



LAKE CONTRARY DREDGING OUTFALL MONITORING PLAN



WRS WATER
RESOURCES
SOLUTIONS



PREPARED FOR AMBROZI CIVIL CONTRACTORS
DATE: 7/29/24
SUBMITTED BY: WATER RESOURCES SOLUTIONS

SUMMARY

Lake Contrary, an oxbow lake adjacent to the Missouri River in St. Joseph, Missouri, is planned to be dredged for the purposes of restoring recreation uses and preserving the lake's environment. This document creates a monitoring plan to ensure that material deposited into the Missouri River from the

dredging operation does not impact the river's navigation channel. The plan includes an outline of the project location, soil composition, dredging operations, monitoring methodology, and monitoring frequency.

BACKGROUND

Lake Contrary is a 335-acre oxbow lake located in St. Joseph Missouri, near 5220 Southwest Lakefront Lane West (Figure 1). It was a former channel of the Missouri River prior to its formation. The lake had been a source of recreation for St. Joseph, once adjoined by the Lake Contrary Amusement Park, which permanently closed in the 1960s. Since then, soil deposits have accumulated, decreasing the water's depth, limiting residents' accessibility, and impacting the lake's natural habitat. A plan to dredge Lake Contrary has been proposed to reinvigorate the location both environmentally and recreationally.

Under the dredging plan, dredged materials will be disposed of by pumping them into the Missouri River between Southwest Lakefront Lane West and Ingersoll Road, at approximately 39°43'22.65"N, 94°54'13.42"W. To alleviate concern that the discharged sediments could settle and potentially reduce the width or depth of the river's navigation channel at or near the discharge point, the U.S. Army Corps of Engineers Kansas City District office (USACE)

requested a detailed monitoring plan to ensure the dredged material remains sufficiently distributed and suspended within the river flow. If the monitoring shows the navigation channel is impacted, dredging may be limited or completely halted. USACE's requirement for the plan obligates the project sponsor to describe and demonstrate adequate monitoring of hydrographic survey extents, survey methods, survey density, and survey frequency to ensure that no material deposition sufficient to impede the channel occurs at or immediately downstream of the discharge location. Figure 1 shows the location of the navigation channel along Lake Contrary. The plan also includes a pre-construction survey, as well as scheduled surveys throughout the duration of dredging activities.

The purpose of this report is to address the USACE's requirement that a detailed monitoring plan be created before dredging begins.

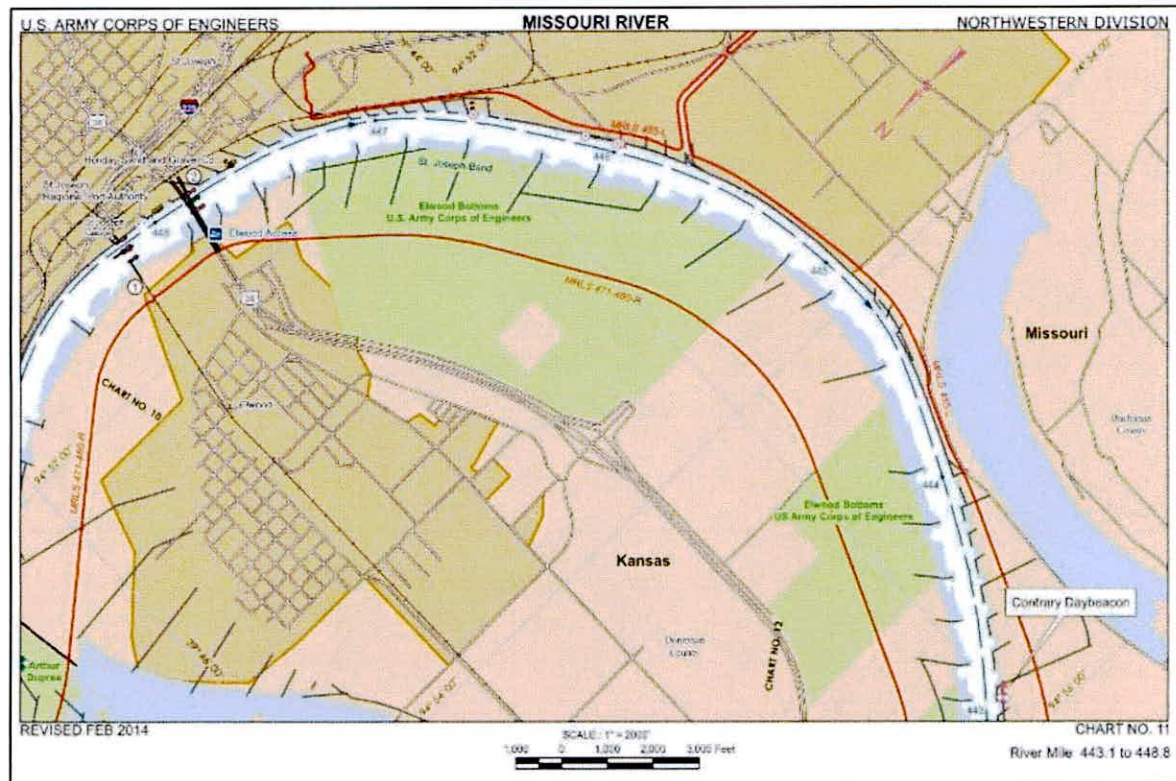


FIGURE 1 NAVIGATION CHANNEL ALONG LAKE CONTRARY SHOWN IN BLUE (LAKE CONTRARY IS ON THE RIGHT SIDE OF THE IMAGE)

SEDIMENTATION SAMPLING

One important factor that determines the level of required monitoring of a dredging project like this one is the soil composition of the project site. Soil composition impacts the propensity for the material to settle out of entrainment. A fine-grained soil composed of silt and clay is more likely to remain entrained by the flowing water and therefore require less frequent monitoring. On the converse, coarse grained soils like sand are expected to have a higher likelihood to settle out of the river flow and more rapidly contribute to shoaling. Courser soils therefore require more frequent monitoring.

