log)	1.684
KM Standard Error of Mean (logged)	0.041	95% H-UCL (KM -Log)	43.5
KM SD (logged)	0.128	95% Critical H Value (KM-Log)	1.684
KM Standard Error of Mean (logged)	0.041		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	31.98	Mean in Log Scale	3.429
SD in Original Scale	11.86	SD in Log Scale	0.24
95% t UCL (Assumes normality)	34.28	95% H-Stat UCL	33.32

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL 46.06

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aroclor 1254 (µg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	44
		Number of Missing Observations	55
Number of Detects	43	Number of Non-Detects	31
Number of Distinct Detects	29	Number of Distinct Non-Detects	18

Minimum Detect	10	Minimum Non-Detect	40
Maximum Detect	340	Maximum Non-Detect	96
Variance Detects	5612	Percent Non-Detects	41.89%
Mean Detects	105.1	SD Detects	74.91
Median Detects	110	CV Detects	0.713
Skewness Detects	1.19	Kurtosis Detects	2.277
Mean of Logged Detects	4.353	SD of Logged Detects	0.869

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.877	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.923	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.122	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.156	Detected Data appear Normal at 1% Significance Level

Detected Data appear Approximate Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	73.68	KM Standard Error of Mean	8.14
90KM SD	67.96	95% KM (BCA) UCL	87.32
95% KM (t) UCL	87.24	95% KM (Percentile Bootstrap) UCL	87.11
95% KM (z) UCL	87.06	95% KM Bootstrap t UCL	90.45
90% KM Chebyshev UCL	98.1	95% KM Chebyshev UCL	109.2
97.5% KM Chebyshev UCL	124.5	99% KM Chebyshev UCL	154.7

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.047	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.763	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.157	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.137	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.805	k star (bias corrected MLE)	1.694
Theta hat (MLE)	58.24	Theta star (bias corrected MLE)	62.03
nu hat (MLE)	155.2	nu star (bias corrected)	145.7
Mean (detects)	105.1		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.388	Mean	73.06
Maximum	340	Median	40.6
SD	68.99	CV	0.944
k hat (MLE)	1.23	k star (bias corrected MLE)	1.189
Theta hat (MLE)	59.39	Theta star (bias corrected MLE)	61.43
nu hat (MLE)	182.1	nu star (bias corrected)	176
Adjusted Level of Significance (β)	0.0468		
Approximate Chi Square Value (176.03, α)	146.3	Adjusted Chi Square Value (176.03, β)	145.8
95% Gamma Approximate UCL	87.88	95% Gamma Adjusted UCL	88.2

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	73.68	SD (KM)	67.96
Variance (KM)	4619	SE of Mean (KM)	8.14
k hat (KM)	1.175	k star (KM)	1.137
nu hat (KM)	173.9	nu star (KM)	168.2
theta hat (KM)	62.7	theta star (KM)	64.83
80% gamma percentile (KM)	117.3	90% gamma percentile (KM)	164.4
95% gamma percentile (KM)	211	99% gamma percentile (KM)	318.3

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (168.20, α)	139.2	Adjusted Chi Square Value (168.20, β)	138.7
95% KM Approximate Gamma UCL	89.02	95% KM Adjusted Gamma UCL	89.35

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**	
10% Shapiro Wilk Critical Value	0.951	Detected Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.19	**Lilliefors GOF Test**	
10% Lilliefors Critical Value	0.123	Detected Data Not Lognormal at 10% Significance Level	

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	74.49	Mean in Log Scale	3.965
SD in Original Scale	67.68	SD in Log Scale	0.826
95% t UCL (assumes normality of ROS data)	87.6	95% Percentile Bootstrap UCL	87.27
95% BCA Bootstrap UCL	87.84	95% Bootstrap t UCL	89.62
95% H-UCL (Log ROS)	90.82		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.91	KM Geo Mean	49.89
KM SD (logged)	0.899	95% Critical H Value (KM-Log)	2.16
KM Standard Error of Mean (logged)	0.124	95% H-UCL (KM -Log)	93.75
KM SD (logged)	0.899	95% Critical H Value (KM-Log)	2.16
KM Standard Error of Mean (logged)	0.124		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	73.16	Mean in Log Scale	3.932
SD in Original Scale	68.37	SD in Log Scale	0.834
95% t UCL (Assumes normality)	86.4	95% H-Stat UCL	88.7

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL 87.24

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aroclor 1260 (µg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	48
		Number of Missing Observations	55
Number of Detects	26	Number of Non-Detects	48
Number of Distinct Detects	23	Number of Distinct Non-Detects	29
Minimum Detect	4.4	Minimum Non-Detect	40
Maximum Detect	90	Maximum Non-Detect	96
Variance Detects	626	Percent Non-Detects	64.86%
Mean Detects	36.13	SD Detects	25.02
Median Detects	26.5	CV Detects	0.692
Skewness Detects	0.805	Kurtosis Detects	-0.477
Mean of Logged Detects	3.326	SD of Logged Detects	0.785

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.9	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk Critical Value	0.891	Detected Data appear Normal at 1% Significance Level	
Lilliefors Test Statistic	0.197	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.199	Detected Data appear Normal at 1% Significance Level	

Detected Data appear Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	27.84	KM Standard Error of Mean	2.977
90KM SD	18.88	95% KM (BCA) UCL	32.5
95% KM (t) UCL	32.8	95% KM (Percentile Bootstrap) UCL	32.65
95% KM (z) UCL	32.74	95% KM Bootstrap t UCL	33.24
90% KM Chebyshev UCL	36.78	95% KM Chebyshev UCL	40.82
97.5% KM Chebyshev UCL	46.44	99% KM Chebyshev UCL	57.47

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.312	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.757	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.107	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.173	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.065	k star (bias corrected MLE)	1.852
Theta hat (MLE)	17.5	Theta star (bias corrected MLE)	19.5
nu hat (MLE)	107.4	nu star (bias corrected)	96.33
Mean (detects)	36.13		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.4	Mean	27.2
Maximum	90	Median	22.48
SD	16.87	CV	0.62
k hat (MLE)	3.584	k star (bias corrected MLE)	3.447
Theta hat (MLE)	7.59	Theta star (bias corrected MLE)	7.89
nu hat (MLE)	530.4	nu star (bias corrected)	510.2
Adjusted Level of Significance (β)	0.0468		
Approximate Chi Square Value (510.20, α)	458.8	Adjusted Chi Square Value (510.20, β)	457.9
95% Gamma Approximate UCL	30.25	95% Gamma Adjusted UCL	30.31

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	27.84	SD (KM)	18.88
Variance (KM)	356.4	SE of Mean (KM)	2.977
k hat (KM)	2.175	k star (KM)	2.096
nu hat (KM)	321.9	nu star (KM)	310.2
theta hat (KM)	12.8	theta star (KM)	13.29
80% gamma percentile (KM)	41.46	90% gamma percentile (KM)	53.56
95% gamma percentile (KM)	65.08	99% gamma percentile (KM)	90.55

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (310.18, α)	270.4	Adjusted Chi Square Value (310.18, β)	269.6
95% KM Approximate Gamma UCL	31.94	95% KM Adjusted Gamma UCL	32.03

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.963	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.933	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0941	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.156	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	26.09	Mean in Log Scale	3.11
SD in Original Scale	17.01	SD in Log Scale	0.532
95% t UCL (assumes normality of ROS data)	29.38	95% Percentile Bootstrap UCL	29.42
95% BCA Bootstrap UCL	29.84	95% Bootstrap t UCL	29.97
95% H-UCL (Log ROS)	29.02		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.104	KM Geo Mean	22.3
KM SD (logged)	0.693	95% Critical H Value (KM-Log)	1.981
KM Standard Error of Mean (logged)	0.132	95% H-UCL (KM -Log)	33.28
KM SD (logged)	0.693	95% Critical H Value (KM-Log)	1.981
KM Standard Error of Mean (logged)	0.132		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	32.18	Mean in Log Scale	3.365
SD in Original Scale	15.61	SD in Log Scale	0.483
95% t UCL (Assumes normality)	35.2	95% H-Stat UCL	36.07

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL	32.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

4,4'DDD (µg/kg)

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	10
Minimum	0.69	Mean	1.773
Maximum	3.7	Median	1.35
SD	1.323	Std. Error of Mean	0.661
Coefficient of Variation	0.746	Skewness	1.652

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.828	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.687	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.361	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.413	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.329	95% Adjusted-CLT UCL (Chen-1995)	3.444
		95% Modified-t UCL (Johnson-1978)	3.42

Gamma GOF Test

A-D Test Statistic	0.376	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.32	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	2.81	k star (bias corrected MLE)	0.869
Theta hat (MLE)	0.631	Theta star (bias corrected MLE)	2.039
nu hat (MLE)	22.48	nu star (bias corrected)	6.953
MLE Mean (bias corrected)	1.773	MLE Sd (bias corrected)	1.901
		Approximate Chi Square Value (0.05)	2.145
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL	5.746	95% Adjusted Gamma UCL	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.792	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.277	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.346	Data appear Lognormal at 10% Significance Level	

Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	-0.371	Mean of logged Data	0.384
Maximum of Logged Data	1.308	SD of logged Data	0.693

Assuming Lognormal Distribution

95% H-UCL	12.54	90% Chebyshev (MVUE) UCL	3.5
95% Chebyshev (MVUE) UCL	4.294	97.5% Chebyshev (MVUE) UCL	5.396
99% Chebyshev (MVUE) UCL	7.561		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	2.86	95% BCA Bootstrap UCL	N/A
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
90% Chebyshev(Mean, Sd) UCL	3.757	95% Chebyshev(Mean, Sd) UCL	4.655
97.5% Chebyshev(Mean, Sd) UCL	5.903	99% Chebyshev(Mean, Sd) UCL	8.353

Suggested UCL to Use

95% Student's-t UCL	3.329

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

4,4'DDE (µg/kg)

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	10
Minimum	0.63	Mean	1.933
Maximum	4.3	Median	1.4
SD	1.628	Std. Error of Mean	0.814
Coefficient of Variation	0.842	Skewness	1.643

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.687	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.331	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.413	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.848	95% Adjusted-CLT UCL (Chen-1995)	3.986
		95% Modified-t UCL (Johnson-1978)	3.959

Gamma GOF Test

A-D Test Statistic	0.302	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.266	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	2.18	k star (bias corrected MLE)	0.712
Theta hat (MLE)	0.887	Theta star (bias corrected MLE)	2.716
nu hat (MLE)	17.44	nu star (bias corrected)	5.693
MLE Mean (bias corrected)	1.933	MLE Sd (bias corrected)	2.291
		Approximate Chi Square Value (0.05)	1.485
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL	7.409	95% Adjusted Gamma UCL	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.792	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.221	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.346	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	-0.462	Mean of logged Data	0.412
Maximum of Logged Data	1.459	SD of logged Data	0.799

Assuming Lognormal Distribution

95% H-UCL	25.19	90% Chebyshev (MVUE) UCL	4.068
95% Chebyshev (MVUE) UCL	5.051	97.5% Chebyshev (MVUE) UCL	6.416
99% Chebyshev (MVUE) UCL	9.095		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	3.271	95% BCA Bootstrap UCL	N/A
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
90% Chebyshev(Mean, Sd) UCL	4.374	95% Chebyshev(Mean, Sd) UCL	5.48
97.5% Chebyshev(Mean, Sd) UCL	7.015	99% Chebyshev(Mean, Sd) UCL	10.03

Suggested UCL to Use

95% Student's-t UCL 3.848

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

4,4'DDT (µg/kg)

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	10
Number of Detects	3	Number of Non-Detects	1
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	2.1	Minimum Non-Detect	5.8
Maximum Detect	5.4	Maximum Non-Detect	5.8
Variance Detects	2.823	Percent Non-Detects	25%
Mean Detects	3.933	SD Detects	1.68
Median Detects	4.3	CV Detects	0.427
Skewness Detects	-0.935	Kurtosis Detects	N/A
Mean of Logged Detects	1.296	SD of Logged Detects	0.493

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.

Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.964	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk Critical Value	0.753	Detected Data appear Normal at 1% Significance Level	
Lilliefors Test Statistic	0.253	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.429	Detected Data appear Normal at 1% Significance Level	

Detected Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	3.933	KM Standard Error of Mean	0.97
90KM SD	1.372	95% KM (BCA) UCL	N/A
95% KM (t) UCL	6.216	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	5.529	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	6.844	95% KM Chebyshev UCL	8.162
97.5% KM Chebyshev UCL	9.992	99% KM Chebyshev UCL	13.59

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.339	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.637	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.309	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.433	Detected data appear Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	6.934	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.567	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	41.6	nu star (bias corrected)	N/A
Mean (detects)	3.933		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.1	Mean	3.91
Maximum	5.4	Median	4.069
SD	1.373	CV	0.351
k hat (MLE)	9.183	k star (bias corrected MLE)	2.463
Theta hat (MLE)	0.426	Theta star (bias corrected MLE)	1.588
nu hat (MLE)	73.47	nu star (bias corrected)	19.7
Adjusted Level of Significance (β)	0.00498		
Approximate Chi Square Value (19.70, α)	10.63	Adjusted Chi Square Value (19.70, β)	N/A
95% Gamma Approximate UCL	7.245	95% Gamma Adjusted UCL	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	3.933	SD (KM)	1.372

Variance (KM)	1.882	SE of Mean (KM)	0.97
k hat (KM)	8.22	k star (KM)	2.222
nu hat (KM)	65.76	nu star (KM)	17.77
theta hat (KM)	0.479	theta star (KM)	1.771
80% gamma percentile (KM)	5.816	90% gamma percentile (KM)	7.465
95% gamma percentile (KM)	9.028	99% gamma percentile (KM)	12.47

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (17.77, α)	9.227	Adjusted Chi Square Value (17.77, β)	6.132
95% KM Approximate Gamma UCL	7.576	95% KM Adjusted Gamma UCL	11.4

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.918	**Shapiro Wilk GOF Test**	
10% Shapiro Wilk Critical Value	0.789	Detected Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.296	**Lilliefors GOF Test**	
10% Lilliefors Critical Value	0.389	Detected Data appear Lognormal at 10% Significance Level	

Detected Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.863	Mean in Log Scale	1.296
SD in Original Scale	1.379	SD in Log Scale	0.402
95% t UCL (assumes normality of ROS data)	5.486	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	8.304		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.296	KM Geo Mean	3.653
KM SD (logged)	0.402	95% Critical H Value (KM-Log)	3.186
KM Standard Error of Mean (logged)	0.285	95% H-UCL (KM -Log)	8.304
KM SD (logged)	0.402	95% Critical H Value (KM-Log)	3.186
KM Standard Error of Mean (logged)	0.285		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.675	Mean in Log Scale	1.238
SD in Original Scale	1.466	SD in Log Scale	0.419
95% t UCL (Assumes normality)	5.4	95% H-Stat UCL	8.275

