Western Refining Southwest LLC
A subsidiary of Marathon Petroleum Corporation
I-40 Exit 39
Jamestown, NM 87347

August 27, 2021

Mr. Kevin Pierard, Chief
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

RE: Response to Disapproval, Natural Attenuation Assessment and Proposed Work Plan for the Hydrocarbon Seep Area
French Drain Soil Sampling Investigation Work Plan
Western Refining Southwest LLC, Gallup Refinery
EPA ID #NMD000333211
HWB-WRG-20-023

Dear Mr. Pierard:

Attached please find the response to comments contained in the New Mexico Environment Department (NMED) above referenced Disapproval letter dated January 26, 2021. Included with this submittal is a red-line/strike-out version of the report in electronic format. Two hard copies and an electronic version of the revised report are also attached.

As set forth in our proposed workplan, Gallup Refinery (Refinery) is prepared to use the existing and currently collected data to provide a limited summary of MNA parameters in key wells; however, except for adding, tert-butyl-ether (TBA), ethene, sulfide, and ferrous iron for key wells, the Refinery is not prepared to engage in additional field or laboratory sampling (i.e., hydrogen or carbon dioxide) as part of Interim Measures reporting. The Refinery believes there is sufficient analytical data at present to support an inference of anaerobic degradation of chlorinated compounds.

If you have any questions or comments regarding the information contained herein, please do not hesitate to contact Mr. John Moore at (505) 879-7643.

<u>Certification</u>

I certify under penalty of law that this document and all attachments were prepared under my direction of supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the

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information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,
Western Refining Southwest LLC, Gallup Refinery

Ruth A. Cade

Ruth Cade
Vice-President

Attachments

cc: D. Cobrain, NMED HWB
M. Suzuki, NMED HWB
T. McDill, NMOCD
L. King, EPA Region 6
G. McCartney, Marathon Petroleum Corporation
K. Luka, Marathon Petroleum Corporation
J. Moore, Marathon Gallup Refinery
H. Jones, Trihydro Corporation

ATTACHMENT 1

RESPONSE TO COMMENTS

New Mexico Environment Department (NMED) to Western Refining Southwest LLC, Gallup Refinery (Refinery) Comment Letter "Disapproval, Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area, French Drain Soil Sampling Investigation Work Plan" (January 26, 2021)

NMED Comment	Refinery Response
Comment 1:	**Response 1:**
The Report does not present data that support the evidence of natural attenuation potential. For example, although the Evaluation of Current MNA Conditions Section, pages 5 and 6, provides a list of the site conditions that are favorable for anaerobic biodegradation of chlorinated compounds, the supporting data that demonstrate such conditions are not provided. All relevant groundwater monitoring wells where chlorinated compounds were previously detected must individually be evaluated to support the evidence. In order to evaluate such evidence, all pertinent parameters for natural attenuation (e.g., ORP, dissolved oxygen (DO), electron acceptors and donors, released chlorinated compounds and their daughter products, pH, and temperature) must be tabulated and compared, and the potential for biodegradation to occur in each well must be evaluated and discussed. In addition, although the potential of MTBE degradation was also required to be evaluated in accordance with the NMED's February 1, 2018 letter, the evaluation was not included in the Report. Include the evaluation in the revised Report.	All available data pertinent to MNA have been compiled in one table and organized by monitoring well for wells upgradient and within the hydrocarbon seep area. Only wells that did not contain separate phase hydrocarbon (SPH) in 2020 are included. The wells evaluated and the data are provided in a new Table 1 and shown on Figure 1. For the assessment of key MNA parameters, the data set contains analytical and field data from 2018 through 2020. A statistical analyses of contaminant trends were prepared using available chlorinated volatile organic compound (CVOC) and methyl tertiary butyl ether (MTBE) data from 2014 to 2020.

New Mexico Environment Department (NMED) to Western Refining Southwest LLC, Gallup Refinery (Refinery) Comment Letter "Disapproval, Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area, French Drain Soil Sampling Investigation Work Plan" (January 26, 2021)

NMED Comment	Refinery Response
Comment 2:	**Response 2:**
In the Hydrogeology Section, Subsurface Conditions, page 3, the Permittee states, "[i]n the Hydrocarbon Seep Area, three-dimensional geological modeling using available boring log information strongly suggests that the swale in the area of the hydrocarbon seep area is underlain by a corresponding swale in the shallow alluvium that likely influences shallow groundwater flow in this area. This is shown in Figure 3." Figure 3, 30 Modeling of Local Geology in the Hydrocarbon Seep Area, includes a magnified image of the subsurface conditions in the hydrocarbon seep area; however, the depths where the subsurface features are located are not indicated. Include this information in the revised Report. In addition, the location of the swale is not clear from the figure. The swale is presumably a stringer of relatively coarse sediments; however, such channel does not appear to be present in the magnified image. Indicate the location of the swale and provide a description of the location in the revised Report.	Figure 3 has been renumbered as Figure 2. The new Figure 2 (referenced on page 4 of the document) includes a scale and the location of pertinent features, e.g., hydrocarbon seep area. The swale referred to in the text is the Hydrocarbon Seep Area.