To determine the soil composition of Lake Contrary's bed, subsurface soil sampling, testing, and characterization of the lakebed sediments was conducted in Spring 2024 by Terracon Consultants SE, Inc., a national geotechnical engineering and testing consultant with an office in Lenexa, Kansas (Terracon 2024). The resulting report is contained in Appendix A of this report.

Terracon's soil testing satisfies the USACE requirement that the dredging project sponsor provide gradation analyses of the material to be dredged. Eight test pits were dug. Four of those—labeled pits T-1 through T-4—were dug with an excavator including

four samples collected at 1, 4, 5, and 6 feet deep. The remaining four test pits—S-1 to S-4—were hand dug at a depth of 1 foot. Following collection, sieve and hydrometer tests were conducted on the samples. A sieve test is a method of grain distribution analysis by passing the soil sample through a sieve which has progressively smaller meshes. These sorted samples are then weighed to determine the variation in coarse to fine grain sediments (Hossain et al. 2021). A hydrometer test is used in addition to the sieve test to determine the composition of finer grain samples which the sieve test has difficulty sorting. It is accomplished by measuring the time it takes particles to settle from suspension when placed in a liquid (Hossian et al. 2021). The combination of these methods gives a comprehensive grain size distribution from coarse to fine grain particles.

The results of the grain size testing conducted by Terracon are shown in Table 1 through Table 3. They demonstrate the soil of Lake Contrary’s bed is composed primarily of silt and clay. With the exception of only one location—sample location T-1, at a depth of

5 to 6 feet (Table 2)—all tested locations were dominated by primarily silt and usually more clay than sand. Table 1 only lists one sample that has significant amounts of sand, which is at T-1 at the 1- to 2-foot depth. The T-1 location is located along the beach at Lake Contrary, which may contribute to the higher levels of sand found there (Appendix A). Table 3 is almost exclusively dominated by silt and clay with small amounts of sand for those sample locations. Overall, the Lake Contrary bed sampling shows that there is a significant amount of fines compared to coarse grained soils. The average of all samples is sand = 12.4 percent, silt = 59.95 percent, and clay = 27.65 percent. Due to the relatively high composition of fines, it is recommended that the monitoring frequency be decreased as compared to the once per week baseline given in correspondence with the USACE. The fine-grained sediment is likely to stay in suspension rather than settling and contribute to shoaling. The suggested monitoring frequency will be outlined later in this report.

TABLE 1 LAKE CONTRARY BED SAMPLING (CREATED BY TERRACON)

Boring ID	Depth (Ft)	USCS Classification				USCS	AASHTO	LL	PL	PI	Cc	Cu
● S-1	1 - 2											
☒ S-2	1 - 2											
▲ S-3	1 - 2											
★ S-4	1 - 2											
⊙ T-1	1 - 2											
Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay	
● S-1	1 - 2	2	0.051	0.015		0.0	0.0	7.7		68.8	23.5	
☒ S-2	1 - 2	0.85	0.045	0.007		0.0	0.0	2.9		71.3	25.7	
▲ S-3	1 - 2	2	0.052	0.02		0.0	0.0	8.7		71.3	20.0	
★ S-4	1 - 2	0.85	0.04	0.007		0.0	0.0	2.6		69.9	27.5	
⊙ T-1	1 - 2	2	0.064	0.033		0.0	0.0	31.0		53.2	15.7	

TABLE 2 LAKE CONTRARY BED SAMPLING (CREATED BY TERRACON)

Boring ID	Depth (Ft)	USCS Classification				USCS	AASHTO	LL	PL	PI	Cc	Cu
● T-1	5 - 6											
☒ T-2	1 - 2											
▲ T-2	5 - 6											
★ T-3	1 - 2											
⊙ T-3	5 - 6											
Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay	
● T-1	5 - 6	4.75	0.106	0.048		0.0	0.0	51.6		26.0	22.4	
☒ T-2	1 - 2	2	0.041	0.009		0.0	0.0	6.7		67.5	25.8	
▲ T-2	5 - 6	9.5	0.05	0.002		0.0	0.0	21.6		37.2	41.2	
★ T-3	1 - 2	4.75	0.044	0.003		0.0	0.0	1.8		63.2	35.1	
⊙ T-3	5 - 6	2	0.045	0.005		0.0	0.0	2.3		68.4	29.3	

TABLE 3 LAKE CONTRARY BED SAMPLING (CREATED BY TERRACON)

Boring ID	Depth (Ft)	USCS Classification				USCS	AASHTO	LL	PL	PI	Cc	Cu
● T-4	1 - 2											
☒ T-4	5 - 6											
Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay	
● T-4	1 - 2	0.85	0.051	0.023		0.0	0.0	9.2		72.9	17.9	
☒ T-4	5 - 6	0.425	0.037			0.0	0.0	2.7		49.7	47.7	

DREDGING OUTLINE

The dredging discharge mechanism and location were established in coordination with the Kansas City USACE to ensure adequate distribution and entrainment of material in the river and, therefore, limited shoaling (Michael Gossenauer, personal communication, July 8, 2024). Dredged material will be removed using a single 20-inch diameter, 1,206.43-foot-long high-density polyethylene pipe (Figure 2). Slurry will be pumped at a rate of approximately 10,000 gallons per minute and removable

solids pumped at approximately 300 cubic yards per hour. A rock check at the discharge point will be installed using 2- to 5-inch bull rock in a 100 square foot pad. The outfall will be submerged suspended at 4 to 6 feet deep, optimally, along the river thalweg. If any dredged material is placed on land, with approval of USACE, the necessary bulkheads, dikes, weirs, spillways, and other construction will require approval, including a maintenance plan.



FIGURE 2 OUTFALL LOCATION AND DREDGING INFORMATION

DETAILED MONITORING

The dredging project will include the following monitoring plan, to adequately monitor pre-construction conditions, hydrographic survey extents, survey methods, survey density, and survey frequency to ensure that no material deposition sufficient to impede the channel occurs at or immediately downstream of the discharge location. The level of monitoring was determined based on findings of the previously described soil testing and the monitoring requirements established in coordination with USACE for a previous similar project nearby (Michael Gossenauer, personal communication, July 8, 2024).