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL	6.216

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Dieldrin (µg/kg)

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	10
Minimum	1.1	Mean	2.575
Maximum	3.8	Median	2.7
SD	1.379	Std. Error of Mean	0.69
Coefficient of Variation	0.536	Skewness	-0.157

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.841	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.687	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.293	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.413	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level
Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.198	95% Adjusted-CLT UCL (Chen-1995)	3.652
		95% Modified-t UCL (Johnson-1978)	4.189

Gamma GOF Test

A-D Test Statistic	0.452	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.326	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level
Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	4.049	k star (bias corrected MLE)	1.179
Theta hat (MLE)	0.636	Theta star (bias corrected MLE)	2.184
nu hat (MLE)	32.39	nu star (bias corrected)	9.432
MLE Mean (bias corrected)	2.575	MLE Sd (bias corrected)	2.372
		Approximate Chi Square Value (0.05)	3.59
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL	6.765	95% Adjusted Gamma UCL	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.867	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.792	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.29	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.346	Data appear Lognormal at 10% Significance Level	

Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	0.817
Maximum of Logged Data	1.335	SD of logged Data	0.609

Assuming Lognormal Distribution

95% H-UCL	12.19	90% Chebyshev (MVUE) UCL	4.896
95% Chebyshev (MVUE) UCL	5.94	97.5% Chebyshev (MVUE) UCL	7.388
99% Chebyshev (MVUE) UCL	10.23		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	3.709	95% BCA Bootstrap UCL	N/A
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
90% Chebyshev(Mean, Sd) UCL	4.644	95% Chebyshev(Mean, Sd) UCL	5.581
97.5% Chebyshev(Mean, Sd) UCL	6.882	99% Chebyshev(Mean, Sd) UCL	9.437

Suggested UCL to Use

95% Student's-t UCL	4.198

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Total Organic Carbon (%)

General Statistics

Total Number of Observations	128	Number of Distinct Observations	121
		Number of Missing Observations	8
Minimum	0.151	Mean	4.159
Maximum	18.3	Median	3.59
SD	3.113	Std. Error of Mean	0.275
Coefficient of Variation	0.749	Skewness	1.729

Normal GOF Test

Shapiro Wilk Test Statistic	0.867	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.135	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.091	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.615	95% Adjusted-CLT UCL (Chen-1995)	4.656
		95% Modified-t UCL (Johnson-1978)	4.622

Gamma GOF Test

A-D Test Statistic	1.42	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.769	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0782	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0836	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.659	k star (bias corrected MLE)	1.625
Theta hat (MLE)	2.507	Theta star (bias corrected MLE)	2.559
nu hat (MLE)	424.6	nu star (bias corrected)	416
MLE Mean (bias corrected)	4.159	MLE Sd (bias corrected)	3.263
		Approximate Chi Square Value (0.05)	369.7
Adjusted Level of Significance	0.0481	Adjusted Chi Square Value	369.2

Assuming Gamma Distribution

95% Approximate Gamma UCL	4.679	95% Adjusted Gamma UCL	4.686

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.891	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	1.127E-13	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.135	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.072	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.89	Mean of logged Data	1.094
Maximum of Logged Data	2.907	SD of logged Data	0.955

Assuming Lognormal Distribution

95% H-UCL	5.654	90% Chebyshev (MVUE) UCL	6.098
95% Chebyshev (MVUE) UCL	6.737	97.5% Chebyshev (MVUE) UCL	7.624
99% Chebyshev (MVUE) UCL	9.365		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	4.611	95% BCA Bootstrap UCL	4.682
95% Standard Bootstrap UCL	4.619	95% Bootstrap-t UCL	4.708
95% Hall's Bootstrap UCL	4.716	95% Percentile Bootstrap UCL	4.612
90% Chebyshev(Mean, Sd) UCL	4.984	95% Chebyshev(Mean, Sd) UCL	5.358
97.5% Chebyshev(Mean, Sd) UCL	5.877	99% Chebyshev(Mean, Sd) UCL	6.897

Suggested UCL to Use

95% Approximate Gamma UCL	4.679

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 11/11/2022 3:20:21 PM
From File	Tower Slip ProUCL Input_g.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Dibenzofuran (µg/kg)

General Statistics

Total Number of Observations	92	Number of Distinct Observations	70
		Number of Missing Observations	13
Number of Detects	63	Number of Non-Detects	29
Number of Distinct Detects	51	Number of Distinct Non-Detects	23
Minimum Detect	0.26	Minimum Non-Detect	20
Maximum Detect	2300	Maximum Non-Detect	6500
Variance Detects	288481	Percent Non-Detects	31.52%
Mean Detects	357.1	SD Detects	537.1
Median Detects	130	CV Detects	1.504
Skewness Detects	2.073	Kurtosis Detects	3.583
Mean of Logged Detects	4.54	SD of Logged Detects	2.157

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.671	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.271	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.129	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	277.9	KM Standard Error of Mean	53.04
90KM SD	481.8	95% KM (BCA) UCL	376.9
95% KM (t) UCL	366.1	95% KM (Percentile Bootstrap) UCL	366.9
95% KM (z) UCL	365.2	95% KM Bootstrap t UCL	384.5
90% KM Chebyshev UCL	437	95% KM Chebyshev UCL	509.1
97.5% KM Chebyshev UCL	609.2	99% KM Chebyshev UCL	805.7

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.677	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.821	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.117	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.119	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.478	k star (bias corrected MLE)	0.466
Theta hat (MLE)	746.9	Theta star (bias corrected MLE)	766.4
nu hat (MLE)	60.25	nu star (bias corrected)	58.71
Mean (detects)	357.1		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	254.5
Maximum	2300	Median	75.41
SD	469.2	CV	1.844
k hat (MLE)	0.273	k star (bias corrected MLE)	0.271
Theta hat (MLE)	933.6	Theta star (bias corrected MLE)	939.3
nu hat (MLE)	50.16	nu star (bias corrected)	49.85
Adjusted Level of Significance (β)	0.0474		
Approximate Chi Square Value (49.85, α)	34.64	Adjusted Chi Square Value (49.85, β)	34.44
95% Gamma Approximate UCL	366.3	95% Gamma Adjusted UCL	368.4

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	277.9	SD (KM)	481.8
Variance (KM)	232152	SE of Mean (KM)	53.04
k hat (KM)	0.333	k star (KM)	0.329
nu hat (KM)	61.22	nu star (KM)	60.56
theta hat (KM)	835.3	theta star (KM)	844.4
80% gamma percentile (KM)	435.1	90% gamma percentile (KM)	809.9
95% gamma percentile (KM)	1234	99% gamma percentile (KM)	2322

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (60.56, α)	43.66	Adjusted Chi Square Value (60.56, β)	43.44
95% KM Approximate Gamma UCL	385.5	95% KM Adjusted Gamma UCL	387.5

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.904	**Shapiro Wilk GOF Test**
10% Shapiro Wilk P Value	3.7515E-5	Detected Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.145	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.102	Detected Data Not Lognormal at 10% Significance Level

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	252.7	Mean in Log Scale	3.966
SD in Original Scale	469.8	SD in Log Scale	2.076
95% t UCL (assumes normality of ROS data)	334.1	95% Percentile Bootstrap UCL	340.2
95% BCA Bootstrap UCL	353.2	95% Bootstrap t UCL	355.1
95% H-UCL (Log ROS)	973.3		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.821	KM Geo Mean	45.64
KM SD (logged)	2.49	95% Critical H Value (KM-Log)	4.035
KM Standard Error of Mean (logged)	0.306	95% H-UCL (KM -Log)	2906
KM SD (logged)	2.49	95% Critical H Value (KM-Log)	4.035
KM Standard Error of Mean (logged)	0.306		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	459.2	Mean in Log Scale	4.625
SD in Original Scale	731.4	SD in Log Scale	2.171
95% t UCL (Assumes normality)	585.9	95% H-Stat UCL	2452

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL 385.5

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	104	Number of Distinct Observations	64
		Number of Missing Observations	1
Number of Detects	55	Number of Non-Detects	49
Number of Distinct Detects	36	Number of Distinct Non-Detects	31
Minimum Detect	0.29	Minimum Non-Detect	5.1
Maximum Detect	9.4	Maximum Non-Detect	12.1
Variance Detects	7.159	Percent Non-Detects	47.12%
Mean Detects	2.183	SD Detects	2.676
Median Detects	1.1	CV Detects	1.226
Skewness Detects	2.01	Kurtosis Detects	2.506
Mean of Logged Detects	0.313	SD of Logged Detects	0.875

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.594	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.332	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.138	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.752	KM Standard Error of Mean	0.227
90KM SD	2.115	95% KM (BCA) UCL	2.142
95% KM (t) UCL	2.13	95% KM (Percentile Bootstrap) UCL	2.142
95% KM (z) UCL	2.126	95% KM Bootstrap t UCL	2.22
90% KM Chebyshev UCL	2.434	95% KM Chebyshev UCL	2.743
97.5% KM Chebyshev UCL	3.172	99% KM Chebyshev UCL	4.014

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	5.104	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.775	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.257	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.123	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.208	k star (bias corrected MLE)	1.154
Theta hat (MLE)	1.808	Theta star (bias corrected MLE)	1.892
nu hat (MLE)	132.8	nu star (bias corrected)	126.9
Mean (detects)	2.183		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.227	Mean	1.709
Maximum	9.4	Median	1.1
SD	2.045	CV	1.197
k hat (MLE)	1.486	k star (bias corrected MLE)	1.449
Theta hat (MLE)	1.15	Theta star (bias corrected MLE)	1.179
nu hat (MLE)	309	nu star (bias corrected)	301.4
Adjusted Level of Significance (β)	0.0477		
Approximate Chi Square Value (301.44, α)	262.2	Adjusted Chi Square Value (301.44, β)	261.7
95% Gamma Approximate UCL	1.964	95% Gamma Adjusted UCL	1.968

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.752	SD (KM)	2.115
Variance (KM)	4.475	SE of Mean (KM)	0.227
k hat (KM)	0.686	k star (KM)	0.673
nu hat (KM)	142.7	nu star (KM)	139.9
theta hat (KM)	2.554	theta star (KM)	2.605
80% gamma percentile (KM)	2.884	90% gamma percentile (KM)	4.44
95% gamma percentile (KM)	6.05	99% gamma percentile (KM)	9.908

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (139.94, α)	113.6	Adjusted Chi Square Value (139.94, β)	113.3
95% KM Approximate Gamma UCL	2.159	95% KM Adjusted Gamma UCL	2.165

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.866	**Shapiro Wilk GOF Test**	
10% Shapiro Wilk P Value	1.7247E-6	Detected Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**	
10% Lilliefors Critical Value	0.109	Detected Data Not Lognormal at 10% Significance Level	

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.72	Mean in Log Scale	0.233
SD in Original Scale	2.012	SD in Log Scale	0.668
95% t UCL (assumes normality of ROS data)	2.048	95% Percentile Bootstrap UCL	2.06
95% BCA Bootstrap UCL	2.109	95% Bootstrap t UCL	2.142
95% H-UCL (Log ROS)	1.793		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.19	KM Geo Mean	1.21
KM SD (logged)	0.748	95% Critical H Value (KM-Log)	1.998
KM Standard Error of Mean (logged)	0.09	95% H-UCL (KM -Log)	1.854
KM SD (logged)	0.748	95% Critical H Value (KM-Log)	1.998
KM Standard Error of Mean (logged)	0.09		

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.867	Mean in Log Scale	0.762
SD in Original Scale	2.148	SD in Log Scale	0.807
95% t UCL (Assumes normality)	3.217	95% H-Stat UCL	3.492

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL 2.13

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	104	Number of Distinct Observations	55
		Number of Missing Observations	1
Minimum	2	Mean	5.079
Maximum	9.5	Median	4.85
SD	1.823	Std. Error of Mean	0.179
Coefficient of Variation	0.359	Skewness	0.39

Normal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk P Value	0.00532	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.0727	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.101	Data appear Normal at 1% Significance Level	

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.376	95% Adjusted-CLT UCL (Chen-1995)	5.38
		95% Modified-t UCL (Johnson-1978)	5.377

Gamma GOF Test

A-D Test Statistic	0.526	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0711	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0885	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.471	k star (bias corrected MLE)	7.261
Theta hat (MLE)	0.68	Theta star (bias corrected MLE)	0.699
nu hat (MLE)	1554	nu star (bias corrected)	1510
MLE Mean (bias corrected)	5.079	MLE Sd (bias corrected)	1.885
		Approximate Chi Square Value (0.05)	1421
Adjusted Level of Significance	0.0477	Adjusted Chi Square Value	1420

Assuming Gamma Distribution

95% Approximate Gamma UCL	5.398	95% Adjusted Gamma UCL	5.402

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0.00229	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0814	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0798	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.693	Mean of logged Data	1.557
Maximum of Logged Data	2.251	SD of logged Data	0.382

Assuming Lognormal Distribution

95% H-UCL	5.454	90% Chebyshev (MVUE) UCL	5.691
95% Chebyshev (MVUE) UCL	5.959	97.5% Chebyshev (MVUE) UCL	6.332
99% Chebyshev (MVUE) UCL	7.063		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	5.373	95% BCA Bootstrap UCL	5.372
95% Standard Bootstrap UCL	5.372	95% Bootstrap-t UCL	5.399
95% Hall's Bootstrap UCL	5.397	95% Percentile Bootstrap UCL	5.366
90% Chebyshev(Mean, Sd) UCL	5.615	95% Chebyshev(Mean, Sd) UCL	5.858
97.5% Chebyshev(Mean, Sd) UCL	6.195	99% Chebyshev(Mean, Sd) UCL	6.858

Suggested UCL to Use

95% Student's-t UCL 5.376

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	104	Number of Distinct Observations	63
		Number of Missing Observations	1
Number of Detects	101	Number of Non-Detects	3
Number of Distinct Detects	62	Number of Distinct Non-Detects	2
Minimum Detect	0.13	Minimum Non-Detect	0.49
Maximum Detect	3.3	Maximum Non-Detect	0.53
Variance Detects	0.401	Percent Non-Detects	2.885%
Mean Detects	0.789	SD Detects	0.633
Median Detects	0.58	CV Detects	0.803
Skewness Detects	1.772	Kurtosis Detects	3.318
Mean of Logged Detects	-0.51	SD of Logged Detects	0.741