New Mexico Environment Department (NMED) to Western Refining Southwest LLC, Gallup Refinery (Refinery) Comment Letter "Disapproval, Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area, French Drain Soil Sampling Investigation Work Plan" (January 26, 2021)

NMED Comment	Refinery Response
Comment 3:	**Response 3:**
In the Natural Attenuation Section, page 4, the Permittee states, "[a] generalized diagram of typical hydrocarbon groundwater plume redox conditions is shown Figure 4," and "[i]n general, the sequence of electron acceptor use is as follows: 02 > NO^{3-} > Mn(III) or Mn(IV) > Fe(III) > SO_4^{-2}" Figure 4, Reducing Regimes in a Typical Hydrocarbon Groundwater Plume, indicates that the least aerobic regime is methanogenic. However, the electron acceptors under methanogenic conditions are not included in the statement above. Include the information for consistency in the revised Report.	Figure 4 has been renumbered as Figure 3. The text on page 4 has been updated to read: "O_2 > NO_{3-} > Mn(III) or Mn (IV) > Fe(III) > SO_4^{-2} > CO_2"
Comment 4:	**Response 4:**
In the Evaluation of Current MNA Conditions Section, page 4, the Permittee states, "Table 2 presents oxidation reduction potential (ORP) field data from quarterly sampling from quarters 1, 3 and 4 in 2016 (Western 2017)." Although Table 1, MNA Analytical Data, presents the most recent data, Table 2, 2016 ORP Field Data, presents the data collected in 2016. It is not clear why the 2016 ORP data is presented rather than the most recent data. Provide an explanation or revise the Report to include the most recent data.	Table 2 has been deleted from the report. Table 1 has been revised to include the ORP data collected between 2018 and 2020.

New Mexico Environment Department (NMED) to Western Refining Southwest LLC, Gallup Refinery (Refinery) Comment Letter "Disapproval, Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area, French Drain Soil Sampling Investigation Work Plan" (January 26, 2021)

NMED Comment	Refinery Response
Comment 5:	**Response 5:**
In the Evaluation of Current MNA Conditions Section, page 5, the Permittee states, "[e]vidence for conditions favorable for anaerobic biodegradation of chlorinated compounds includes [d]etection of vinyl chloride, which is typically a byproduct of TCE degradation." The accumulation of vinyl chloride is likely occurring based on the site's groundwater conditions. Indicate wells where vinyl chloride concentrations are detected in the revised Report and provide figures (concentrations versus time plots) that present trends for vinyl chloride concentrations at the wells in the revised Report .	Figure 1 has been revised to show those wells with consistent detection of vinyl chloride. Time trend plots of vinyl chloride are also provided for these wells in Attachment A.
Comment 6:	**Response 6:**
In the Evaluation of Current MNA Conditions Section, page 5, the Permittee states, "[e]vidence for conditions favorable for anaerobic biodegradation of chlorinated compounds includes [d]epleted sulfate in wells with elevated benzene (e.g., MKTF-10, MKTF-16, MKTF-17), indicating reducing conditions and sulfate reduction to sulfite [sic] as part of anaerobic biodegradation." The concentrations of chlorinated compounds are consistent in these wells according to Table 1. Although the Permittee states that favorable conditions for anaerobic biodegradation of chlorinated compounds exist, the chlorinated compounds do not appear to be degrading in the wells. Resolve the discrepancy or provide clarification in the revised Report.	A trend analysis has been provided in Attachment A and discussed in "*Evaluation for CVOCs"* on page 7.