HYDROGRAPHIC SURVEY EXTENTS

The survey extents will be one location immediately downstream of the outfall pipe as well as 3 additional surveys at intervals of 500 feet following. The exact locations of these surveys will be determined by the USACE, as stated in correspondence. Survey locations will correlate to USACE's cross sections established for 2024 (Figure 3). At the time this plan was created, the exact locations had not been provided.

PRE-CONSTRUCTION SURVEYS

Before dredging occurs, a bathymetric survey will be conducted to determine the baseline conditions.

SURVEY METHOD

Survey will be conducted using multibeam sonar to create bathymetric surveys of the river channel profile. Prairie Engineers, PC, a surveying, mapping, and engineering

consulting firm headquartered in Columbia, Illinois, and with offices in Kansas City, Missouri, and Lenexa, Kansas, will conduct the survey. The survey will be conducted with a Norbit Winghead multibeam sonar. It uses a curved transducer array to send and receive sonar waves that map the riverbed. The backscatter, or the intensity of sound echo, helps to determine the composition of the bed. It collects data in an "x,y,z" format which can include either depth or elevation. Dual band GPS will also be used to provide more accurate coordinate capture. The boat that will be used to conduct the survey comes equipped with an Inertial Measurement Unit (IMU) which can measure the angular rate and acceleration. The orientation measurements come with 6 degrees of freedom, including x, y, z, pitch, roll, and yaw. This orientation compensation will limit the impact of waves due to traffic on the river and improve the measurement accuracy of the sonar.

These bathymetric surveys will determine the depth of the bed of the river. The depth measurement will be used to determine if and to what degree shoaling occurs. Depth measurements will be compared to the initial survey benchmarking to identify any changes. Additionally, these surveys will determine if depth measurements negatively impact the following requirements for the navigation channel of the Missouri River, as outlined by the USACE:

DURING FULL NAVIGATION SERVICE

- Minimum Channel Depth: 9 feet

- Minimum Width: 300 feet
- Target Flow: 41,000 cubic feet per second

DURING INTERMEDIATE NAVIGATION SERVICE

- Minimum Channel Depth: 8.5 feet
- Minimum Width: 250 feet

DURING MINIMUM NAVIGATION SERVICE

- Minimum Channel Depth: 8 feet
- Minimum Width: 200 feet
- Target Flows: 35,000 cubic feet per second

If survey monitoring finds depth and width requirements have been compromised, navigation may be limited, or portions of the river may be closed. If target flows are below the requirements, dam and reservoir releases may be used to increase flow. If reservoir capacities are low, this method is not used, and restrictions may be placed. The normal navigation season length is 8 months, and in Kansas City, Missouri, it begins March 28 and continues through November 27. In years with greater water supply the end date may be extended to the December 7. These dates and channel requirements are defined by the USACE.