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.815	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.167	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.102	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.775	KM Standard Error of Mean	0.0617
90KM SD	0.626	95% KM (BCA) UCL	0.88
95% KM (t) UCL	0.878	95% KM (Percentile Bootstrap) UCL	0.884
95% KM (z) UCL	0.877	95% KM Bootstrap t UCL	0.893
90% KM Chebyshev UCL	0.961	95% KM Chebyshev UCL	1.044
97.5% KM Chebyshev UCL	1.161	99% KM Chebyshev UCL	1.389

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.992	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.765	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0915	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0904	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.987	k star (bias corrected MLE)	1.935
Theta hat (MLE)	0.397	Theta star (bias corrected MLE)	0.408

nu hat (MLE)	401.4	nu star (bias corrected)	390.8
Mean (detects)	0.789		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.13	Mean	0.774
Maximum	3.3	Median	0.57
SD	0.63	CV	0.814
k hat (MLE)	1.957	k star (bias corrected MLE)	1.907
Theta hat (MLE)	0.396	Theta star (bias corrected MLE)	0.406
nu hat (MLE)	407	nu star (bias corrected)	396.6
Adjusted Level of Significance (β)	0.0477		
Approximate Chi Square Value (396.56, α)	351.4	Adjusted Chi Square Value (396.56, β)	350.8
95% Gamma Approximate UCL	0.873	95% Gamma Adjusted UCL	0.875

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.775	SD (KM)	0.626
Variance (KM)	0.391	SE of Mean (KM)	0.0617
k hat (KM)	1.536	k star (KM)	1.499
nu hat (KM)	319.6	nu star (KM)	311.7
theta hat (KM)	0.505	theta star (KM)	0.517
80% gamma percentile (KM)	1.2	90% gamma percentile (KM)	1.616
95% gamma percentile (KM)	2.021	99% gamma percentile (KM)	2.934

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (311.69, α)	271.8	Adjusted Chi Square Value (311.69, β)	271.3
95% KM Approximate Gamma UCL	0.889	95% KM Adjusted Gamma UCL	0.891

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.972	**Shapiro Wilk GOF Test**
10% Shapiro Wilk P Value	0.19	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0505	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.0809	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.776	Mean in Log Scale	-0.527
SD in Original Scale	0.628	SD in Log Scale	0.738
95% t UCL (assumes normality of ROS data)	0.878	95% Percentile Bootstrap UCL	0.879
95% BCA Bootstrap UCL	0.885	95% Bootstrap t UCL	0.891
95% H-UCL (Log ROS)	0.896		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.529	KM Geo Mean	0.589
KM SD (logged)	0.738	95% Critical H Value (KM-Log)	1.99

KM Standard Error of Mean (logged)	0.073	95% H-UCL (KM -Log)	0.894
KM SD (logged)	0.738	95% Critical H Value (KM-Log)	1.99
KM Standard Error of Mean (logged)	0.073		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.773	Mean in Log Scale	-0.534
SD in Original Scale	0.63	SD in Log Scale	0.744
95% t UCL (Assumes normality)	0.876	95% H-Stat UCL	0.895

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 10% Significance Level

Suggested UCL to Use

KM H-UCL 0.894

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	104	Number of Distinct Observations	98
		Number of Missing Observations	1
Minimum	9.4	Mean	30.13
Maximum	98.1	Median	30.1
SD	12.49	Std. Error of Mean	1.225
Coefficient of Variation	0.415	Skewness	1.448

Normal GOF Test

Shapiro Wilk Test Statistic	0.918	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	4.2171E-7	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.0527	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.101	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	32.16	95% Adjusted-CLT UCL (Chen-1995)	32.33
		95% Modified-t UCL (Johnson-1978)	32.19

Gamma GOF Test

A-D Test Statistic	0.93	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0825	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0885	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.943	k star (bias corrected MLE)	5.778
Theta hat (MLE)	5.069	Theta star (bias corrected MLE)	5.214
nu hat (MLE)	1236	nu star (bias corrected)	1202
MLE Mean (bias corrected)	30.13	MLE Sd (bias corrected)	12.53
		Approximate Chi Square Value (0.05)	1122
Adjusted Level of Significance	0.0477	Adjusted Chi Square Value	1121

Assuming Gamma Distribution

95% Approximate Gamma UCL	32.26	95% Adjusted Gamma UCL	32.29

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk P Value	0.00158	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.108	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.0798	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.241	Mean of logged Data	3.319
Maximum of Logged Data	4.586	SD of logged Data	0.433

Assuming Lognormal Distribution

95% H-UCL	32.76	90% Chebyshev (MVUE) UCL	34.34
95% Chebyshev (MVUE) UCL	36.16	97.5% Chebyshev (MVUE) UCL	38.69
99% Chebyshev (MVUE) UCL	43.66		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	32.14	95% BCA Bootstrap UCL	32.37
95% Standard Bootstrap UCL	32.16	95% Bootstrap-t UCL	32.49
95% Hall's Bootstrap UCL	32.68	95% Percentile Bootstrap UCL	32.18
90% Chebyshev(Mean, Sd) UCL	33.8	95% Chebyshev(Mean, Sd) UCL	35.47
97.5% Chebyshev(Mean, Sd) UCL	37.78	99% Chebyshev(Mean, Sd) UCL	42.31

Suggested UCL to Use

95% Student's-t UCL 32.16

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	104	Number of Distinct Observations	87
		Number of Missing Observations	1
Minimum	8920	Mean	22790
Maximum	58700	Median	23050
SD	7848	Std. Error of Mean	769.6
Coefficient of Variation	0.344	Skewness	0.765

Normal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0.00458	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.0416	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.101	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	24067	95% Adjusted-CLT UCL (Chen-1995)	24117
		95% Modified-t UCL (Johnson-1978)	24077

Gamma GOF Test

A-D Test Statistic	1.017	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0783	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0884	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.219	k star (bias corrected MLE)	7.988
Theta hat (MLE)	2773	Theta star (bias corrected MLE)	2853
nu hat (MLE)	1710	nu star (bias corrected)	1662
MLE Mean (bias corrected)	22790	MLE Sd (bias corrected)	8063
		Approximate Chi Square Value (0.05)	1568
Adjusted Level of Significance	0.0477	Adjusted Chi Square Value	1567

Assuming Gamma Distribution

95% Approximate Gamma UCL	24151	95% Adjusted Gamma UCL	24171

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk P Value	0.00134	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.102	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.0798	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.096	Mean of logged Data	9.972
Maximum of Logged Data	10.98	SD of logged Data	0.365

Assuming Lognormal Distribution

95% H-UCL	24396	90% Chebyshev (MVUE) UCL	25415
95% Chebyshev (MVUE) UCL	26563	97.5% Chebyshev (MVUE) UCL	28156
99% Chebyshev (MVUE) UCL	31285		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	24056	95% BCA Bootstrap UCL	24152
95% Standard Bootstrap UCL	24053	95% Bootstrap-t UCL	24175
95% Hall's Bootstrap UCL	24200	95% Percentile Bootstrap UCL	24081
90% Chebyshev(Mean, Sd) UCL	25099	95% Chebyshev(Mean, Sd) UCL	26144
97.5% Chebyshev(Mean, Sd) UCL	27596	99% Chebyshev(Mean, Sd) UCL	30447

Suggested UCL to Use

95% Student's-t UCL 24067

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	104	Number of Distinct Observations	97
		Number of Missing Observations	1
Minimum	97	Mean	409.8
Maximum	981	Median	398
SD	189.1	Std. Error of Mean	18.54
Coefficient of Variation	0.461	Skewness	0.574

Normal GOF Test

Shapiro Wilk Test Statistic	0.956	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0.00788	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.0873	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.101	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	440.6	95% Adjusted-CLT UCL (Chen-1995)	441.4
		95% Modified-t UCL (Johnson-1978)	440.8

Gamma GOF Test

A-D Test Statistic	0.402	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0598	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0887	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.466	k star (bias corrected MLE)	4.344
Theta hat (MLE)	91.76	Theta star (bias corrected MLE)	94.35
nu hat (MLE)	929	nu star (bias corrected)	903.5
MLE Mean (bias corrected)	409.8	MLE Sd (bias corrected)	196.6
		Approximate Chi Square Value (0.05)	834.8
Adjusted Level of Significance	0.0477	Adjusted Chi Square Value	833.8

Assuming Gamma Distribution

95% Approximate Gamma UCL	443.6	95% Adjusted Gamma UCL	444.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0.0252	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0778	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0798	Data appear Lognormal at 10% Significance Level

Data appear Approximate Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.575	Mean of logged Data	5.9
Maximum of Logged Data	6.889	SD of logged Data	0.506

Assuming Lognormal Distribution

95% H-UCL	454.3	90% Chebyshev (MVUE) UCL	479.2
95% Chebyshev (MVUE) UCL	508.6	97.5% Chebyshev (MVUE) UCL	549.5
99% Chebyshev (MVUE) UCL	629.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	440.3	95% BCA Bootstrap UCL	441.4
95% Standard Bootstrap UCL	440.3	95% Bootstrap-t UCL	442.3
95% Hall's Bootstrap UCL	441.7	95% Percentile Bootstrap UCL	440.4
90% Chebyshev(Mean, Sd) UCL	465.5	95% Chebyshev(Mean, Sd) UCL	490.7
97.5% Chebyshev(Mean, Sd) UCL	525.6	99% Chebyshev(Mean, Sd) UCL	594.3

Suggested UCL to Use

95% Student's-t UCL	440.6

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aroclor 1242 (µg/kg)

General Statistics

Total Number of Observations	54	Number of Distinct Observations	28
		Number of Missing Observations	8
Number of Detects	1	Number of Non-Detects	53
Number of Distinct Detects	1	Number of Distinct Non-Detects	28

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Aroclor 1242 (µg/kg) was not processed!

Aroclor 1248 (µg/kg)

General Statistics

Total Number of Observations	54	Number of Distinct Observations	30
		Number of Missing Observations	8
Number of Detects	2	Number of Non-Detects	52
Number of Distinct Detects	2	Number of Distinct Non-Detects	28
Minimum Detect	43	Minimum Non-Detect	40
Maximum Detect	120	Maximum Non-Detect	96
Variance Detects	2965	Percent Non-Detects	96.3%
Mean Detects	81.5	SD Detects	54.45
Median Detects	81.5	CV Detects	0.668
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	4.274	SD of Logged Detects	0.726

Warning: Data set has only 2 Detected Values.

This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	42.95	KM Standard Error of Mean	2.513
90KM SD	10.69	95% KM (BCA) UCL	N/A
95% KM (t) UCL	47.16	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	47.09	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	50.49	95% KM Chebyshev UCL	53.91
97.5% KM Chebyshev UCL	58.65	99% KM Chebyshev UCL	67.96

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	4.119	k star (bias corrected MLE)	N/A
Theta hat (MLE)	19.78	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	16.48	nu star (bias corrected)	N/A
Mean (detects)	81.5		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	42.95	SD (KM)	10.69
Variance (KM)	114.2	SE of Mean (KM)	2.513
k hat (KM)	16.15	k star (KM)	15.27
nu hat (KM)	1745	nu star (KM)	1649
theta hat (KM)	2.659	theta star (KM)	2.813
80% gamma percentile (KM)	51.83	90% gamma percentile (KM)	57.51
95% gamma percentile (KM)	62.49	99% gamma percentile (KM)	72.57

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0456
Approximate Chi Square Value (N/A, α)	1556	Adjusted Chi Square Value (N/A, β)	1553
95% KM Approximate Gamma UCL	45.53	95% KM Adjusted Gamma UCL	45.6

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	31.93	Mean in Log Scale	3.396
SD in Original Scale	15	SD in Log Scale	0.345
95% t UCL (assumes normality of ROS data)	35.35	95% Percentile Bootstrap UCL	35.47
95% BCA Bootstrap UCL	36.74	95% Bootstrap t UCL	37.09
95% H-UCL (Log ROS)	34.39		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.745	KM Geo Mean	42.3
KM SD (logged)	0.148	95% Critical H Value (KM-Log)	1.708
KM Standard Error of Mean (logged)	0.0449	95% H-UCL (KM -Log)	44.27
KM SD (logged)	0.148	95% Critical H Value (KM-Log)	1.708
KM Standard Error of Mean (logged)	0.0449		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	30.9	Mean in Log Scale	3.388
SD in Original Scale	13.32	SD in Log Scale	0.252
95% t UCL (Assumes normality)	33.93	95% H-Stat UCL	32.43

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL 47.16

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aroclor 1254 (µg/kg)

General Statistics

Total Number of Observations	54	Number of Distinct Observations	38
		Number of Missing Observations	8
Number of Detects	28	Number of Non-Detects	26
Number of Distinct Detects	23	Number of Distinct Non-Detects	16
Minimum Detect	10	Minimum Non-Detect	40
Maximum Detect	340	Maximum Non-Detect	96
Variance Detects	6745	Percent Non-Detects	48.15%
Mean Detects	113.9	SD Detects	82.13
Median Detects	110	CV Detects	0.721
Skewness Detects	1.294	Kurtosis Detects	2.04
Mean of Logged Detects	4.452	SD of Logged Detects	0.836

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.878	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.896	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.125	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.191	Detected Data appear Normal at 1% Significance Level

Detected Data appear Approximate Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	73.79	KM Standard Error of Mean	10.2
90KM SD	71.91	95% KM (BCA) UCL	91.95
95% KM (t) UCL	90.87	95% KM (Percentile Bootstrap) UCL	91.49
95% KM (z) UCL	90.57	95% KM Bootstrap t UCL	94.14
90% KM Chebyshev UCL	104.4	95% KM Chebyshev UCL	118.3
97.5% KM Chebyshev UCL	137.5	99% KM Chebyshev UCL	175.3

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.357	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.759	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.114	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.168	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.915	k star (bias corrected MLE)	1.733
Theta hat (MLE)	59.47	Theta star (bias corrected MLE)	65.69
nu hat (MLE)	107.2	nu star (bias corrected)	97.07
Mean (detects)	113.9		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	68.44
Maximum	340	Median	34.5
SD	76.18	CV	1.113
k hat (MLE)	0.602	k star (bias corrected MLE)	0.581
Theta hat (MLE)	113.6	Theta star (bias corrected MLE)	117.8
nu hat (MLE)	65.04	nu star (bias corrected)	62.76
Adjusted Level of Significance (β)	0.0456		
Approximate Chi Square Value (62.76, α)	45.54	Adjusted Chi Square Value (62.76, β)	45.13
95% Gamma Approximate UCL	94.32	95% Gamma Adjusted UCL	95.16