New Mexico Environment Department (NMED) to Western Refining Southwest LLC, Gallup Refinery (Refinery) Comment Letter "Disapproval, Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area, French Drain Soil Sampling Investigation Work Plan" (January 26, 2021)

NMED Comment	Refinery Response
In addition, an analysis for the end product of sulfate reduction (sulfide) is not being conducted under the current groundwater monitoring work plan. The increase in sulfide levels may provide direct evidence of sulfate reduction. Propose to conduct sulfide analysis for pertinent wells in the next groundwater monitoring work plan update.	Sulfide and ethene will be added to the analyte list for key wells (see Table 6). In the current data set, the data for dissolved (field filtered) iron is assumed as ferrous iron. The use of field filtered iron versus unfiltered for total iron will continue as a method of quantifying ferrous iron.
Comment 7:	**Response 7:**
In the Evaluation of Current MNA Conditions Section, page 6, the Permittee states, "[t]o date, insufficient monitoring well analytical data is available to perform a statistical analysis of concentration trends. As more data become available, contaminant trend plots can be developed and statistical analysis can be performed." A total of fifty MKTF wells has been installed in the vicinity of the hydrocarbon seep area since 2014. There appear to be a sufficient number of wells. Relevant analytical data have been collected since 2014 for most wells. There appears to be sufficient data. Provide information regarding the insufficient data that are necessary to conduct such statistical analysis or include the analysis using available historical data in the revised Report.	The Refinery has provided statistical analysis for chlorinated hydrocarbons and MTBE in specific wells where sufficient data exists for these compounds (Attachments A and B).

New Mexico Environment Department (NMED) to Western Refining Southwest LLC, Gallup Refinery (Refinery) Comment Letter "Disapproval, Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area, French Drain Soil Sampling Investigation Work Plan" (January 26, 2021)

NMED Comment	Refinery Response
Comment 8:	**Response 8:**
In the Proposed Workplan for Natural Attenuation Evaluation for Future Annual Reports Section, page 6, the Permittee states, "MPC proposes that a natural attenuation evaluation section be completed on an annual basis using the existing quarterly sampling analyte list as shown in Table 3 as lines of evidence," and "[t]ables will be added to future annual reports with these analytes, and a new section will be added to present these key data and to summarize natural attenuation progress, including trends in contaminant concentrations and key MNA indicators." It is not appropriate to include the natural attenuation evaluation section in an annual groundwater monitoring report. Rather, a separate letter report that focuses on the evaluation of natural attenuation in the hydrocarbon seep area must be prepared and submitted. Submit the separate natural attenuation evaluation letter report that includes the data collected in year 2021 no later than March 31, 2022.	The Refinery agrees to prepare a natural attenuation evaluation on an annual basis. The MNA evaluation will be submitted to NMED in a letter report. Reports will be submitted on March 31 of each year starting in 2022.

New Mexico Environment Department (NMED) to Western Refining Southwest LLC, Gallup Refinery (Refinery) Comment Letter "Disapproval, Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area, French Drain Soil Sampling Investigation Work Plan" (January 26, 2021)

NMED Comment	Refinery Response
Comment 9:	**Response 9:**
The Proposed Workplan for Natural Attenuation Evaluation for Future Annual Reports Section, page 6, states, "MPC proposes that a natural attenuation evaluation section be completed on an annual basis using the existing quarterly sampling analyte list as shown in Table 3 as lines of evidence. These lines of evidence will include: • Benzene, MTBE, 1,1-DCA, 1,2-DCA, TCE, and vinyl chloride analytical results • Inorganic analyses including dissolved/total analyses for iron and manganese, nitrate/nitrate, pH and sulfate to determine their availability as terminal electron receptors and the redox state. A table of the results will be prepared. • Field measurements conducted during quarterly sampling and well purging (pH, ORP and dissolved oxygen) • As more data become available, and trends become evident, a Mann-Kendall statistical analysis will be performed to quantify contaminant concentration trends." Resolve the issues listed below and/or provide clarification in the revised Report: a) Table 3, Existing Groundwater Quarterly Sampling Analyses and MNA Applicability, lists BTEX, 1,1-DCA, 1,2-DCA, TCE, and vinyl chloride data to be monitored while the statement proposes benzene, MTBE, 1,1-DCA, 1,2-DCA, TCE, and vinyl chloride data to be monitored. These monitoring	A) Table 3 has been replaced with Table 6. The text in the Proposed Workplan for Natural Attenuation Evaluation for Future Annual Reports, page 7, has been updated to include BTEX. B) Table 6 and the text on page 7 have been updated to include chlorinated compounds and daughter products. C) Tertiary butyl alcohol (TBA) will be included in the 2022 groundwater monitoring work plan update as requested. D) Ethene will be added for key wells containing vinyl chloride.

New Mexico Environment Department (NMED) to Western Refining Southwest LLC, Gallup Refinery (Refinery) Comment Letter "Disapproval, Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area, French Drain Soil Sampling Investigation Work Plan" (January 26, 2021)

NMED Comment	Refinery Response
parameters must be consistent. Include BTEX in the revised Report. b) All released chlorinated compounds and their daughter products (e.g., PCE, cis-DCE) that were historically detected in the pertinent wells must be included as natural attenuation monitoring parameters in the revised Report. c) The degradation products of MTBE (e.g., tert-butyl alcohol) must be monitored to demonstrate MTBE natural attenuation in pertinent wells. Propose to conduct the analyses of the degradation products of MTBE in the next groundwater monitoring work plan update. d) The daughter products of vinyl chloride (e.g., ethene) must be monitored to evaluate vinyl chloride natural attenuation in pertinent wells. Propose to conduct the analyses of the daughter products of vinyl chloride in the next groundwater monitoring work plan update.	