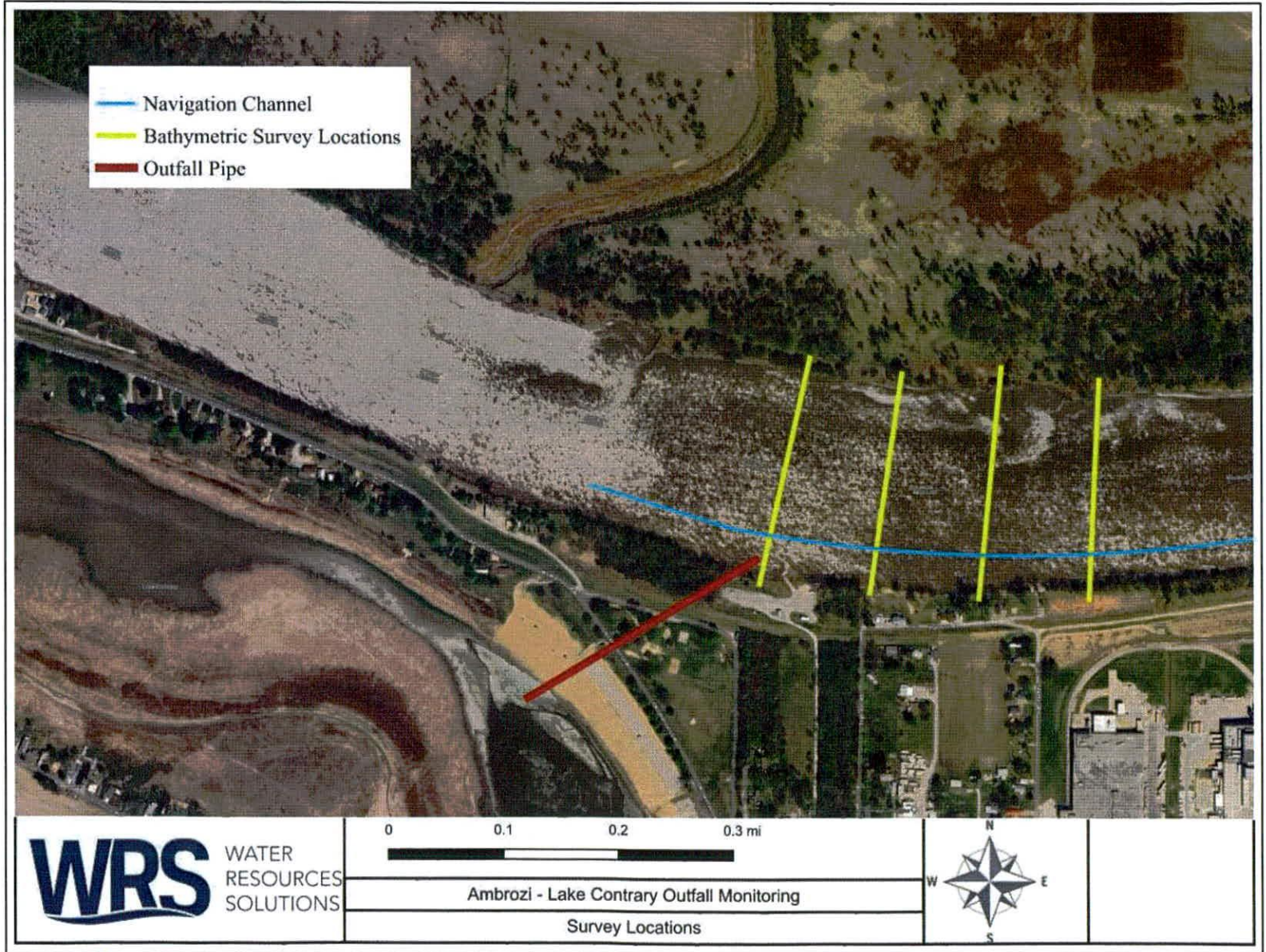
SURVEY DENSITY

During survey data collection, three to four runs will be conducted at each survey site, with around 50 percent overlap. This patterning will be done to increase the accuracy of the surveys. A transect will be established to determine the level of overlap for each of the runs. The data will be processed through Xylem Inc.'s HYPACK® Survey software, which is able to produce a real time point cloud which will be corrected and geo-referenced. The vessel requires at least 3 feet of water depth to be used; if measurements need to be taken up to the banks, a shallow water open hulled boat will be used.

SURVEY FREQUENCY

Due to the high presence of fine-grained loam as well as high levels of silt and clay, the frequency of surveys is suggested to occur every other week for the duration of dredging. If significant changes to the navigation channel of the Missouri River occur or if the minimum requirements of the navigation channel are exceeded, dredging may be limited or stopped completely. The above navigation requirements will be used to determine whether dredging needs to be limited or stopped as defined by the USACE.

FIGURE 3 APPROXIMATE SURVEY LOCATIONS MAP



REPORTING

Following each survey, a report will be created and submitted within the week to the USACE, along with the associated data collected during the surveys. The report will include a summary of the survey and its findings, bed elevation difference maps to show the aggradation or degradation of the bed compared to the initial survey, and depth maps to show adequate navigation depths at the time of the survey. If a reduction in the navigation channel occurs, the contracting officer will be notified as soon as possible, and the channel restriction will be marked. Plans to limit the impact to the navigation channel will be created at that time to restore the minimum channel dimensions. The response may vary based on the intensity of shoaling found by the monitoring program. If a reduction in the channel is persistent or considered too large, dredging may be limited or completely stopped.

REFERENCES

Terracon Consultants SE, Inc. 2024. *Lake Contrary Dredging Evaluation Laboratory Data Report*. Lenexa, Kansas: Terracon Consultants SE.

Hossain, S., A. Islam, F.F. Badhon, T. Imtiaz. 2021. *Properties and Behavior of Soil – Online Lab Manual*. University of Texas at Arlington Libraries: Mavs Open Press. 3-4.

United States Army Corps of Engineers. "Missouri River Navigation". Missouri River Basin, Water Management Division. Last accessed 26 July, 2024. www.nwd-mr.usace.army.mil/rcc/tenmost/tenmosth11.html.

United States Army Corps of Engineers). 2014. "Lower Missouri River Navigation Charts: Rulo, Nebraska to St. Louis, Missouri". Northwestern Division. Last Accessed 26th July, 2024. www.nwk.usace.army.mil/Missions/Civil-Works/Navigation/.

APPENDIX A

Lake Contrary Dredging Evaluation

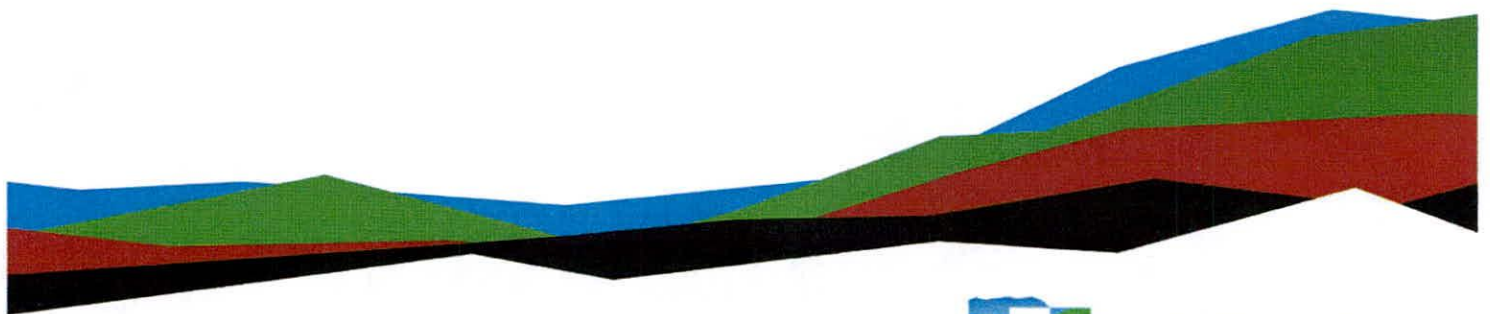
Laboratory Data Report

St. Joseph, Missouri

July 23, 2024 | Terracon Project No. 02245037.01

Prepared for:

GDS, LLC/Ambrozi.US
St. Joseph, Missouri 64501



Nationwide
[Terracon.com](https://www.terracon.com)

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- Geotechnical
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July 23, 2024

GDS, LLC/Ambrozi.US
1207 S 4th Street
St. Joseph, Missouri 64501

Attn: Lauren Morgan
P: (816) 200-0708
E: lmorgan@ambrozi.com

Re: Laboratory Data Report
Lake Contrary Dredging Evaluation
5220 SW Lakefront Lane W
St. Joseph, Missouri
Terracon Project No. 02245037.01

Dear Ms. Morgan:

We have completed a subsurface exploration and laboratory testing for the referenced project in general accordance with Terracon Proposal No. P02245037 dated March 6, 2024. This report presents the findings of the laboratory testing for the project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

Kevin D. Friedrichs

Kevin D. Friedrichs, P.E.
Project Engineer
Missouri: PE 2013010325

Kole C. Berg

Kole C. Berg, P.E.
Senior Consultant
Missouri: PE 2002016417

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Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the  logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

Refer to each individual Attachment for a listing of contents.