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	73.79	SD (KM)	71.91
Variance (KM)	5172	SE of Mean (KM)	10.2
k hat (KM)	1.053	k star (KM)	1.007
nu hat (KM)	113.7	nu star (KM)	108.7
theta hat (KM)	70.08	theta star (KM)	73.3
80% gamma percentile (KM)	118.7	90% gamma percentile (KM)	169.6
95% gamma percentile (KM)	220.5	99% gamma percentile (KM)	338.7

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (108.73, α)	85.66	Adjusted Chi Square Value (108.73, β)	85.1
95% KM Approximate Gamma UCL	93.66	95% KM Adjusted Gamma UCL	94.28

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.936	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.153	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.151	Detected Data Not Lognormal at 10% Significance Level

Detected Data appear Approximate Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	73.92	Mean in Log Scale	3.94
SD in Original Scale	72.27	SD in Log Scale	0.828
95% t UCL (assumes normality of ROS data)	90.39	95% Percentile Bootstrap UCL	90.63
95% BCA Bootstrap UCL	92.83	95% Bootstrap t UCL	94.38
95% H-UCL (Log ROS)	92.46		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.907	KM Geo Mean	49.76
KM SD (logged)	0.886	95% Critical H Value (KM-Log)	2.201
KM Standard Error of Mean (logged)	0.156	95% H-UCL (KM -Log)	96.29
KM SD (logged)	0.886	95% Critical H Value (KM-Log)	2.201
KM Standard Error of Mean (logged)	0.156		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	72.73	Mean in Log Scale	3.913
SD in Original Scale	72.85	SD in Log Scale	0.831
95% t UCL (Assumes normality)	89.33	95% H-Stat UCL	90.24

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL 90.87

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aroclor 1260 (µg/kg)

General Statistics

Total Number of Observations	54	Number of Distinct Observations	36
		Number of Missing Observations	8
Number of Detects	15	Number of Non-Detects	39
Number of Distinct Detects	14	Number of Distinct Non-Detects	24
Minimum Detect	4.4	Minimum Non-Detect	40
Maximum Detect	78	Maximum Non-Detect	96
Variance Detects	531.4	Percent Non-Detects	72.22%
Mean Detects	35.29	SD Detects	23.05
Median Detects	26	CV Detects	0.653
Skewness Detects	0.585	Kurtosis Detects	-0.791
Mean of Logged Detects	3.306	SD of Logged Detects	0.824

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk Critical Value	0.835	Detected Data appear Normal at 1% Significance Level	
Lilliefors Test Statistic	0.19	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level	

Detected Data appear Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	26.32	KM Standard Error of Mean	3.508
90KM SD	16.46	95% KM (BCA) UCL	31.86
95% KM (t) UCL	32.19	95% KM (Percentile Bootstrap) UCL	31.97
95% KM (z) UCL	32.09	95% KM Bootstrap t UCL	32.16
90% KM Chebyshev UCL	36.85	95% KM Chebyshev UCL	41.61
97.5% KM Chebyshev UCL	48.23	99% KM Chebyshev UCL	61.23

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.336	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.147	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.095	k star (bias corrected MLE)	1.72
Theta hat (MLE)	16.85	Theta star (bias corrected MLE)	20.52
nu hat (MLE)	62.84	nu star (bias corrected)	51.61
Mean (detects)	35.29		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.4	Mean	25.68
Maximum	78	Median	21.94
SD	14.12	CV	0.55
k hat (MLE)	4.361	k star (bias corrected MLE)	4.131
Theta hat (MLE)	5.888	Theta star (bias corrected MLE)	6.215
nu hat (MLE)	471	nu star (bias corrected)	446.2
Adjusted Level of Significance (β)	0.0456		
Approximate Chi Square Value (446.19, α)	398.2	Adjusted Chi Square Value (446.19, β)	397
95% Gamma Approximate UCL	28.77	95% Gamma Adjusted UCL	28.86

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	26.32	SD (KM)	16.46
Variance (KM)	271	SE of Mean (KM)	3.508
k hat (KM)	2.556	k star (KM)	2.426
nu hat (KM)	276.1	nu star (KM)	262.1
theta hat (KM)	10.3	theta star (KM)	10.85
80% gamma percentile (KM)	38.51	90% gamma percentile (KM)	48.95
95% gamma percentile (KM)	58.8	99% gamma percentile (KM)	80.41

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (262.06, α)	225.6	Adjusted Chi Square Value (262.06, β)	224.6
95% KM Approximate Gamma UCL	30.58	95% KM Adjusted Gamma UCL	30.7

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.92	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.197	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	23.81	Mean in Log Scale	3.035
SD in Original Scale	14.53	SD in Log Scale	0.509
95% t UCL (assumes normality of ROS data)	27.12	95% Percentile Bootstrap UCL	27.23
95% BCA Bootstrap UCL	27.81	95% Bootstrap t UCL	28.29
95% H-UCL (Log ROS)	27.03		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.048	KM Geo Mean	21.06
KM SD (logged)	0.728	95% Critical H Value (KM-Log)	2.055
KM Standard Error of Mean (logged)	0.196	95% H-UCL (KM -Log)	33.72
KM SD (logged)	0.728	95% Critical H Value (KM-Log)	2.055
KM Standard Error of Mean (logged)	0.196		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	30.71	Mean in Log Scale	3.339
SD in Original Scale	12.93	SD in Log Scale	0.447
95% t UCL (Assumes normality)	33.66	95% H-Stat UCL	34.9

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL	32.19

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

4,4'DDD (µg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	8
Minimum	0.69	Mean	2.195
Maximum	3.7	Median	2.195

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 4,4'DDD (µg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

4,4'DDE (µg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	8
Minimum	1.2	Mean	1.4
Maximum	1.6	Median	1.4

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 4,4'DDE (µg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

4,4'DDT (µg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	8
Minimum	2.1	Mean	3.2
Maximum	4.3	Median	3.2

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 4,4'DDT (µg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Dieldrin (µg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	8
Minimum	1.7	Mean	2.75
Maximum	3.8	Median	2.75

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Dieldrin (µg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Total Organic Carbon (%)

General Statistics

Total Number of Observations	97	Number of Distinct Observations	92
		Number of Missing Observations	8
Minimum	0.151	Mean	4.295
Maximum	16.7	Median	3.76
SD	3.141	Std. Error of Mean	0.319
Coefficient of Variation	0.731	Skewness	1.198

Normal GOF Test

Shapiro Wilk Test Statistic	0.91	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	1.9856E-7	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.133	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.104	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.825	95% Adjusted-CLT UCL (Chen-1995)	4.861
		95% Modified-t UCL (Johnson-1978)	4.832

Gamma GOF Test

A-D Test Statistic	1.522	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.771	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.108	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0926	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.481	k star (bias corrected MLE)	1.442
Theta hat (MLE)	2.9	Theta star (bias corrected MLE)	2.978
nu hat (MLE)	287.4	nu star (bias corrected)	279.8
MLE Mean (bias corrected)	4.295	MLE Sd (bias corrected)	3.577
		Approximate Chi Square Value (0.05)	242.1
Adjusted Level of Significance	0.0475	Adjusted Chi Square Value	241.6

Assuming Gamma Distribution

95% Approximate Gamma UCL	4.965	95% Adjusted Gamma UCL	4.976

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.869	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk P Value	4.253E-12	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.17	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.0825	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.89	Mean of logged Data	1.084
Maximum of Logged Data	2.815	SD of logged Data	1.047

Assuming Lognormal Distribution

95% H-UCL	6.538	90% Chebyshev (MVUE) UCL	7.034
95% Chebyshev (MVUE) UCL	7.924	97.5% Chebyshev (MVUE) UCL	9.159
99% Chebyshev (MVUE) UCL	11.59		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	4.82	95% BCA Bootstrap UCL	4.841
95% Standard Bootstrap UCL	4.822	95% Bootstrap-t UCL	4.883
95% Hall's Bootstrap UCL	4.89	95% Percentile Bootstrap UCL	4.818
90% Chebyshev(Mean, Sd) UCL	5.252	95% Chebyshev(Mean, Sd) UCL	5.686
97.5% Chebyshev(Mean, Sd) UCL	6.287	99% Chebyshev(Mean, Sd) UCL	7.469

Suggested UCL to Use

95% Student's-t UCL	4.825

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 11/11/2022 3:21:08 PM
From File	Tower Slip ProUCL Input_h.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Dibenzofuran (µg/kg)

General Statistics

Total Number of Observations	24	Number of Distinct Observations	19
		Number of Missing Observations	7
Minimum	14	Mean	78.29
Maximum	250	Median	71
SD	54.36	Std. Error of Mean	11.1
Coefficient of Variation	0.694	Skewness	1.264

Normal GOF Test

Shapiro Wilk Test Statistic	0.866	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.884	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.147	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.205	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	97.31	95% Adjusted-CLT UCL (Chen-1995)	99.6
		95% Modified-t UCL (Johnson-1978)	97.79

Gamma GOF Test

A-D Test Statistic	0.63	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.148	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.18	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.132	k star (bias corrected MLE)	1.893
Theta hat (MLE)	36.73	Theta star (bias corrected MLE)	41.36
nu hat (MLE)	102.3	nu star (bias corrected)	90.86
MLE Mean (bias corrected)	78.29	MLE Sd (bias corrected)	56.91
		Approximate Chi Square Value (0.05)	69.88
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	68.58

Assuming Gamma Distribution

95% Approximate Gamma UCL	101.8	95% Adjusted Gamma UCL	103.7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.93	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.158	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.162	Data appear Lognormal at 10% Significance Level	

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.639	Mean of logged Data	4.108
Maximum of Logged Data	5.521	SD of logged Data	0.767

Assuming Lognormal Distribution

95% H-UCL	117	90% Chebyshev (MVUE) UCL	121.3
95% Chebyshev (MVUE) UCL	139.9	97.5% Chebyshev (MVUE) UCL	165.7
99% Chebyshev (MVUE) UCL	216.3		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	96.54	95% BCA Bootstrap UCL	99.83
95% Standard Bootstrap UCL	96.3	95% Bootstrap-t UCL	102.1
95% Hall's Bootstrap UCL	106.3	95% Percentile Bootstrap UCL	96.79
90% Chebyshev(Mean, Sd) UCL	111.6	95% Chebyshev(Mean, Sd) UCL	126.7
97.5% Chebyshev(Mean, Sd) UCL	147.6	99% Chebyshev(Mean, Sd) UCL	188.7

Suggested UCL to Use

95% Student's-t UCL	97.31

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	24
Number of Detects	15	Number of Non-Detects	16
Number of Distinct Detects	9	Number of Distinct Non-Detects	15
Minimum Detect	0.58	Minimum Non-Detect	8
Maximum Detect	2.8	Maximum Non-Detect	14.8
Variance Detects	0.268	Percent Non-Detects	51.61%
Mean Detects	1.329	SD Detects	0.518
Median Detects	1.3	CV Detects	0.39
Skewness Detects	1.461	Kurtosis Detects	4.182
Mean of Logged Detects	0.218	SD of Logged Detects	0.377

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.865	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Detected Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.234	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level

Detected Data appear Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.329	KM Standard Error of Mean	0.134
90KM SD	0.501	95% KM (BCA) UCL	1.552
95% KM (t) UCL	1.556	95% KM (Percentile Bootstrap) UCL	1.553
95% KM (z) UCL	1.549	95% KM Bootstrap t UCL	1.64
90% KM Chebyshev UCL	1.73	95% KM Chebyshev UCL	1.912
97.5% KM Chebyshev UCL	2.164	99% KM Chebyshev UCL	2.66

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.454	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.19	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.757	k star (bias corrected MLE)	6.25
Theta hat (MLE)	0.171	Theta star (bias corrected MLE)	0.213
nu hat (MLE)	232.7	nu star (bias corrected)	187.5
Mean (detects)	1.329		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.58	Mean	1.305
Maximum	2.8	Median	1.282
SD	0.36	CV	0.276
k hat (MLE)	15.27	k star (bias corrected MLE)	13.82
Theta hat (MLE)	0.0855	Theta star (bias corrected MLE)	0.0945
nu hat (MLE)	946.9	nu star (bias corrected)	856.6
Adjusted Level of Significance (β)	0.0413		
Approximate Chi Square Value (856.55, α)	789.6	Adjusted Chi Square Value (856.55, β)	786.1
95% Gamma Approximate UCL	1.416	95% Gamma Adjusted UCL	1.422

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.329	SD (KM)	0.501
Variance (KM)	0.251	SE of Mean (KM)	0.134
k hat (KM)	7.045	k star (KM)	6.385
nu hat (KM)	436.8	nu star (KM)	395.9
theta hat (KM)	0.189	theta star (KM)	0.208
80% gamma percentile (KM)	1.739	90% gamma percentile (KM)	2.031
95% gamma percentile (KM)	2.295	99% gamma percentile (KM)	2.846

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (395.87, α)	350.8	Adjusted Chi Square Value (395.87, β)	348.4
95% KM Approximate Gamma UCL	1.5	95% KM Adjusted Gamma UCL	1.51

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.286	Mean in Log Scale	0.218
SD in Original Scale	0.361	SD in Log Scale	0.262
95% t UCL (assumes normality of ROS data)	1.396	95% Percentile Bootstrap UCL	1.391
95% BCA Bootstrap UCL	1.424	95% Bootstrap t UCL	1.435
95% H-UCL (Log ROS)	1.401		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.218	KM Geo Mean	1.244
KM SD (logged)	0.364	95% Critical H Value (KM-Log)	1.832
KM Standard Error of Mean (logged)	0.0973	95% H-UCL (KM -Log)	1.501
KM SD (logged)	0.364	95% Critical H Value (KM-Log)	1.832
KM Standard Error of Mean (logged)	0.0973		

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	3.346	Mean in Log Scale	0.95
SD in Original Scale	2.161	SD in Log Scale	0.778
95% t UCL (Assumes normality)	4.005	95% H-Stat UCL	4.771

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL 1.556

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	34	Number of Distinct Observations	30
		Number of Missing Observations	0
Minimum	3.1	Mean	6.718
Maximum	12	Median	6.65
SD	2.465	Std. Error of Mean	0.423
Coefficient of Variation	0.367	Skewness	0.422

Normal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk Critical Value	0.908	Data appear Normal at 1% Significance Level	
Lilliefors Test Statistic	0.123	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.175	Data appear Normal at 1% Significance Level	

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	7.434	95% Adjusted-CLT UCL (Chen-1995)	7.446
		95% Modified-t UCL (Johnson-1978)	7.439