New Mexico Environment Department (NMED) to Western Refining Southwest LLC, Gallup Refinery (Refinery) Comment Letter "Disapproval, Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area, French Drain Soil Sampling Investigation Work Plan" (January 26, 2021)

NMED Comment	Refinery Response
Comment 10:	**Response 10:**
Table 1, MNA Analytical Data, does not provide important natural attenuation evaluation parameters such as DO concentrations. Include all important parameters necessary to evaluate natural attenuation potential. Table 1 must list the wells with data relevant to the natural attenuation of chlorinated compounds; remove wells where chlorinated compounds were not Fr [sp: detected] In addition, prepare a separate table that lists parameters necessary to evaluate natural attenuation of MTBE in the revised Report. The table must list the wells with data relevant to the natural attenuation of MTBE. Furthermore, each table must provide a score for each well to weigh the potential for natural attenuation of chlorinated compounds and MTBE based on the data listed in the table. The revised Report must include a section to discuss how the scoring system is developed. Such scoring system may be referenced from a technical guidance such as EPA's Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, 1998. It should be noted that natural attenuation is not a remedial option for the sites where SPH or high concentrations of contaminants are present. This evaluation must focus on the fate of chlorinated compounds and MTBE.	Table 1 has been updated to provide all available MNA data for CVOC and MTBE. Table 2 provides the MNA criteria put forth by EPA. Table 3 summarizes the score for the applicable refinery wells and uses the EPA guidelines to characterize the evidence for MNA as either inadequate, limited, adequate, or strong.

ATTACHMENT 2

REVISED REPORT

Western Refining Southwest LLC
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August 27, 2021

Mr. Kevin Pierard, Chief
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

RE: Revised Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area
Western Refining Southwest LLC, Gallup Refinery
(dba Western Refining Southwest, Inc.)
EPA ID# NMD000333211

Dear Mr. Pierard:

Western Refining Southwest LLC, Gallup Refinery (Refinery) is submitting this letter in response to a request from the New Mexico Environment Department (NMED) Hazardous Waste Bureau for an assessment of natural attenuation in the hydrocarbon seep area at the Gallup refinery. This request was contained in a letter dated February 1, 2018, entitled *Disapproval, Interim Measures Report Hydrocarbon Seep Area, Western Refining Southwest Inc., Gallup Refinery, EPA ID# NMD000333211, HWB-WRG-15-002* and further defined in a letter dated January 26, 2021 entitled *Disapproval, Natural Attenuation Assessment and Proposed Work Plan for the Hydrocarbon Seep Area*. The area identified includes the Marketing Tank Farm area in the southwest portion of the refinery (Figure 1).

More specifically, the request is presented in NMED Comment 12, #2 through #5; relevant portions of which are excerpted as follows:

2. *The field analytical parameters such as dissolved oxygen concentration and oxidation-reduction potential (ORP) must be evaluated and presented to support the argument that reducing conditions and anaerobic degradation are occurring. Also, the ratio of total and dissolved iron concentrations must be examined to support the argument…*
3. *…Revise the Report to propose submittal of a work plan to investigate the occurrence of anaerobic dichlorination.*
4. *The accumulation of vinyl chloride may be occurring based on the site's groundwater conditions. In the plan referenced in Item 3 above, propose to monitor and evaluate the groundwater for analytical parameters pertinent to the accumulation of degradation of vinyl chloride (e.g., concentrations of daughter products, dissolved oxygen, chloride, redox potential and pH)…*

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5. *The Permittee must evaluate for the occurrence of hydrocarbon and MTBE degradation (e.g., concentrations of the electron acceptors, degradation byproducts, redox potential, and pH). Include all findings and interpretation of the existing data in the revised Report.*

Pursuant to the above request, this letter presents an evaluation of monitored natural attenuation (MNA) using existing monitoring well analytical data and proposes a workplan consisting of a similar evaluation of natural attenuation for future analyses. Findings would be included in an MNA evaluation report. Table 1 lists the monitoring wells within the area that were evaluated. The list consists of selected MKTF-designated wells within and hydraulically upgradient of the Hydrocarbon Seep Area. These wells contain chlorinated volatile organic compounds (CVOCs) above the NMED Groundwater Cleanup Levels (New Mexico Administrative Code 20.6.2.3103) and without separate phase hydrocarbon (SPH) observed in 2020.