Project Description

Item	Description
Project Description	Lake Contrary is an abandoned lake located southwest of St. Joseph, Missouri. We understand that the client would like to dredge the lake to a depth of 6 feet from its current condition. The dredged material is to be discharged into the river. The US Army Corps of Engineers (USACE) has requested that Ambrozi provide gradation analyses of the material to be dredged. This report is a summary of these gradation analyses.

Site Conditions

Item	Description
Project Location	Lake Contrary is located at 5220 SW Lakefront Lane W in St. Joseph, Missouri. Lake Contrary is approximately 335 acres.
Existing Improvements	The lake is presently dry and filled with silt.
Existing Topography	The site is relatively flat.

General Comments

Variations will occur between sample locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in

Laboratory Data Report

Lake Contrary Dredging Evaluation | St. Joseph, Missouri
July 23, 2024 | Terracon Project No. 02245037.01



accordance with generally accepted subsurface exploration practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use of or reliance on the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, cost estimating, excavation support, and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development.

Laboratory Data Report

Lake Contrary Dredging Evaluation | St. Joseph, Missouri
July 23, 2024 | Terracon Project No. 02245037.01



Attachments

Exploration and Testing Procedures

Field Exploration

Testpit and Sample Layout: Terracon personnel provided the test pit and sample layout using handheld GPS equipment (estimated horizontal precision of about ± 10 feet) and referencing existing site features. Approximate ground surface elevations were estimated by interpolation from Google Earth.

Subsurface Exploration Procedures: We advanced the test pits (designated T-1 to T-4) with a track-mounted excavator provided by the County. We were unable to access a large portion of the lakebed with this equipment due to soft conditions, so additional hand-dug samples (designated S-1 to S-4) were collected to supplement the test pit samples. Two bulk samples (one from a depth of about 1 foot and one from a depth of about 5 feet) were collected from each test pit, and one bulk sample was collected at a depth of 1 foot in each hand-dug location.

Laboratory Testing

The laboratory testing program included grain size distribution (sieve/hydrometer) tests on collected samples.

Laboratory Data Report

Lake Contrary Dredging Evaluation | St. Joseph, Missouri
July 23, 2024 | Terracon Project No. 02245037.01



Site Location and Exploration Plans

Contents:

Site Location Plan

Exploration Plan

Note: All attachments are one page unless noted above.

Laboratory Data Report
 Lake Contrary Dredging Evaluation | St. Joseph, Missouri
 July 23, 2024 | Terracon Project No. 02245037.01