Gamma GOF Test

A-D Test Statistic	0.385	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.111	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.151	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.553	k star (bias corrected MLE)	6.906
Theta hat (MLE)	0.89	Theta star (bias corrected MLE)	0.973
nu hat (MLE)	513.6	nu star (bias corrected)	469.6
MLE Mean (bias corrected)	6.718	MLE Sd (bias corrected)	2.557
		Approximate Chi Square Value (0.05)	420.3
Adjusted Level of Significance	0.0422	Adjusted Chi Square Value	418.1

Assuming Gamma Distribution

95% Approximate Gamma UCL	7.505	95% Adjusted Gamma UCL	7.547

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.958	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.943	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.108	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.137	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.131	Mean of logged Data	1.837
Maximum of Logged Data	2.485	SD of logged Data	0.379

Assuming Lognormal Distribution

95% H-UCL	7.62	90% Chebyshev (MVUE) UCL	8.077
95% Chebyshev (MVUE) UCL	8.687	97.5% Chebyshev (MVUE) UCL	9.534
99% Chebyshev (MVUE) UCL	11.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	7.413	95% BCA Bootstrap UCL	7.441
95% Standard Bootstrap UCL	7.407	95% Bootstrap-t UCL	7.483
95% Hall's Bootstrap UCL	7.46	95% Percentile Bootstrap UCL	7.403
90% Chebyshev(Mean, Sd) UCL	7.986	95% Chebyshev(Mean, Sd) UCL	8.561
97.5% Chebyshev(Mean, Sd) UCL	9.358	99% Chebyshev(Mean, Sd) UCL	10.92

Suggested UCL to Use

95% Student's-t UCL 7.434

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	28
		Number of Missing Observations	0
Minimum	0.25	Mean	0.587
Maximum	1	Median	0.6
SD	0.214	Std. Error of Mean	0.0384
Coefficient of Variation	0.365	Skewness	0.231

Normal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk Critical Value	0.902	Data appear Normal at 1% Significance Level	
Lilliefors Test Statistic	0.123	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.182	Data appear Normal at 1% Significance Level	

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.652	95% Adjusted-CLT UCL (Chen-1995)	0.652
		95% Modified-t UCL (Johnson-1978)	0.652

Gamma GOF Test

A-D Test Statistic	0.493	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.112	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.158	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.393	k star (bias corrected MLE)	6.699
Theta hat (MLE)	0.0794	Theta star (bias corrected MLE)	0.0876
nu hat (MLE)	458.4	nu star (bias corrected)	415.3
MLE Mean (bias corrected)	0.587	MLE Sd (bias corrected)	0.227
		Approximate Chi Square Value (0.05)	369.1
Adjusted Level of Significance	0.0413	Adjusted Chi Square Value	366.7

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.66	95% Adjusted Gamma UCL	0.665

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.115	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.143	Data appear Lognormal at 10% Significance Level	

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.386	Mean of logged Data	-0.602
Maximum of Logged Data	0	SD of logged Data	0.387

Assuming Lognormal Distribution

95% H-UCL	0.672	90% Chebyshev (MVUE) UCL	0.714
95% Chebyshev (MVUE) UCL	0.771	97.5% Chebyshev (MVUE) UCL	0.851
99% Chebyshev (MVUE) UCL	1.006		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	0.65	95% BCA Bootstrap UCL	0.649
95% Standard Bootstrap UCL	0.648	95% Bootstrap-t UCL	0.655
95% Hall's Bootstrap UCL	0.653	95% Percentile Bootstrap UCL	0.647
90% Chebyshev(Mean, Sd) UCL	0.702	95% Chebyshev(Mean, Sd) UCL	0.754
97.5% Chebyshev(Mean, Sd) UCL	0.827	99% Chebyshev(Mean, Sd) UCL	0.969

Suggested UCL to Use

95% Student's-t UCL	0.652

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	30
		Number of Missing Observations	0
Minimum	18	Mean	35.92
Maximum	49.5	Median	38.8
SD	9.204	Std. Error of Mean	1.653
Coefficient of Variation	0.256	Skewness	-0.294

Normal GOF Test

Shapiro Wilk Test Statistic	0.925	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.902	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.167	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.182	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	38.72	95% Adjusted-CLT UCL (Chen-1995)	38.54
		95% Modified-t UCL (Johnson-1978)	38.71

Gamma GOF Test

A-D Test Statistic	1.06	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.194	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.158	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	14.22	k star (bias corrected MLE)	12.87
Theta hat (MLE)	2.525	Theta star (bias corrected MLE)	2.791
nu hat (MLE)	881.8	nu star (bias corrected)	797.8
MLE Mean (bias corrected)	35.92	MLE Sd (bias corrected)	10.01
		Approximate Chi Square Value (0.05)	733.2
Adjusted Level of Significance	0.0413	Adjusted Chi Square Value	729.8

Assuming Gamma Distribution

95% Approximate Gamma UCL	39.08	95% Adjusted Gamma UCL	39.26

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.907	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.202	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.143	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.89	Mean of logged Data	3.546
Maximum of Logged Data	3.902	SD of logged Data	0.279

Assuming Lognormal Distribution

95% H-UCL	39.47	90% Chebyshev (MVUE) UCL	41.49
95% Chebyshev (MVUE) UCL	43.98	97.5% Chebyshev (MVUE) UCL	47.44
99% Chebyshev (MVUE) UCL	54.23		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	38.64	95% BCA Bootstrap UCL	38.49
95% Standard Bootstrap UCL	38.56	95% Bootstrap-t UCL	38.63
95% Hall's Bootstrap UCL	38.49	95% Percentile Bootstrap UCL	38.55
90% Chebyshev(Mean, Sd) UCL	40.88	95% Chebyshev(Mean, Sd) UCL	43.12
97.5% Chebyshev(Mean, Sd) UCL	46.24	99% Chebyshev(Mean, Sd) UCL	52.36

Suggested UCL to Use

95% Student's-t UCL 38.72

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Iron (mg/kg)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	28
		Number of Missing Observations	0
Minimum	16400	Mean	31397
Maximum	46200	Median	33400
SD	8649	Std. Error of Mean	1553
Coefficient of Variation	0.275	Skewness	-0.207

Normal GOF Test

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.902	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.152	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.182	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	34033	95% Adjusted-CLT UCL (Chen-1995)	33890
		95% Modified-t UCL (Johnson-1978)	34024

Gamma GOF Test

A-D Test Statistic	0.992	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.171	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.158	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	12.38	k star (bias corrected MLE)	11.21

Theta hat (MLE)	2535	Theta star (bias corrected MLE)	2802
nu hat (MLE)	767.8	nu star (bias corrected)	694.8
MLE Mean (bias corrected)	31397	MLE Sd (bias corrected)	9379
		Approximate Chi Square Value (0.05)	634.7
Adjusted Level of Significance	0.0413	Adjusted Chi Square Value	631.5

Assuming Gamma Distribution

95% Approximate Gamma UCL	34373	95% Adjusted Gamma UCL	34546

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.184	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.143	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.705	Mean of logged Data	10.31
Maximum of Logged Data	10.74	SD of logged Data	0.299

Assuming Lognormal Distribution

95% H-UCL	34764	90% Chebyshev (MVUE) UCL	36632
95% Chebyshev (MVUE) UCL	38970	97.5% Chebyshev (MVUE) UCL	42215
99% Chebyshev (MVUE) UCL	48588		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	33952	95% BCA Bootstrap UCL	33742
95% Standard Bootstrap UCL	33892	95% Bootstrap-t UCL	34015
95% Hall's Bootstrap UCL	33873	95% Percentile Bootstrap UCL	33742
90% Chebyshev(Mean, Sd) UCL	36057	95% Chebyshev(Mean, Sd) UCL	38168
97.5% Chebyshev(Mean, Sd) UCL	41097	99% Chebyshev(Mean, Sd) UCL	46852

Suggested UCL to Use

95% Student's-t UCL 34033

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Manganese (mg/kg)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	31
		Number of Missing Observations	0
Minimum	333	Mean	751.2
Maximum	1190	Median	732
SD	216	Std. Error of Mean	38.79
Coefficient of Variation	0.287	Skewness	0.228

Normal GOF Test

Shapiro Wilk Test Statistic	0.974	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.902	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.105	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.182	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	817.1	95% Adjusted-CLT UCL (Chen-1995)	816.7
		95% Modified-t UCL (Johnson-1978)	817.3

Gamma GOF Test

A-D Test Statistic	0.237	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0868	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.158	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.89	k star (bias corrected MLE)	10.76
Theta hat (MLE)	63.18	Theta star (bias corrected MLE)	69.81
nu hat (MLE)	737.2	nu star (bias corrected)	667.2
MLE Mean (bias corrected)	751.2	MLE Sd (bias corrected)	229
		Approximate Chi Square Value (0.05)	608.3
Adjusted Level of Significance	0.0413	Adjusted Chi Square Value	605.1

Assuming Gamma Distribution

95% Approximate Gamma UCL	824	95% Adjusted Gamma UCL	828.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.968	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.102	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.143	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.808	Mean of logged Data	6.579
Maximum of Logged Data	7.082	SD of logged Data	0.304

Assuming Lognormal Distribution

95% H-UCL	833	90% Chebyshev (MVUE) UCL	878.2
95% Chebyshev (MVUE) UCL	935.1	97.5% Chebyshev (MVUE) UCL	1014
99% Chebyshev (MVUE) UCL	1169		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	815	95% BCA Bootstrap UCL	816.2
95% Standard Bootstrap UCL	813.6	95% Bootstrap-t UCL	822.4
95% Hall's Bootstrap UCL	821.4	95% Percentile Bootstrap UCL	813.3
90% Chebyshev(Mean, Sd) UCL	867.6	95% Chebyshev(Mean, Sd) UCL	920.3
97.5% Chebyshev(Mean, Sd) UCL	993.5	99% Chebyshev(Mean, Sd) UCL	1137

Suggested UCL to Use

95% Student's-t UCL 817.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aroclor 1242 (µg/kg)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	10
Number of Detects	1	Number of Non-Detects	19
Number of Distinct Detects	1	Number of Distinct Non-Detects	18

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Aroclor 1242 (µg/kg) was not processed!

Aroclor 1248 (µg/kg)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	18
		Number of Missing Observations	10
Number of Detects	0	Number of Non-Detects	20
Number of Distinct Detects	0	Number of Distinct Non-Detects	18

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Aroclor 1248 (µg/kg) was not processed!

Aroclor 1254 (µg/kg)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	17
		Number of Missing Observations	10
Number of Detects	15	Number of Non-Detects	5
Number of Distinct Detects	12	Number of Distinct Non-Detects	5
Minimum Detect	11	Minimum Non-Detect	55
Maximum Detect	160	Maximum Non-Detect	71
Variance Detects	3387	Percent Non-Detects	25%
Mean Detects	88.73	SD Detects	58.19
Median Detects	120	CV Detects	0.656
Skewness Detects	-0.146	Kurtosis Detects	-2.029
Mean of Logged Detects	4.169	SD of Logged Detects	0.929

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.238	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level

Detected Data appear Approximate Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	74.09	KM Standard Error of Mean	12.94
90KM SD	55.28	95% KM (BCA) UCL	94.35
95% KM (t) UCL	96.46	95% KM (Percentile Bootstrap) UCL	95.14
95% KM (z) UCL	95.37	95% KM Bootstrap t UCL	98.31
90% KM Chebyshev UCL	112.9	95% KM Chebyshev UCL	130.5
97.5% KM Chebyshev UCL	154.9	99% KM Chebyshev UCL	202.9

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.119	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.751	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.281	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.225	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.725	k star (bias corrected MLE)	1.424
Theta hat (MLE)	51.45	Theta star (bias corrected MLE)	62.31
nu hat (MLE)	51.74	nu star (bias corrected)	42.72
Mean (detects)	88.73		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	11	Mean	77.08
Maximum	160	Median	42.14
SD	54.07	CV	0.701
k hat (MLE)	1.915	k star (bias corrected MLE)	1.661
Theta hat (MLE)	40.25	Theta star (bias corrected MLE)	46.41
nu hat (MLE)	76.6	nu star (bias corrected)	66.44
Adjusted Level of Significance (β)	0.038		
Approximate Chi Square Value (66.44, α)	48.68	Adjusted Chi Square Value (66.44, β)	47.48
95% Gamma Approximate UCL	105.2	95% Gamma Adjusted UCL	107.9

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	74.09	SD (KM)	55.28
Variance (KM)	3056	SE of Mean (KM)	12.94
k hat (KM)	1.796	k star (KM)	1.56
nu hat (KM)	71.85	nu star (KM)	62.41
theta hat (KM)	41.24	theta star (KM)	47.49
80% gamma percentile (KM)	114.1	90% gamma percentile (KM)	152.9
95% gamma percentile (KM)	190.5	99% gamma percentile (KM)	275.1

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (62.41, α)	45.24	Adjusted Chi Square Value (62.41, β)	44.08
95% KM Approximate Gamma UCL	102.2	95% KM Adjusted Gamma UCL	104.9

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.838	**Shapiro Wilk GOF Test**	
10% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.281	**Lilliefors GOF Test**	
10% Lilliefors Critical Value	0.202	Detected Data Not Lognormal at 10% Significance Level	

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	74.43	Mean in Log Scale	3.989
SD in Original Scale	56.05	SD in Log Scale	0.859
95% t UCL (assumes normality of ROS data)	96.1	95% Percentile Bootstrap UCL	94.83
95% BCA Bootstrap UCL	94.95	95% Bootstrap t UCL	98.63
95% H-UCL (Log ROS)	126.2		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.949	KM Geo Mean	51.87
KM SD (logged)	0.903	95% Critical H Value (KM-Log)	2.496
KM Standard Error of Mean (logged)	0.223	95% H-UCL (KM -Log)	130.8
KM SD (logged)	0.903	95% Critical H Value (KM-Log)	2.496
KM Standard Error of Mean (logged)	0.223		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	74.3	Mean in Log Scale	3.984
SD in Original Scale	56.18	SD in Log Scale	0.864
95% t UCL (Assumes normality)	96.02	95% H-Stat UCL	126.6

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL 96.46

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aroclor 1260 (µg/kg)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	10
Number of Detects	11	Number of Non-Detects	9
Number of Distinct Detects	11	Number of Distinct Non-Detects	8
Minimum Detect	10	Minimum Non-Detect	50
Maximum Detect	90	Maximum Non-Detect	86
Variance Detects	818.4	Percent Non-Detects	45%
Mean Detects	37.27	SD Detects	28.61
Median Detects	27	CV Detects	0.768
Skewness Detects	1.017	Kurtosis Detects	-0.297
Mean of Logged Detects	3.352	SD of Logged Detects	0.767

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.846	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.792	Detected Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.223	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.291	Detected Data appear Normal at 1% Significance Level