Table 1 includes key analytical data collected between 2018 and 2020 for CVOCs, volatile organic compounds (VOC), methyl tert-butyl ether (MTBE), MNA indicator parameters, and relevant field parameters. These data are used to evaluate the potential for MNA in a procedure developed by the U.S. Environmental Protection Agency (USEPA) (1998). A more complete data set of laboratory analytical results from the period 2014 through 2020 is used for the statistical trend analysis (Attachments A and B). Figure 1 shows the location of these wells, and also the wells with SPH detected in the 3rd Quarter 2020 sampling event.

Background

The Hydrocarbon Seep area is located in the western portion of the refinery to the west-southwest of the refinery tank farm. Historically, the Hydrocarbon Seep Area has been impacted by releases of SPH associated with refinery operation. Hydrocarbon seeps were discovered in 2013.

CVOCs detected as part of routine quarterly sampling in this area between 2014 and 2020 include trichloroethene (TCE), 1,1-dichloroethane (1,1-DCA), 1,2-dichloroethane (1,2-DCA), 1,1-dichloroethene (1,1-DCE), tetrachloroethene (PCE), and vinyl chloride. Monitoring wells with consistent detection of vinyl chloride are shown in Figure 1. VOCs detected above the NMED Groundwater Cleanup Level standards include benzene, toluene, ethylbenzene, and xylenes (BTEX), and MTBE. Table 1 presents recent groundwater analytical data for monitoring wells in the Hydrocarbon Seep Area and nearby Marketing Tank Farm (MKTF) monitoring wells.

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Hydrogeology
Surface Conditions
Site topographic features include high ground in the southeast gradually decreasing to a lowland fluvial plain to the northwest. Elevations on the refinery property range from 7,040 feet (ft) to 6,860 feet. Surface soils within most of the area of investigation are primarily Rehobeth silty clay loam. Rehobeth soil properties include alkaline pH (ranging from 8 to 9 standard units) and salinity (naturally occurring and typically measuring up to approximately 8 millimhos per centimeter (MPC 2019).

Local surface water features include the refinery evaporation ponds and a number of small ponds (one cattle water pond and two small unnamed spring fed ponds). The site is located in the Puerco River Valley, north of the Zuni Uplift with overland flows directed northward to the tributaries of the Puerco River. The Puerco River continues to the west to the confluence with the Little Colorado River. The South Fork of the Puerco River is intermittent and retains flow only during and immediately following precipitation events (MPC 2019).

Subsurface Conditions
The shallow subsurface soils consist of fluvial and alluvial deposits comprised of clay and silt with minor inter-bedded sand layers. Very low permeability bedrock (e.g., claystones and siltstones) underlie the surface soils and effectively form an aquitard. The Chinle Group, which is Upper Triassic, crops out over a large area on the southern margin of the San Juan Basin. The uppermost recognized local Formation is the Petrified Forest Formation and the Sonsela Sandstone Bed is the uppermost recognized regional aquifer (MPC 2019). Aquifer test of the Sonsela Bed northeast of Prewitt indicated a transmissivity of greater than 100 ft squared per day (Stone and others, 1983). The Sonsela Sandstone's highest point occurs southeast of the site and slopes downward to the northwest as it passes under the refinery. The Sonsela Sandstone forms a water-bearing reservoir with artesian conditions throughout the central and western portions of the refinery property.

The diverse properties and complex, irregular stratigraphy of the surface soils across the site cause a wide range of hydraulic conductivity ranging from less than 10^{-2} centimeters per second (cm/sec) for gravel like sands immediately overlying the Petrified Forest Formation to 10^{-8} cm/sec in the clay soils located near the surface (Western 2009). Generally, shallow groundwater at the refinery follows the upper contact of the Petrified Forest Formation with prevailing flow from the southeast to the northwest.

Three-dimensional geological modeling using available boring log information strongly suggests that the swale in the area of the hydrocarbon seep area is underlain by a corresponding swale in the shallow alluvium that likely influences shallow groundwater flow in this area. This is shown in Figure 2.

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Monitored Natural Attenuation
MNA was assessed for this area following references published by the Interstate Technology Regulatory Council (ITRC) (1999), the USEPA (1998) and the New Jersey Department of Environmental Protection (NJDEP 2012).

Dissolved organic compounds can be degraded naturally in groundwater, with the rate dependent on the redox state of the groundwater and the presence of suitable electron receptors for microbial degradation (NJDEP 2012). Biodegradation under aerobic (oxidizing) conditions is generally faster than under anaerobic (reducing) conditions, but degradation occurs under both redox regimes.