Site Location

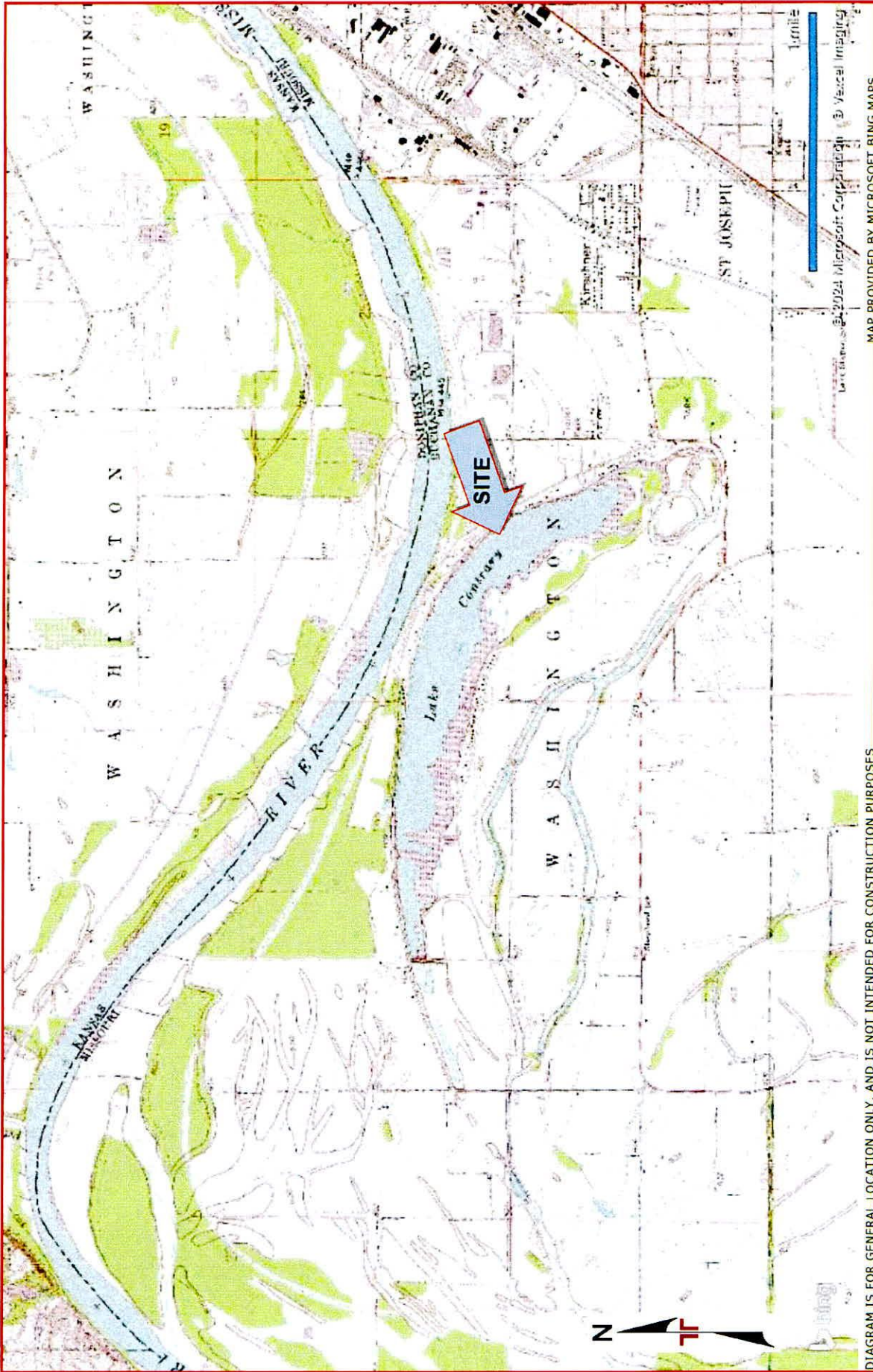


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Laboratory Data Report

Lake Contrary Dredging Evaluation | St. Joseph, Missouri
July 23, 2024 | Terracon Project No. 02245037.01