Detected Data appear Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	32.3	KM Standard Error of Mean	6.467
90KM SD	23.58	95% KM (BCA) UCL	43.34
95% KM (t) UCL	43.48	95% KM (Percentile Bootstrap) UCL	43.28
95% KM (z) UCL	42.93	95% KM Bootstrap t UCL	45.9
90% KM Chebyshev UCL	51.7	95% KM Chebyshev UCL	60.48
97.5% KM Chebyshev UCL	72.68	99% KM Chebyshev UCL	96.64

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.399	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.258	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.032	k star (bias corrected MLE)	1.539
Theta hat (MLE)	18.34	Theta star (bias corrected MLE)	24.23
nu hat (MLE)	44.71	nu star (bias corrected)	33.85
Mean (detects)	37.27		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	10	Mean	31.56
Maximum	90	Median	24.36
SD	21.92	CV	0.694
k hat (MLE)	3.041	k star (bias corrected MLE)	2.618
Theta hat (MLE)	10.38	Theta star (bias corrected MLE)	12.06
nu hat (MLE)	121.6	nu star (bias corrected)	104.7
Adjusted Level of Significance (β)	0.038		
Approximate Chi Square Value (104.71, α)	82.1	Adjusted Chi Square Value (104.71, β)	80.52
95% Gamma Approximate UCL	40.25	95% Gamma Adjusted UCL	41.04

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	32.3	SD (KM)	23.58
Variance (KM)	555.9	SE of Mean (KM)	6.467
k hat (KM)	1.876	k star (KM)	1.628
nu hat (KM)	75.06	nu star (KM)	65.13
theta hat (KM)	17.21	theta star (KM)	19.83
80% gamma percentile (KM)	49.51	90% gamma percentile (KM)	65.97
95% gamma percentile (KM)	81.87	99% gamma percentile (KM)	117.6

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (65.13, α)	47.56	Adjusted Chi Square Value (65.13, β)	46.38
95% KM Approximate Gamma UCL	44.23	95% KM Adjusted Gamma UCL	45.36

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**	
10% Shapiro Wilk Critical Value	0.876	Detected Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.139	**Lilliefors GOF Test**	
10% Lilliefors Critical Value	0.231	Detected Data appear Lognormal at 10% Significance Level	

Detected Data appear Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	30.75	Mean in Log Scale	3.246
SD in Original Scale	22.14	SD in Log Scale	0.577
95% t UCL (assumes normality of ROS data)	39.31	95% Percentile Bootstrap UCL	39.17
95% BCA Bootstrap UCL	41.36	95% Bootstrap t UCL	44.64
95% H-UCL (Log ROS)	40.07		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.239	KM Geo Mean	25.5
KM SD (logged)	0.674	95% Critical H Value (KM-Log)	2.205
KM Standard Error of Mean (logged)	0.2	95% H-UCL (KM -Log)	45
KM SD (logged)	0.674	95% Critical H Value (KM-Log)	2.205
KM Standard Error of Mean (logged)	0.2		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	36.15	Mean in Log Scale	3.435
SD in Original Scale	21.16	SD in Log Scale	0.575
95% t UCL (Assumes normality)	44.33	95% H-Stat UCL	48.28

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL 43.48

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

4,4'DDD (µg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	2
Minimum	1.3	Mean	1.35
Maximum	1.4	Median	1.35

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 4,4'DDD (µg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

4,4'DDE (µg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	2
Minimum	0.63	Mean	2.465
Maximum	4.3	Median	2.465

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 4,4'DDE (µg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

4,4'DDT (µg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	2
Number of Detects	1	Number of Non-Detects	1
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 4,4'DDT (µg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Dieldrin (µg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	2
Minimum	1.1	Mean	2.4
Maximum	3.7	Median	2.4

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Dieldrin (µg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Total Organic Carbon (%)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	31
		Number of Missing Observations	0
Minimum	0.987	Mean	3.731
Maximum	18.3	Median	3.3
SD	3.036	Std. Error of Mean	0.545
Coefficient of Variation	0.814	Skewness	3.825

Normal GOF Test

Shapiro Wilk Test Statistic	0.606	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.902	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.259	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.182	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.657	95% Adjusted-CLT UCL (Chen-1995)	5.028
		95% Modified-t UCL (Johnson-1978)	4.719

Gamma GOF Test

A-D Test Statistic	0.891	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.164	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.159	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.813	k star (bias corrected MLE)	2.562
Theta hat (MLE)	1.327	Theta star (bias corrected MLE)	1.456
nu hat (MLE)	174.4	nu star (bias corrected)	158.8
MLE Mean (bias corrected)	3.731	MLE Sd (bias corrected)	2.331
		Approximate Chi Square Value (0.05)	130.7
Adjusted Level of Significance	0.0413	Adjusted Chi Square Value	129.3

Assuming Gamma Distribution

95% Approximate Gamma UCL	4.534	95% Adjusted Gamma UCL	4.584

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.936	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.14	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.143	Data appear Lognormal at 10% Significance Level	

Data appear Approximate Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.0131	Mean of logged Data	1.129
Maximum of Logged Data	2.907	SD of logged Data	0.589

Assuming Lognormal Distribution

95% H-UCL	4.56	90% Chebyshev (MVUE) UCL	4.883
95% Chebyshev (MVUE) UCL	5.44	97.5% Chebyshev (MVUE) UCL	6.213
99% Chebyshev (MVUE) UCL	7.731		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	4.628	95% BCA Bootstrap UCL	5.058
95% Standard Bootstrap UCL	4.608	95% Bootstrap-t UCL	5.403
95% Hall's Bootstrap UCL	8.552	95% Percentile Bootstrap UCL	4.708
90% Chebyshev(Mean, Sd) UCL	5.367	95% Chebyshev(Mean, Sd) UCL	6.108
97.5% Chebyshev(Mean, Sd) UCL	7.136	99% Chebyshev(Mean, Sd) UCL	9.157

Suggested UCL to Use

95% H-UCL 4.56

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 11/11/2022 3:22:01 PM
From File	Tower Slip ProUCL Input_i.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TOTAL 18 PAH (U=0) (ug/kg)

General Statistics

Total Number of Observations	136	Number of Distinct Observations	101
		Number of Missing Observations	0
Minimum	0.69	Mean	21914
Maximum	240000	Median	6500
SD	37836	Std. Error of Mean	3244
Coefficient of Variation	1.727	Skewness	2.971

Normal GOF Test

Shapiro Wilk Test Statistic	0.611	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.281	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.0883	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	27287	95% Adjusted-CLT UCL (Chen-1995)	28133
		95% Modified-t UCL (Johnson-1978)	27425

Gamma GOF Test

A-D Test Statistic	1.558	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.852	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.13	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0863	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.368	k star (bias corrected MLE)	0.365
Theta hat (MLE)	59533	Theta star (bias corrected MLE)	60058
nu hat (MLE)	100.1	nu star (bias corrected)	99.25
MLE Mean (bias corrected)	21914	MLE Sd (bias corrected)	36278
		Approximate Chi Square Value (0.05)	77.26
Adjusted Level of Significance	0.0482	Adjusted Chi Square Value	77.06

Assuming Gamma Distribution

95% Approximate Gamma UCL	28148	95% Adjusted Gamma UCL	28224

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.826	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk P Value	0	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.235	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.0699	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.371	Mean of logged Data	8.183
Maximum of Logged Data	12.39	SD of logged Data	2.949

Assuming Lognormal Distribution

95% H-UCL	859425	90% Chebyshev (MVUE) UCL	584400
95% Chebyshev (MVUE) UCL	742076	97.5% Chebyshev (MVUE) UCL	960924
99% Chebyshev (MVUE) UCL	1390810		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	27250	95% BCA Bootstrap UCL	28199
95% Standard Bootstrap UCL	27243	95% Bootstrap-t UCL	28730
95% Hall's Bootstrap UCL	28559	95% Percentile Bootstrap UCL	27567
90% Chebyshev(Mean, Sd) UCL	31647	95% Chebyshev(Mean, Sd) UCL	36056
97.5% Chebyshev(Mean, Sd) UCL	42175	99% Chebyshev(Mean, Sd) UCL	54195

Suggested UCL to Use

95% Student's-t UCL 27287

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

TOTAL 18 PAH (U=1/2 MDL) (ug/kg)

General Statistics

Total Number of Observations	136	Number of Distinct Observations	96
		Number of Missing Observations	0
Minimum	3.2	Mean	21930
Maximum	240000	Median	6500
SD	37847	Std. Error of Mean	3245
Coefficient of Variation	1.726	Skewness	2.968

Normal GOF Test

Shapiro Wilk Test Statistic	0.611	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.281	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.0883	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	27305	95% Adjusted-CLT UCL (Chen-1995)	28151
		95% Modified-t UCL (Johnson-1978)	27443

Gamma GOF Test

A-D Test Statistic	1.456	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.844	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.109	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0859	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.398	k star (bias corrected MLE)	0.394
Theta hat (MLE)	55106	Theta star (bias corrected MLE)	55648
nu hat (MLE)	108.2	nu star (bias corrected)	107.2
MLE Mean (bias corrected)	21930	MLE Sd (bias corrected)	34934
		Approximate Chi Square Value (0.05)	84.3
Adjusted Level of Significance	0.0482	Adjusted Chi Square Value	84.08

Assuming Gamma Distribution

95% Approximate Gamma UCL	27886	95% Adjusted Gamma UCL	27958

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.871	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.201	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0699	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.163	Mean of logged Data	8.341
Maximum of Logged Data	12.39	SD of logged Data	2.56

Assuming Lognormal Distribution

95% H-UCL	265692	90% Chebyshev (MVUE) UCL	221535
95% Chebyshev (MVUE) UCL	276285	97.5% Chebyshev (MVUE) UCL	352275
99% Chebyshev (MVUE) UCL	501542		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	27268	95% BCA Bootstrap UCL	28252
95% Standard Bootstrap UCL	27261	95% Bootstrap-t UCL	28745
95% Hall's Bootstrap UCL	28584	95% Percentile Bootstrap UCL	27576
90% Chebyshev(Mean, Sd) UCL	31666	95% Chebyshev(Mean, Sd) UCL	36077
97.5% Chebyshev(Mean, Sd) UCL	42198	99% Chebyshev(Mean, Sd) UCL	54221

Suggested UCL to Use

95% Student's-t UCL 27305

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

TOTAL 18 PAH (U=1/2 RDL) (ug/kg)

General Statistics

Total Number of Observations	136	Number of Distinct Observations	95
		Number of Missing Observations	0
Minimum	23	Mean	21953
Maximum	240000	Median	6500
SD	37868	Std. Error of Mean	3247
Coefficient of Variation	1.725	Skewness	2.965

Normal GOF Test

Shapiro Wilk Test Statistic	0.611	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.281	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.0883	Data Not Normal at 1% Significance Level	

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	27331	95% Adjusted-CLT UCL (Chen-1995)	28177
		95% Modified-t UCL (Johnson-1978)	27469

Gamma GOF Test

A-D Test Statistic	1.571	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.837	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0914	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0856	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.429	k star (bias corrected MLE)	0.424
Theta hat (MLE)	51200	Theta star (bias corrected MLE)	51750
nu hat (MLE)	116.6	nu star (bias corrected)	115.4
MLE Mean (bias corrected)	21953	MLE Sd (bias corrected)	33706
		Approximate Chi Square Value (0.05)	91.59
Adjusted Level of Significance	0.0482	Adjusted Chi Square Value	91.36

Assuming Gamma Distribution

95% Approximate Gamma UCL	27658	95% Adjusted Gamma UCL	27727

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.898	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	1.462E-13	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0699	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.135	Mean of logged Data	8.479
Maximum of Logged Data	12.39	SD of logged Data	2.261

Assuming Lognormal Distribution

95% H-UCL	124793	90% Chebyshev (MVUE) UCL	116304
95% Chebyshev (MVUE) UCL	142620	97.5% Chebyshev (MVUE) UCL	179144
99% Chebyshev (MVUE) UCL	250890		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	27294	95% BCA Bootstrap UCL	28245
95% Standard Bootstrap UCL	27287	95% Bootstrap-t UCL	28764
95% Hall's Bootstrap UCL	28622	95% Percentile Bootstrap UCL	27600
90% Chebyshev(Mean, Sd) UCL	31695	95% Chebyshev(Mean, Sd) UCL	36107
97.5% Chebyshev(Mean, Sd) UCL	42232	99% Chebyshev(Mean, Sd) UCL	54262

Suggested UCL to Use

95% Student's-t UCL 27331

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 11/11/2022 3:26:29 PM
From File	Tower Slip ProUCL Input_j.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TOTAL 18 PAH (U=0) (ug/kg)

General Statistics

Total Number of Observations	105	Number of Distinct Observations	89
		Number of Missing Observations	0
Minimum	0.69	Mean	26274
Maximum	240000	Median	8100
SD	42013	Std. Error of Mean	4100
Coefficient of Variation	1.599	Skewness	2.529

Normal GOF Test

Shapiro Wilk Test Statistic	0.664	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.266	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.1	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	33079	95% Adjusted-CLT UCL (Chen-1995)	34099
		95% Modified-t UCL (Johnson-1978)	33247

Gamma GOF Test

A-D Test Statistic	0.932	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.862	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.103	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0954	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.323	k star (bias corrected MLE)	0.32
Theta hat (MLE)	81288	Theta star (bias corrected MLE)	82020
nu hat (MLE)	67.88	nu star (bias corrected)	67.27
MLE Mean (bias corrected)	26274	MLE Sd (bias corrected)	46422
		Approximate Chi Square Value (0.05)	49.39
Adjusted Level of Significance	0.0477	Adjusted Chi Square Value	49.18

Assuming Gamma Distribution

95% Approximate Gamma UCL	35783	95% Adjusted Gamma UCL	35937

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.834	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk P Value	0	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.213	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.0794	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.371	Mean of logged Data	8.069
Maximum of Logged Data	12.39	SD of logged Data	3.322

Assuming Lognormal Distribution

95% H-UCL	4070453	90% Chebyshev (MVUE) UCL	1688725
95% Chebyshev (MVUE) UCL	2187272	97.5% Chebyshev (MVUE) UCL	2879236
99% Chebyshev (MVUE) UCL	4238464		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	33018	95% BCA Bootstrap UCL	34539
95% Standard Bootstrap UCL	32827	95% Bootstrap-t UCL	34502
95% Hall's Bootstrap UCL	34430	95% Percentile Bootstrap UCL	33002
90% Chebyshev(Mean, Sd) UCL	38574	95% Chebyshev(Mean, Sd) UCL	44146
97.5% Chebyshev(Mean, Sd) UCL	51879	99% Chebyshev(Mean, Sd) UCL	67069