In general, reducing conditions are present in the subsurface where SPH and dissolved organic compounds (e.g., CVOCs, BTEX) are present in groundwater. This has been established by numerous studies (ITRC 2009, Lawrence 2006, and NJDEP 2012) and is generally recognized and accepted. This redox condition is caused by depletion of oxygen through aerobic biodegradation of the dissolved petroleum. A generalized diagram of typical hydrocarbon groundwater plume redox conditions is shown Figure 3. When a release of hydrocarbons occurs into groundwater, existing microbes catalyze reactions between the electron-donating carbon and the electron acceptors, in a sequence that is most favorable to the microbes (ITRC 2010). In general, the sequence of electron acceptor use is as follows:

$$O_2 > NO_3^- > \mathrm{Mn(III)\ or\ Mn\ (IV)} > \mathrm{Fe(III)} > SO_4^{-2} > CO_2$$

The presence of the oxidized inorganic compounds shown above indicates the potential for biodegradation. Moreover, the presence of the reduced forms of these species generally indicates active biodegradation.

The strongest reducing conditions are generally present in the source area of the hydrocarbon plume where SPH is present. More oxidizing (less reducing) conditions are generally present in the downgradient direction of the dissolved hydrocarbon plume, as shown in Figure 4. Figure 4 also shows the areas of the plume where redox conditions are sufficient to allow reduction of the indicated species.

CVOCs generally require anaerobic conditions for biodegradation. Figure 4 presents a list of CVOCs and the likelihood of biodegradation through various degradation mechanisms/pathways. As shown in this figure, the primary mechanisms for biodegradation are reductive dechlorination and dichloroelimination.

Studies of MTBE aerobic biodegradation indicate that it is less recalcitrant than previously thought (Lawrence 2006). Anaerobic biodegradation proceeds more slowly under reducing conditions ranging from methanogenic to nitrate-reducing.

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Evaluation of Current MNA Conditions

Table 1 presents recent (2018 to 2020) groundwater analytical data from the hydrocarbon seep area wells, including organic and inorganic analytes, dissolved oxygen (DO), temperature, and oxidation reduction potential (ORP). This date range was selected to represent current conditions for the analysis of the key MNA parameters. A trend analysis was also conducted using data from the period 2014 through 2020 and is presented in Attachments A and B (CVOCs and MTBE, respectively).

Table 1 includes laboratory analytical data and field data collected during well purging, including temperature, pH, DO, and ORP. Field measurements of DO and ORP can be an indicator of the redox regime of groundwater, with the method of field measurement important to the absolute value of the results. Field pH/ORP is measured using a silver/silver chloride reference electrode. In general, for more accurate measurements of DO/ORP, a groundwater sampling pump and a flow-through cell for well purging and measuring DO/ORP is preferred because this configuration eliminates contact with air. For the DO/ORP data presented in Table 1, measurements were conducted using bailed water from a well, which was then placed into a container for ORP measurement. This procedure introduces oxygen, and actual in situ groundwater conditions would be expected to have a lower, more reducing DO/ORP. Nevertheless, the data in Table 1 can be evaluated in a relative sense for trends.

Evaluation for CVOCs

Qualitatively, current conditions and available geochemical data provide evidence that reducing conditions are present in the Hydrocarbon Seep Area. These reducing conditions create a geochemical environment for the anaerobic biodegradation of SPH and dissolved VOCs and may also be conducive to the anaerobic biodegradation of CVOCs (TCE, 1,1-DCA and 1,2-DCA) (USEPA 1998).

Evidence for conditions favorable for anaerobic biodegradation of CVOCs includes:

- Elevated benzene concentrations indicating that a high dissolved hydrocarbon load is present and anaerobic conditions are occurring. SPH is also present in several areas (Figure 1), which represents a continuing source for dissolved phase hydrocarbons.
- Detection of vinyl chloride, 1,1-DCE and cis-1,2-DCE, which are typical byproducts of TCE degradation. Vinyl chloride was detected consistently in monitoring wells MKTF-2, MKTF-10, MKTF-24, and MKTF-25, as shown in Figure 1.
- Presence of dissolved iron and total iron, indicating likely presence of ferrous iron in response to reducing conditions and anaerobic biodegradation
- Depleted sulfate in wells with elevated benzene (e.g., MKTF-10, MKTF-16, MKTF-17), indicating reducing condition and sulfate reduction to sulfite as part of anaerobic biodegradation.