Exploration Plan

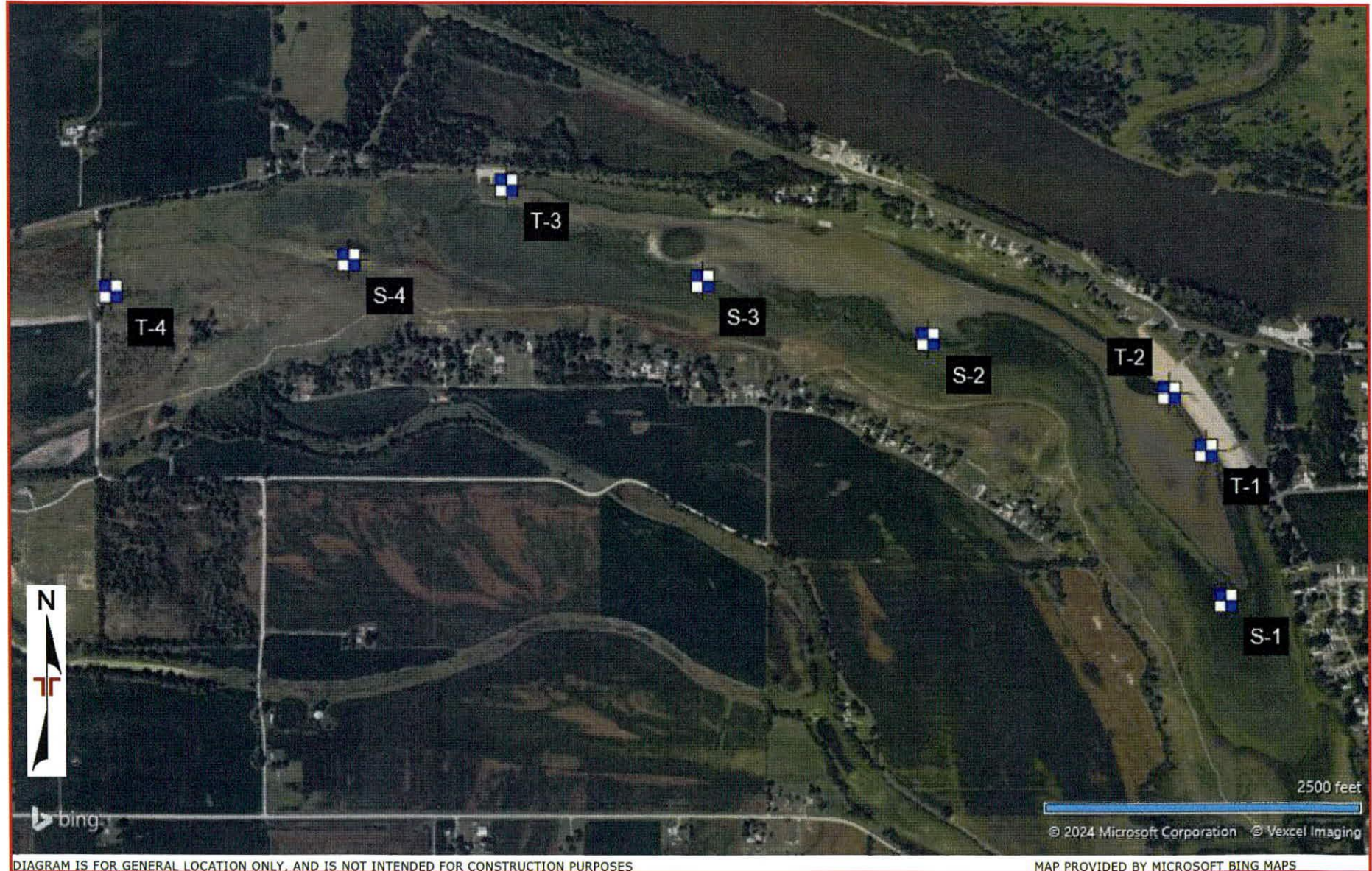


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Laboratory Results

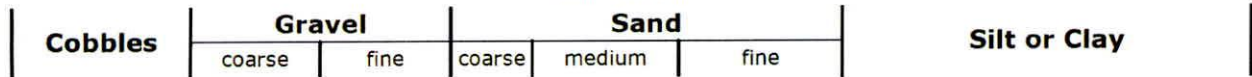
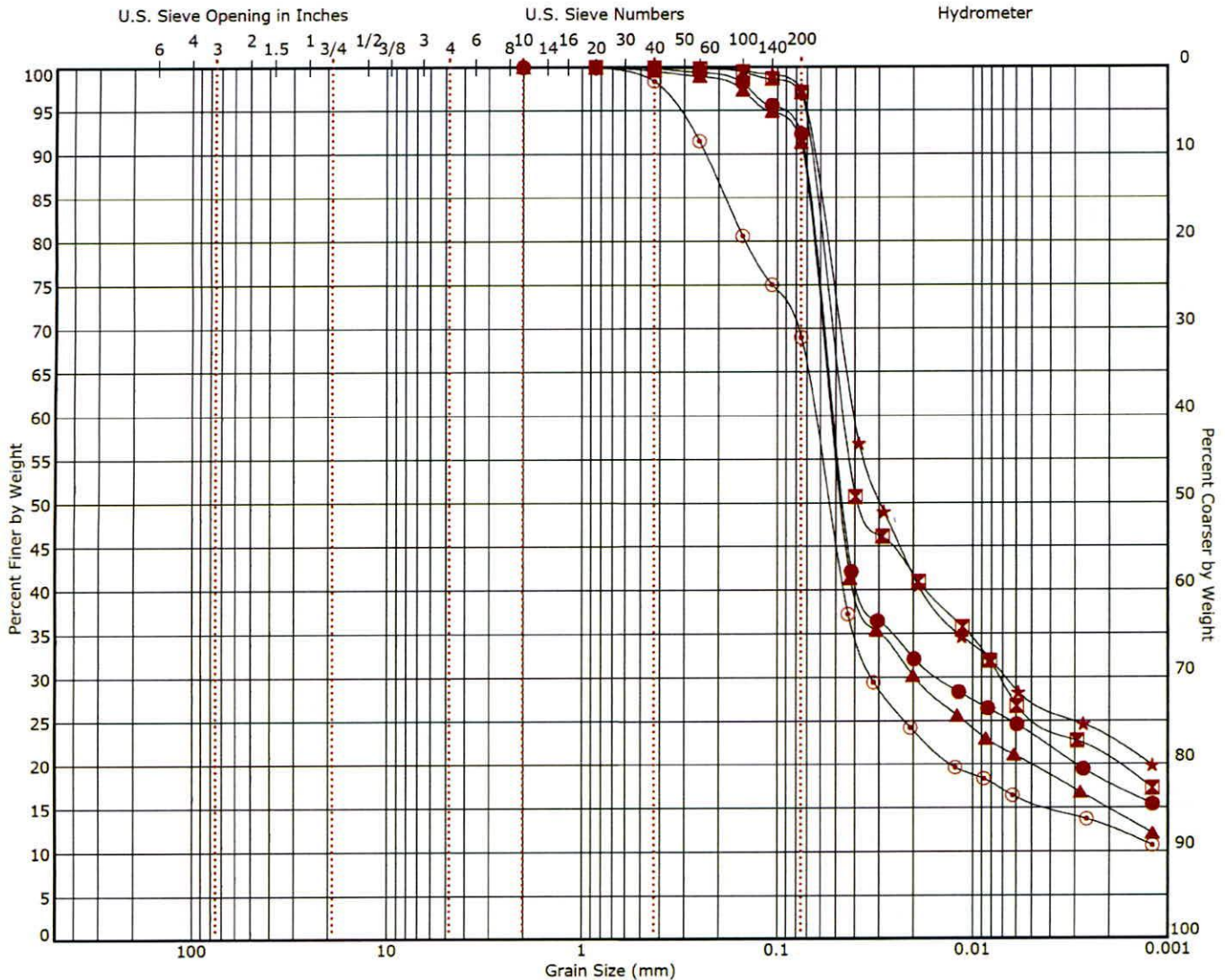
Contents:

Grain Size Distribution (3 pages)

Note: All attachments are one page unless noted above.

Grain Size Distribution

ASTM D422 / ASTM C136



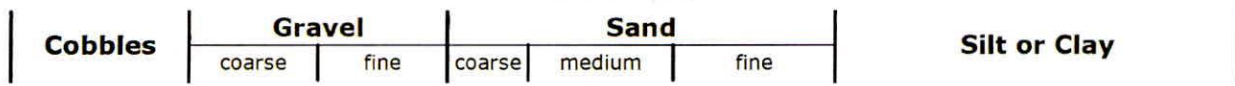
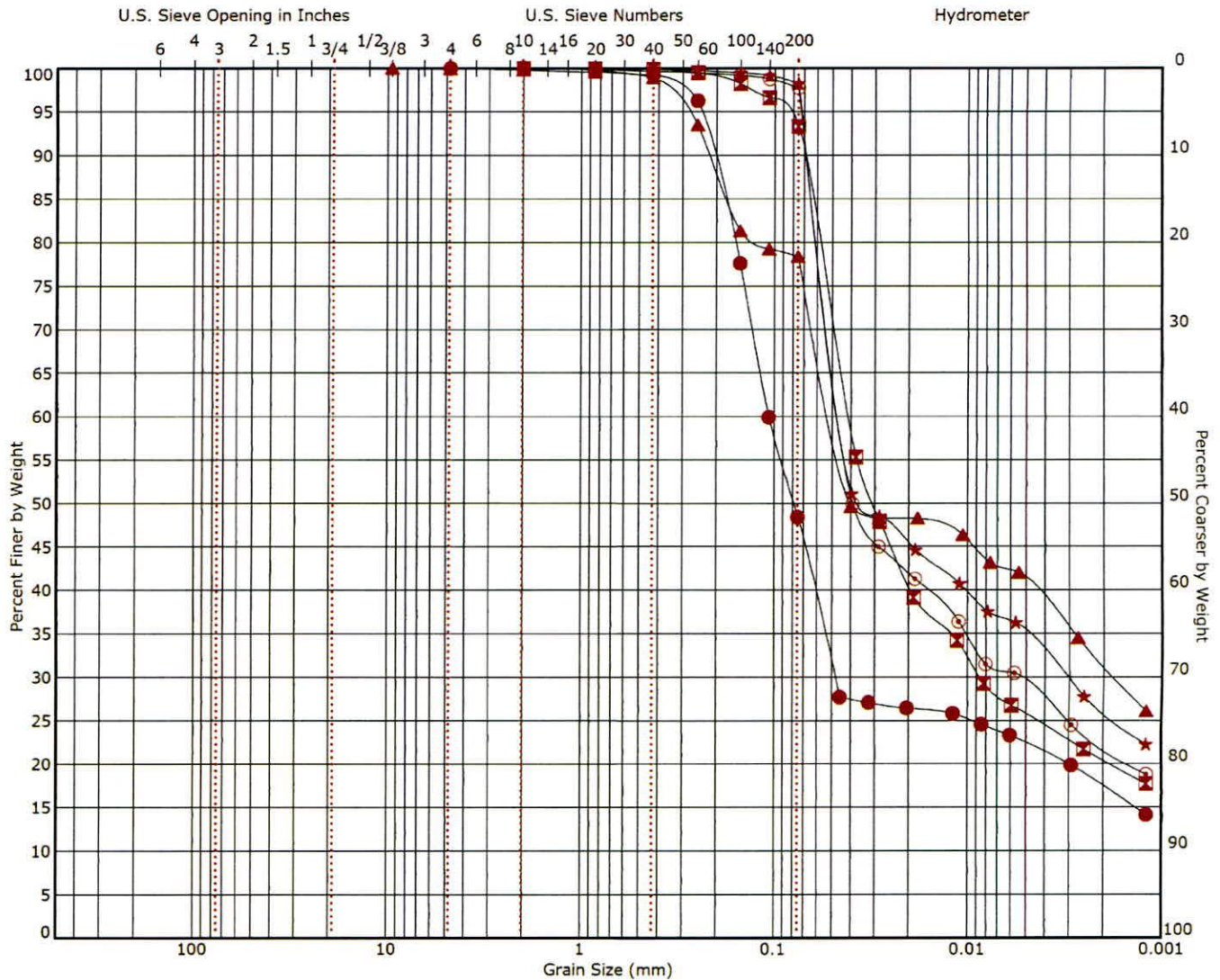
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Laboratory tests are not valid if separated from original report.