Suggested UCL to Use

95% Student's-t UCL 33079

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

TOTAL 18 PAH (U=1/2 MDL) (ug/kg)

General Statistics

Total Number of Observations	105	Number of Distinct Observations	84
		Number of Missing Observations	0
Minimum	3.2	Mean	26295
Maximum	240000	Median	8100
SD	42024	Std. Error of Mean	4101
Coefficient of Variation	1.598	Skewness	2.526

Normal GOF Test

Shapiro Wilk Test Statistic	0.665	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.266	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.1	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	33102	95% Adjusted-CLT UCL (Chen-1995)	34121
		95% Modified-t UCL (Johnson-1978)	33270

Gamma GOF Test

A-D Test Statistic	0.868	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.855	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0788	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.095	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.353	k star (bias corrected MLE)	0.349
Theta hat (MLE)	74550	Theta star (bias corrected MLE)	75346
nu hat (MLE)	74.07	nu star (bias corrected)	73.29
MLE Mean (bias corrected)	26295	MLE Sd (bias corrected)	44511
		Approximate Chi Square Value (0.05)	54.57
Adjusted Level of Significance	0.0477	Adjusted Chi Square Value	54.35

Assuming Gamma Distribution

95% Approximate Gamma UCL	35312	95% Adjusted Gamma UCL	35458

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.867	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	9.837E-14	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.182	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0794	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.163	Mean of logged Data	8.273
Maximum of Logged Data	12.39	SD of logged Data	2.879

Assuming Lognormal Distribution

95% H-UCL	862361	90% Chebyshev (MVUE) UCL	526097
95% Chebyshev (MVUE) UCL	671242	97.5% Chebyshev (MVUE) UCL	872698
99% Chebyshev (MVUE) UCL	1268418		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	33041	95% BCA Bootstrap UCL	34551
95% Standard Bootstrap UCL	32851	95% Bootstrap-t UCL	34533
95% Hall's Bootstrap UCL	34461	95% Percentile Bootstrap UCL	33054
90% Chebyshev(Mean, Sd) UCL	38599	95% Chebyshev(Mean, Sd) UCL	44172
97.5% Chebyshev(Mean, Sd) UCL	51907	99% Chebyshev(Mean, Sd) UCL	67101

Suggested UCL to Use

95% Adjusted Gamma UCL 35458

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

TOTAL 18 PAH (U=1/2 RDL) (ug/kg)

General Statistics

Total Number of Observations	105	Number of Distinct Observations	84
		Number of Missing Observations	0
Minimum	23	Mean	26322
Maximum	240000	Median	8100
SD	42047	Std. Error of Mean	4103
Coefficient of Variation	1.597	Skewness	2.523

Normal GOF Test

Shapiro Wilk Test Statistic	0.665	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.266	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.1	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	33132	95% Adjusted-CLT UCL (Chen-1995)	34150
		95% Modified-t UCL (Johnson-1978)	33300

Gamma GOF Test

A-D Test Statistic	0.943	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.847	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0764	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0947	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.383	k star (bias corrected MLE)	0.379
Theta hat (MLE)	68636	Theta star (bias corrected MLE)	69471
nu hat (MLE)	80.53	nu star (bias corrected)	79.57
MLE Mean (bias corrected)	26322	MLE Sd (bias corrected)	42762
		Approximate Chi Square Value (0.05)	60.01
Adjusted Level of Significance	0.0477	Adjusted Chi Square Value	59.78

Assuming Gamma Distribution

95% Approximate Gamma UCL	34897	95% Adjusted Gamma UCL	35034

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.885	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	2.037E-11	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.15	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0794	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.135	Mean of logged Data	8.451
Maximum of Logged Data	12.39	SD of logged Data	2.538

Assuming Lognormal Distribution

95% H-UCL	315893	90% Chebyshev (MVUE) UCL	240174
95% Chebyshev (MVUE) UCL	301847	97.5% Chebyshev (MVUE) UCL	387447
99% Chebyshev (MVUE) UCL	555591		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	33071	95% BCA Bootstrap UCL	34568
95% Standard Bootstrap UCL	32879	95% Bootstrap-t UCL	34561
95% Hall's Bootstrap UCL	34471	95% Percentile Bootstrap UCL	33090
90% Chebyshev(Mean, Sd) UCL	38632	95% Chebyshev(Mean, Sd) UCL	44208
97.5% Chebyshev(Mean, Sd) UCL	51947	99% Chebyshev(Mean, Sd) UCL	67150

Suggested UCL to Use

95% Adjusted Gamma UCL 35034

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 11/11/2022 3:23:03 PM
From File	Tower Slip ProUCL Input_k.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TOTAL 18 PAH (U=0) (ug/kg)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	1000	Mean	7145
Maximum	20000	Median	4900
SD	5570	Std. Error of Mean	1000
Coefficient of Variation	0.78	Skewness	1.046

Normal GOF Test

Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.902	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.178	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.182	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8843	95% Adjusted-CLT UCL (Chen-1995)	8992
		95% Modified-t UCL (Johnson-1978)	8874

Gamma GOF Test

A-D Test Statistic	0.577	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.761	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.16	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.792	k star (bias corrected MLE)	1.64
Theta hat (MLE)	3988	Theta star (bias corrected MLE)	4358
nu hat (MLE)	111.1	nu star (bias corrected)	101.7
MLE Mean (bias corrected)	7145	MLE Sd (bias corrected)	5580
		Approximate Chi Square Value (0.05)	79.4
Adjusted Level of Significance	0.0413	Adjusted Chi Square Value	78.31

Assuming Gamma Distribution

95% Approximate Gamma UCL	9149	95% Adjusted Gamma UCL	9276

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.0986	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.143	Data appear Lognormal at 10% Significance Level	

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.908	Mean of logged Data	8.57
Maximum of Logged Data	9.903	SD of logged Data	0.819

Assuming Lognormal Distribution

95% H-UCL	10271	90% Chebyshev (MVUE) UCL	10819
95% Chebyshev (MVUE) UCL	12429	97.5% Chebyshev (MVUE) UCL	14662
99% Chebyshev (MVUE) UCL	19050		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	8791	95% BCA Bootstrap UCL	9068
95% Standard Bootstrap UCL	8756	95% Bootstrap-t UCL	9046
95% Hall's Bootstrap UCL	8934	95% Percentile Bootstrap UCL	8777
90% Chebyshev(Mean, Sd) UCL	10146	95% Chebyshev(Mean, Sd) UCL	11506
97.5% Chebyshev(Mean, Sd) UCL	13393	99% Chebyshev(Mean, Sd) UCL	17099

Suggested UCL to Use

95% Student's-t UCL 8843

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

TOTAL 18 PAH (U=1/2 MDL) (ug/kg)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	1000	Mean	7145
Maximum	20000	Median	4900
SD	5570	Std. Error of Mean	1000
Coefficient of Variation	0.78	Skewness	1.046

Normal GOF Test

Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.902	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.178	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.182	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8843	95% Adjusted-CLT UCL (Chen-1995)	8992
		95% Modified-t UCL (Johnson-1978)	8874

Gamma GOF Test

A-D Test Statistic	0.577	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.761	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.16	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.792	k star (bias corrected MLE)	1.64
Theta hat (MLE)	3988	Theta star (bias corrected MLE)	4358
nu hat (MLE)	111.1	nu star (bias corrected)	101.7
MLE Mean (bias corrected)	7145	MLE Sd (bias corrected)	5580
		Approximate Chi Square Value (0.05)	79.4
Adjusted Level of Significance	0.0413	Adjusted Chi Square Value	78.31

Assuming Gamma Distribution

95% Approximate Gamma UCL	9149	95% Adjusted Gamma UCL	9276

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0986	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.143	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.908	Mean of logged Data	8.57
Maximum of Logged Data	9.903	SD of logged Data	0.819

Assuming Lognormal Distribution

95% H-UCL	10271	90% Chebyshev (MVUE) UCL	10819
95% Chebyshev (MVUE) UCL	12429	97.5% Chebyshev (MVUE) UCL	14662
99% Chebyshev (MVUE) UCL	19050		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	8791	95% BCA Bootstrap UCL	9068
95% Standard Bootstrap UCL	8756	95% Bootstrap-t UCL	9046
95% Hall's Bootstrap UCL	8934	95% Percentile Bootstrap UCL	8777
90% Chebyshev(Mean, Sd) UCL	10146	95% Chebyshev(Mean, Sd) UCL	11506
97.5% Chebyshev(Mean, Sd) UCL	13393	99% Chebyshev(Mean, Sd) UCL	17099

Suggested UCL to Use

95% Student's-t UCL 8843

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

TOTAL 18 PAH (U=1/2 RDL) (ug/kg)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	1100	Mean	7158
Maximum	20000	Median	5000
SD	5561	Std. Error of Mean	998.8
Coefficient of Variation	0.777	Skewness	1.048

Normal GOF Test

Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk Critical Value	0.902	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.179	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.182	Data appear Normal at 1% Significance Level	

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	8853	95% Adjusted-CLT UCL (Chen-1995)	9002
		95% Modified-t UCL (Johnson-1978)	8885

Gamma GOF Test

A-D Test Statistic	0.578	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.761	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.135	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.16	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.812	k star (bias corrected MLE)	1.658
Theta hat (MLE)	3950	Theta star (bias corrected MLE)	4317
nu hat (MLE)	112.3	nu star (bias corrected)	102.8
MLE Mean (bias corrected)	7158	MLE Sd (bias corrected)	5559
		Approximate Chi Square Value (0.05)	80.41
Adjusted Level of Significance	0.0413	Adjusted Chi Square Value	79.31

Assuming Gamma Distribution

95% Approximate Gamma UCL	9152	95% Adjusted Gamma UCL	9279

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.955	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.102	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.143	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.003	Mean of logged Data	8.575
Maximum of Logged Data	9.903	SD of logged Data	0.811

Assuming Lognormal Distribution

95% H-UCL	10225	90% Chebyshev (MVUE) UCL	10782
95% Chebyshev (MVUE) UCL	12375	97.5% Chebyshev (MVUE) UCL	14585
99% Chebyshev (MVUE) UCL	18928		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	8801	95% BCA Bootstrap UCL	9074
95% Standard Bootstrap UCL	8766	95% Bootstrap-t UCL	9052
95% Hall's Bootstrap UCL	8944	95% Percentile Bootstrap UCL	8787
90% Chebyshev(Mean, Sd) UCL	10154	95% Chebyshev(Mean, Sd) UCL	11512
97.5% Chebyshev(Mean, Sd) UCL	13395	99% Chebyshev(Mean, Sd) UCL	17096

Suggested UCL to Use

95% Student's-t UCL 8853

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 11/13/2022 1:16:30 PM
From File	Tower Slip ProUCL Input_I.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TEQ WHO(ng/kg)

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	4.992	Mean	16.43
Maximum	23.23	Median	15.85
SD	5.053	Std. Error of Mean	1.401
Coefficient of Variation	0.307	Skewness	-0.67

Normal GOF Test

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.814	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.151	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.271	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	18.93	95% Adjusted-CLT UCL (Chen-1995)	18.46
		95% Modified-t UCL (Johnson-1978)	18.89

Gamma GOF Test

A-D Test Statistic	0.57	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.204	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.413	k star (bias corrected MLE)	6.523
Theta hat (MLE)	1.953	Theta star (bias corrected MLE)	2.519
nu hat (MLE)	218.7	nu star (bias corrected)	169.6
MLE Mean (bias corrected)	16.43	MLE Sd (bias corrected)	6.434
		Approximate Chi Square Value (0.05)	140.5
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	136.7

Assuming Gamma Distribution

95% Approximate Gamma UCL	19.84	95% Adjusted Gamma UCL	20.39

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.808	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.889	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.238	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.215	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.608	Mean of logged Data	2.739
Maximum of Logged Data	3.145	SD of logged Data	0.401

Assuming Lognormal Distribution

95% H-UCL	21.15	90% Chebyshev (MVUE) UCL	22.31
95% Chebyshev (MVUE) UCL	24.87	97.5% Chebyshev (MVUE) UCL	28.43
99% Chebyshev (MVUE) UCL	35.42		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	18.74	95% BCA Bootstrap UCL	18.37
95% Standard Bootstrap UCL	18.66	95% Bootstrap-t UCL	18.76
95% Hall's Bootstrap UCL	18.59	95% Percentile Bootstrap UCL	18.59
90% Chebyshev(Mean, Sd) UCL	20.64	95% Chebyshev(Mean, Sd) UCL	22.54
97.5% Chebyshev(Mean, Sd) UCL	25.18	99% Chebyshev(Mean, Sd) UCL	30.37

Suggested UCL to Use

95% Student's-t UCL 18.93

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

TEQ Birds(ng/kg)

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	7.515	Mean	18.94
Maximum	25.34	Median	18.5
SD	5.012	Std. Error of Mean	1.39
Coefficient of Variation	0.265	Skewness	-0.783

Normal GOF Test

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.814	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.114	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.271	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	21.42	95% Adjusted-CLT UCL (Chen-1995)	20.9
		95% Modified-t UCL (Johnson-1978)	21.37

Gamma GOF Test

A-D Test Statistic	0.462	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.138	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	12.12	k star (bias corrected MLE)	9.376
Theta hat (MLE)	1.562	Theta star (bias corrected MLE)	2.02
nu hat (MLE)	315.2	nu star (bias corrected)	243.8
MLE Mean (bias corrected)	18.94	MLE Sd (bias corrected)	6.185
		Approximate Chi Square Value (0.05)	208.6
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	204

Assuming Gamma Distribution

95% Approximate Gamma UCL	22.13	95% Adjusted Gamma UCL	22.63

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.845	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.889	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.169	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.215	Data appear Lognormal at 10% Significance Level

Data appear Approximate Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.017	Mean of logged Data	2.899
Maximum of Logged Data	3.232	SD of logged Data	0.325

Assuming Lognormal Distribution

95% H-UCL	22.95	90% Chebyshev (MVUE) UCL	24.28
95% Chebyshev (MVUE) UCL	26.64	97.5% Chebyshev (MVUE) UCL	29.91
99% Chebyshev (MVUE) UCL	36.35		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	21.22	95% BCA Bootstrap UCL	20.82
95% Standard Bootstrap UCL	21.14	95% Bootstrap-t UCL	21.09
95% Hall's Bootstrap UCL	20.99	95% Percentile Bootstrap UCL	21.08
90% Chebyshev(Mean, Sd) UCL	23.11	95% Chebyshev(Mean, Sd) UCL	25
97.5% Chebyshev(Mean, Sd) UCL	27.62	99% Chebyshev(Mean, Sd) UCL	32.77