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- Presence of manganese, indicating availability as an electron receptor for anaerobic biodegradation.
- Occasional detection of nitrite above detection limits, indicating reducing conditions and probable use of nitrate as an electron receptor for anaerobic biodegradation.
- Neutral to slightly basic pH conditions, which are favorable for biodegradation.
- Low ORP measurements, indicating reducing conditions are present particularly for MKTF wells located in the paved areas where SPH is present (Figure 1). Wells located to the west in unpaved areas without SPH and elevated dissolved hydrocarbon such as benzene are generally oxidizing.

Chloride concentrations are generally elevated in the MKTF wells, as shown in Table 1, but do not correlate with areas of elevated CVOCs. In the absence of high chloride from other sources, elevated chloride can be used as an indicator of the biodegradation of CVOCs (NJDEP 2012).

MNA Scoring Criteria
From a more quantitative standpoint, an evaluation was conducted on a well-by-well basis in accordance with USEPA guidance (USEPA 1998). Table 2 presents the scoring criteria from the USEPA and the applicability of the criteria to the Hydrocarbon Seep Area, given the analytical requirements of the existing approved Sampling Plan (MPC 2021) and current field sampling practices. Table 3 shows the implementation of the scoring for each well, and presents the final evaluation score for each well, which summarizes the potential for CVOC natural attenuation (reductive dichlorination). Four categories of scores assess the potential for anaerobic biodegradation of CVOCs, as follows:

- > 20 Strong evidence
- 15 to 20 Adequate evidence
- 6 to 14 Limited evidence
- 0 to 5 Inadequate evidence.

As shown in Table 3, the evidentiary scores ranged from 7 to 16, with nine wells deemed "Limited" category and one well deemed "Adequate."

Statistical Analyses
Statistical analyses were performed to determine if the analytical data results from the current monitoring period represent statistical upward or downward trends in analyte concentrations in the groundwater samples collected from MKTF-designated wells.

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Statistical Methods

QAQC and Data Handling

Trace concentrations (estimated results between the reporting limit [RL] and the method detection limit [MDL]) reported since 06/08/2016 were treated as true detected values. Therefore, being the upper bound of non-detect (ND) results, the MDL was used as substitute values for ND values in all statistical evaluations, unless stated otherwise (see Exploratory Data Analysis and General Statistics section). R® (R Core Team, 2020), a programing language and software environment for statistical analysis, was used for all statistical needs.

The statistical evaluation was performed for six chlorinated volatile organic compounds (CVOCs; 1,1-Dichloroethane, 1,1-Dichloroethene, 1,2-Dichloroethane, cis-1,2-Dichloroethene, Trichloroethene, and Vinyl Chloride) and methyl tert-butyl ether (MTBE). All constituents were reported in mg/L. Seven wells for CVOCs (i.e., MKTF-02, MKTF-09, MKTF-10, MKTF-16, MKTF-2, MKTF-24, MKTF-25) and 11 wells for MTBE (i.e. MKTF-04, MKTF-09, MKTF-16, MKTF-17, MKTF-19, MKTF-20, MKTF-21, MKTF-22, MKTF-23, MKTF-24, MKTF-25) were part of the 2020 evaluation.

Exploratory Data Analysis and General Statistics

Exploratory Data Analysis (EDA) was performed on all well-analyte combinations and are presented in Table 4 and Table 5, for the CVOCs and MTBE respectively. For each analyte-location pair, these statistics include the number of samples collected since April 8, 2014, the overall detection rate, the minimum and maximum detected concentrations, the minimum and maximum MDLs reported by laboratories, the overall sample mean, median, and sample standard deviation, and the dates of the range of the first and last sample.

Time Series Plots and Outlier Analysis

Outlier analysis was performed at a 95% confidence level using the Dixon's and Grubbs' tests when the sample size for each analyte-location pair, *n*, was more than 4 but less than 30, with at least one detected result. If the sample size was greater than 25, then the Rosner's test was used instead of or in addition to the two tests mentioned above and up to 3 potential outliers were considered. Because outlier tests' assumptions are often difficult to attain with real data, and the presence of one outlier can mask the detection of another, any extreme and unusual values flagged as outliers by any of the outlier tests (e.g., concentration 3 times greater or 1/3 smaller than the overall concentration) were graphically confirmed using time series plots. The last results were never considered an outlier regardless of their value since they could be the results of a recent event. Results from the outlier analysis are also presented in Table 4 (CVOCs) and Table 5 (MTBE).

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For each analyte-location pair, time series plots were constructed to show any potential trend in CVOCs and MTBE. In addition, any graphically confirmed outliers were also shown on the time series plots (Attachments A [CVOCs] and B [MTBE]).