Grain Size Distribution

ASTM D422 / ASTM C136



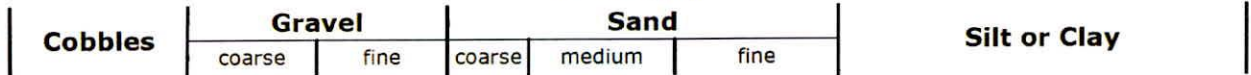
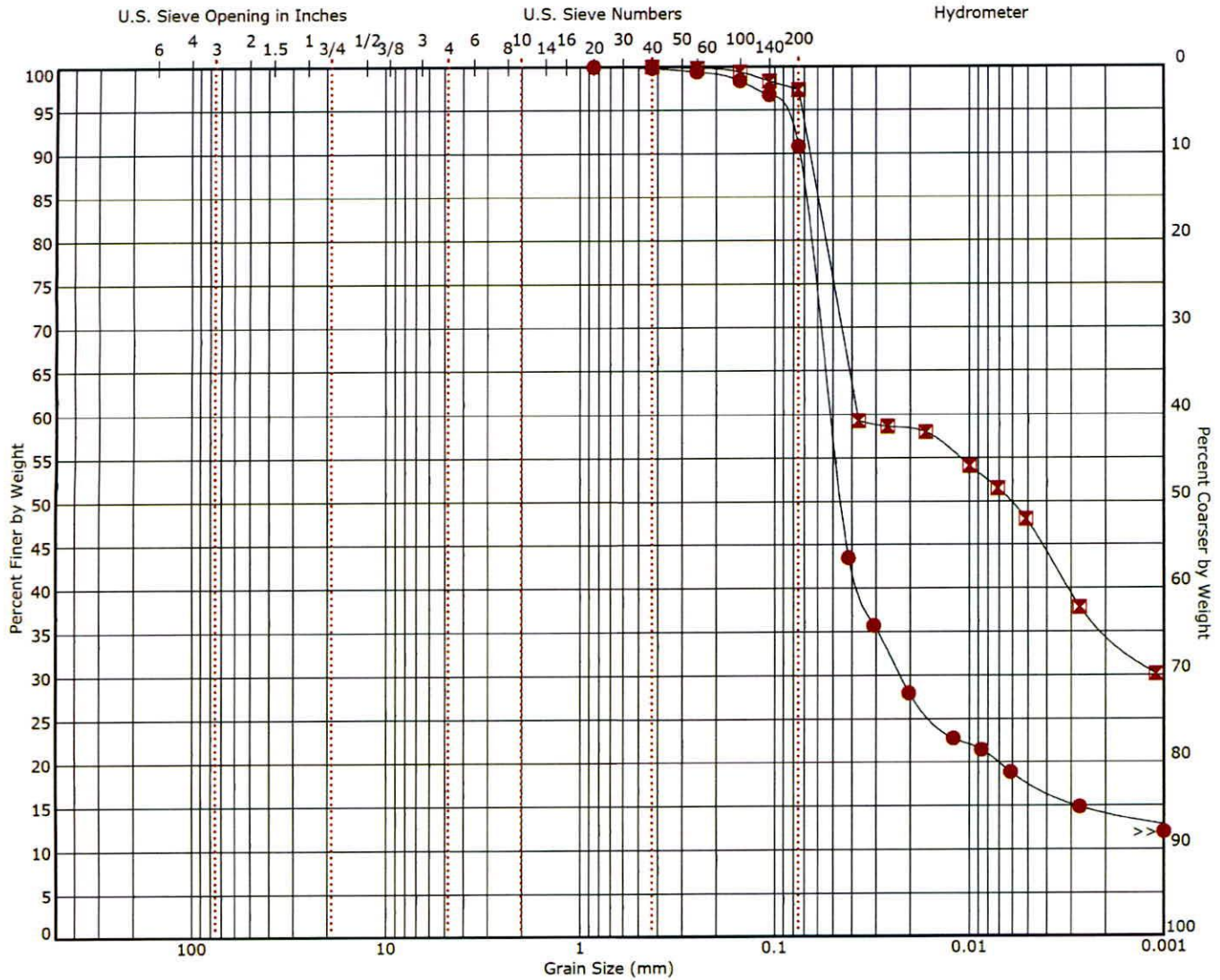
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Grain Size Distribution

ASTM D422 / ASTM C136



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● T-4	1 - 2								
☒ T-4	5 - 6								

Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
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