Suggested UCL to Use

95% Student's-t UCL 21.42

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

TEQ Fish(ng/kg)

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	0.335	Mean	15.26
Maximum	23.23	Median	15.85
SD	6.876	Std. Error of Mean	1.907
Coefficient of Variation	0.45	Skewness	-1.044

Normal GOF Test

Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk Critical Value	0.814	Data appear Normal at 1% Significance Level	
Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.271	Data appear Normal at 1% Significance Level	

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	18.66	95% Adjusted-CLT UCL (Chen-1995)	17.81
		95% Modified-t UCL (Johnson-1978)	18.57

Gamma GOF Test

A-D Test Statistic	1.544	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.319	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.24	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.853	k star (bias corrected MLE)	1.476
Theta hat (MLE)	8.239	Theta star (bias corrected MLE)	10.34
nu hat (MLE)	48.17	nu star (bias corrected)	38.38
MLE Mean (bias corrected)	15.26	MLE Sd (bias corrected)	12.56
		Approximate Chi Square Value (0.05)	25.2
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	23.68

Assuming Gamma Distribution

95% Approximate Gamma UCL	23.25	95% Adjusted Gamma UCL	24.74

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.603	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.889	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.363	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.215	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.093	Mean of logged Data	2.432
Maximum of Logged Data	3.145	SD of logged Data	1.152

Assuming Lognormal Distribution

95% H-UCL	62.31	90% Chebyshev (MVUE) UCL	41.93
95% Chebyshev (MVUE) UCL	51.65	97.5% Chebyshev (MVUE) UCL	65.13
99% Chebyshev (MVUE) UCL	91.61		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	18.4	95% BCA Bootstrap UCL	17.88
95% Standard Bootstrap UCL	18.3	95% Bootstrap-t UCL	18.14
95% Hall's Bootstrap UCL	17.93	95% Percentile Bootstrap UCL	18.22
90% Chebyshev(Mean, Sd) UCL	20.98	95% Chebyshev(Mean, Sd) UCL	23.58
97.5% Chebyshev(Mean, Sd) UCL	27.17	99% Chebyshev(Mean, Sd) UCL	34.24

Suggested UCL to Use

95% Student's-t UCL 18.66

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 11/13/2022 1:17:50 PM
From File	Tower Slip ProUCL Input_m.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TEQ WHO(ng/kg)

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	13.86	Mean	17.94
Maximum	23.23	Median	17.51
SD	4.173	Std. Error of Mean	1.704
Coefficient of Variation	0.233	Skewness	0.183

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.832	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.713	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.291	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.373	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	21.37	95% Adjusted-CLT UCL (Chen-1995)	20.88
		95% Modified-t UCL (Johnson-1978)	21.39

Gamma GOF Test

A-D Test Statistic	0.634	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.697	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.31	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	22.18	k star (bias corrected MLE)	11.2
Theta hat (MLE)	0.809	Theta star (bias corrected MLE)	1.602
nu hat (MLE)	266.1	nu star (bias corrected)	134.4
MLE Mean (bias corrected)	17.94	MLE Sd (bias corrected)	5.361
		Approximate Chi Square Value (0.05)	108.6
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	100.2

Assuming Gamma Distribution

95% Approximate Gamma UCL	22.2	95% Adjusted Gamma UCL	24.05

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.826	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.287	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.298	Data appear Lognormal at 10% Significance Level	

Data appear Approximate Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	2.629	Mean of logged Data	2.864
Maximum of Logged Data	3.145	SD of logged Data	0.234

Assuming Lognormal Distribution

95% H-UCL	22.49	90% Chebyshev (MVUE) UCL	23.07
95% Chebyshev (MVUE) UCL	25.4	97.5% Chebyshev (MVUE) UCL	28.62
99% Chebyshev (MVUE) UCL	34.96		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	20.74	95% BCA Bootstrap UCL	20.55
95% Standard Bootstrap UCL	20.52	95% Bootstrap-t UCL	21.76
95% Hall's Bootstrap UCL	19.49	95% Percentile Bootstrap UCL	20.62
90% Chebyshev(Mean, Sd) UCL	23.05	95% Chebyshev(Mean, Sd) UCL	25.37
97.5% Chebyshev(Mean, Sd) UCL	28.58	99% Chebyshev(Mean, Sd) UCL	34.89

Suggested UCL to Use

95% Student's-t UCL	21.37

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

TEQ Birds(ng/kg)

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	15.65	Mean	18.7
Maximum	22.01	Median	18.3
SD	2.203	Std. Error of Mean	0.899
Coefficient of Variation	0.118	Skewness	0.293

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.713	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.203	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.373	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	20.51	95% Adjusted-CLT UCL (Chen-1995)	20.29
		95% Modified-t UCL (Johnson-1978)	20.53

Gamma GOF Test

A-D Test Statistic	0.212	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.696	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.193	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	86.83	k star (bias corrected MLE)	43.52
Theta hat (MLE)	0.215	Theta star (bias corrected MLE)	0.43
nu hat (MLE)	1042	nu star (bias corrected)	522.3
MLE Mean (bias corrected)	18.7	MLE Sd (bias corrected)	2.834
		Approximate Chi Square Value (0.05)	470.3
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	452.3

Assuming Gamma Distribution

95% Approximate Gamma UCL	20.76	95% Adjusted Gamma UCL	21.59

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.979	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.826	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.184	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.298	Data appear Lognormal at 10% Significance Level	

Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	2.75	Mean of logged Data	2.923
Maximum of Logged Data	3.091	SD of logged Data	0.118

Assuming Lognormal Distribution

95% H-UCL	20.76	90% Chebyshev (MVUE) UCL	21.39
95% Chebyshev (MVUE) UCL	22.61	97.5% Chebyshev (MVUE) UCL	24.31
99% Chebyshev (MVUE) UCL	27.63		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	20.18	95% BCA Bootstrap UCL	20.12
95% Standard Bootstrap UCL	20.06	95% Bootstrap-t UCL	21.18
95% Hall's Bootstrap UCL	22.85	95% Percentile Bootstrap UCL	20.05
90% Chebyshev(Mean, Sd) UCL	21.4	95% Chebyshev(Mean, Sd) UCL	22.62
97.5% Chebyshev(Mean, Sd) UCL	24.31	99% Chebyshev(Mean, Sd) UCL	27.65

Suggested UCL to Use

95% Student's-t UCL	20.51

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

TEQ Fish(ng/kg)

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	0.335	Mean	13.71
Maximum	22.72	Median	14.86
SD	7.514	Std. Error of Mean	3.067
Coefficient of Variation	0.548	Skewness	-1.131

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.922	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.713	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.241	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.373	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	19.89	95% Adjusted-CLT UCL (Chen-1995)	17.24
		95% Modified-t UCL (Johnson-1978)	19.65

Gamma GOF Test

A-D Test Statistic	1	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.713	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.401	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.34	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.158	k star (bias corrected MLE)	0.69
Theta hat (MLE)	11.83	Theta star (bias corrected MLE)	19.85
nu hat (MLE)	13.9	nu star (bias corrected)	8.284
MLE Mean (bias corrected)	13.71	MLE Sd (bias corrected)	16.5
		Approximate Chi Square Value (0.05)	2.901
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	1.88

Assuming Gamma Distribution

95% Approximate Gamma UCL	39.14	95% Adjusted Gamma UCL	60.38

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.632	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.826	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.421	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.298	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.093	Mean of logged Data	2.128
Maximum of Logged Data	3.123	SD of logged Data	1.593

Assuming Lognormal Distribution

95% H-UCL	2498	90% Chebyshev (MVUE) UCL	60.15
95% Chebyshev (MVUE) UCL	77.72	97.5% Chebyshev (MVUE) UCL	102.1
99% Chebyshev (MVUE) UCL	150		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	18.75	95% BCA Bootstrap UCL	17.4
95% Standard Bootstrap UCL	18.35	95% Bootstrap-t UCL	18.3
95% Hall's Bootstrap UCL	17.7	95% Percentile Bootstrap UCL	18.12
90% Chebyshev(Mean, Sd) UCL	22.91	95% Chebyshev(Mean, Sd) UCL	27.08
97.5% Chebyshev(Mean, Sd) UCL	32.86	99% Chebyshev(Mean, Sd) UCL	44.23

Suggested UCL to Use

95% Student's-t UCL 19.89

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 11/13/2022 1:18:31 PM
From File	Tower Slip ProUCL Input_n.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TEQ WHO(ng/kg)

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	4.992	Mean	15.14
Maximum	22.72	Median	15.85
SD	5.685	Std. Error of Mean	2.149
Coefficient of Variation	0.376	Skewness	-0.723

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.971	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.73	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.144	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.35	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	19.31	95% Adjusted-CLT UCL (Chen-1995)	18.05
		95% Modified-t UCL (Johnson-1978)	19.22

Gamma GOF Test

A-D Test Statistic	0.408	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.71	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.196	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.313	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	5.948	k star (bias corrected MLE)	3.494
Theta hat (MLE)	2.545	Theta star (bias corrected MLE)	4.333
nu hat (MLE)	83.27	nu star (bias corrected)	48.91
MLE Mean (bias corrected)	15.14	MLE Sd (bias corrected)	8.099
		Approximate Chi Square Value (0.05)	33.86
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	30.12

Assuming Gamma Distribution

95% Approximate Gamma UCL	21.87	95% Adjusted Gamma UCL	24.58

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.844	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.838	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.238	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.28	Data appear Lognormal at 10% Significance Level	

Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	1.608	Mean of logged Data	2.631
Maximum of Logged Data	3.123	SD of logged Data	0.497

Assuming Lognormal Distribution

95% H-UCL	25.89	90% Chebyshev (MVUE) UCL	24.15
95% Chebyshev (MVUE) UCL	28.11	97.5% Chebyshev (MVUE) UCL	33.61
99% Chebyshev (MVUE) UCL	44.39		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	18.67	95% BCA Bootstrap UCL	17.94
95% Standard Bootstrap UCL	18.42	95% Bootstrap-t UCL	18.75
95% Hall's Bootstrap UCL	18.36	95% Percentile Bootstrap UCL	18.36
90% Chebyshev(Mean, Sd) UCL	21.59	95% Chebyshev(Mean, Sd) UCL	24.51
97.5% Chebyshev(Mean, Sd) UCL	28.56	99% Chebyshev(Mean, Sd) UCL	36.52

Suggested UCL to Use

95% Student's-t UCL	19.31

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

TEQ Birds(ng/kg)

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	7.515	Mean	19.14
Maximum	25.34	Median	22.13
SD	6.789	Std. Error of Mean	2.566
Coefficient of Variation	0.355	Skewness	-0.868

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.879	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.73	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.241	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.35	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level
Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	24.13	95% Adjusted-CLT UCL (Chen-1995)	22.47
		95% Modified-t UCL (Johnson-1978)	23.99

Gamma GOF Test

A-D Test Statistic	0.534	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.709	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.269	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.313	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level
Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	7.051	k star (bias corrected MLE)	4.124
Theta hat (MLE)	2.715	Theta star (bias corrected MLE)	4.642
nu hat (MLE)	98.72	nu star (bias corrected)	57.74
MLE Mean (bias corrected)	19.14	MLE Sd (bias corrected)	9.427
		Approximate Chi Square Value (0.05)	41.27
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	37.11

Assuming Gamma Distribution

95% Approximate Gamma UCL	26.78	95% Adjusted Gamma UCL	29.79

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.826	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.838	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.259	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.28	Data appear Lognormal at 10% Significance Level	

Data appear Approximate Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	2.017	Mean of logged Data	2.879
Maximum of Logged Data	3.232	SD of logged Data	0.445

Assuming Lognormal Distribution

95% H-UCL	30.15	90% Chebyshev (MVUE) UCL	29.19
95% Chebyshev (MVUE) UCL	33.64	97.5% Chebyshev (MVUE) UCL	39.81
99% Chebyshev (MVUE) UCL	51.94		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	23.37	95% BCA Bootstrap UCL	22.45
95% Standard Bootstrap UCL	23.11	95% Bootstrap-t UCL	23.27
95% Hall's Bootstrap UCL	22.25	95% Percentile Bootstrap UCL	23.07
90% Chebyshev(Mean, Sd) UCL	26.84	95% Chebyshev(Mean, Sd) UCL	30.33
97.5% Chebyshev(Mean, Sd) UCL	35.17	99% Chebyshev(Mean, Sd) UCL	44.68

Suggested UCL to Use

95% Student's-t UCL	24.13

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

TEQ Fish(ng/kg)

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	4.021	Mean	16.6
Maximum	23.23	Median	19.08
SD	6.558	Std. Error of Mean	2.479
Coefficient of Variation	0.395	Skewness	-1.287

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach, refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,

but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).

The Chebyshev UCL often results in gross overestimates of the mean.

Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.73	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.219	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.35	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	21.41	95% Adjusted-CLT UCL (Chen-1995)	19.39
		95% Modified-t UCL (Johnson-1978)	21.21

Gamma GOF Test

A-D Test Statistic	0.728	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.71	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.275	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.313	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	4.445	k star (bias corrected MLE)	2.635
Theta hat (MLE)	3.734	Theta star (bias corrected MLE)	6.299
nu hat (MLE)	62.23	nu star (bias corrected)	36.89
MLE Mean (bias corrected)	16.6	MLE Sd (bias corrected)	10.22
		Approximate Chi Square Value (0.05)	23.99
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	20.9

Assuming Gamma Distribution

95% Approximate Gamma UCL	25.53	95% Adjusted Gamma UCL	29.29

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.735	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.838	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.315	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.28	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.392	Mean of logged Data	2.693
Maximum of Logged Data	3.145	SD of logged Data	0.607

Assuming Lognormal Distribution

95% H-UCL	34.54	90% Chebyshev (MVUE) UCL	29.17
95% Chebyshev (MVUE) UCL	34.58	97.5% Chebyshev (MVUE) UCL	42.08
99% Chebyshev (MVUE) UCL	56.81		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	20.67	95% BCA Bootstrap UCL	19.43
95% Standard Bootstrap UCL	20.39	95% Bootstrap-t UCL	20.33
95% Hall's Bootstrap UCL	19.62	95% Percentile Bootstrap UCL	20.14
90% Chebyshev(Mean, Sd) UCL	24.03	95% Chebyshev(Mean, Sd) UCL	27.4
97.5% Chebyshev(Mean, Sd) UCL	32.08	99% Chebyshev(Mean, Sd) UCL	41.26

Suggested UCL to Use

95% Student's-t UCL	21.41

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

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