Nonparametric Trend Analysis

Non-parametric trend analysis was conducted for all analyte-location pairs with a sample size equal to or greater than 8 (not including graphically confirmed outliers) and one detected result above the MDL to assess the temporal stationarity of the constituents' concentrations through time. To avoid trends in the MDLs driving the trend analysis results, the USEPA (2009) recommends ND values be assigned "a common value lower than any of the detected measurements" (USEPA 2009, Section 17.3.2 p. 17-31). ND values were assigned half of the minimum MDLs in each location for all analyses related to the trend analysis. Trend analyses were performed using the nonparametric approach, Mann-Kendall's monotonic trend analysis. Traditional Mann-Kendall trend analysis relies on several assumptions such as no serial correlation, no outliers, and no seasonality. The presence of serial correlation was tested for each location using the rank von Neumann ratio test at 95% confidence level and the results were graphically confirmed using Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). The presence of outliers in the data was addressed during the outlier analysis described above. Seasonal effects between the Summer-Fall (May to October) and Winter-Spring (November to April) sampling events were tested using Wilcoxon-Mann-Whitney tests at a 90% confidence level. The assumption of homogeneity of variance between the two seasons for the Wilcoxon tests for each COC-well combination was performed using the traditional Levene's test. In the absence of both serial autocorrelation and seasonal effect, the traditional Mann-Kendall trend analysis test was used. When serial correlation was identified, a modified Mann-Kendall test for serially correlated data using the Yue and Wang (Yue, 2004) variance correction approach was used. When seasonality was present in the data, a standard seasonal Mann-Kendall test, which performs a nonparametric test for a monotonic trend within each season based on Kendall's tau statistic, was used. Finally, if the presence of both serial correlation and seasonality in the data was confirmed the seasonal Mann-Kendall approach was adapted to handle serial correlation. Results from all trend analyses for the CVOC are presented in Table 4 and for MTBE in Table 5.

Results

COVCs

Nonparametric monotonic increasing trends were identified since 2014 for the following analyte-well pairs with 95% confidence (Table 4):

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- 1,1-Dichloroethene in wells MKTF-10 and MKTF-22
- Vinyl Chloride in wells MKTF-02, MKTF-10, MKTF-24

In addition, evidence of decreasing monotonic trends since 2014 was found, with 95% confidence, for 1,1-Dichloroethane, 1,1-Dichloroethene, cis-1,2-Dichloroethene, and Trichloroethene in wells MKTF-02, MKTF-09, MKTF-24, and MKTF-25.

All other analyte-well pairs showed no evidence of an overall trend since 2014 at a 95% confidence level.

<u>MTBE</u>
The Mann-Kendall (MK) trend analysis test found no evidence of monotonic increasing trends since 2014 for MTBE in the 11 wells with 95% confidence (Table 5). Recent changes in MTBE in well MKTF-17 and MKTF-25 will be monitored moving forward (see time series plot in Attachment B).

In addition, evidence of decreasing monotonic trends since 2014 was found, with 95% confidence, for MTBE in wells MKTF-09, MKTF-16, MKTF-21, and MKTF-24.

All other analyte-well pairs showed no evidence of an overall trend since 2014 at a 95% confidence level.

Proposed Workplan for Natural Attenuation Evaluation for Future Annual Reports
The proposed workplan to evaluate natural attenuation is presented in this section for NMED review and approval. The Refinery proposes that a natural attenuation evaluation be completed on an annual basis using the existing quarterly sampling analyte list (Table 6) as lines of evidence. These lines of evidence will include:

- BTEX, MTBE, tertiary butyl alcohol (TBA), PCE, TCE, cis-1,2- DCE, 1,1-DCE, 1,1-DCA, 1,2-DCA, and vinyl chloride concentrations
- Ethene analysis will be conducted in four monitoring wells with elevated vinyl chloride concentrations (MKTF-2, MKTF-10, MKTF-24, and MKTF-25)
- Dissolved/total iron and manganese, nitrate/nitrite, and sulfate/sulfide to determine their availability as terminal electron receptors and the redox state
- Field parameters such as pH, temperature, ORP, and DO pH, temperature, ORP, and DO

The evaluation in future MNA reports will include data tables summarizing these analytes, updating the USEPA quantitative spreadsheet scoring the MNA potential, and updating the MK

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statistical trend analysis for CVOCs and MTBE. A discussion section will be added summarizing natural attenuation progress, including trends in contaminant concentrations and key MNA indicators. The MNA evaluation will be submitted to NMED in a letter report. Reports will be submitted on March 31 of each year starting in 2022.
If you have any questions or comments regarding the information contained herein, please do not hesitate to contact Mr. John Moore at (505) 879-7643.

Certification

I certify under penalty of law that this document and all attachments were prepared under my direction of supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,
Western Refining Southwest LLC, Marathon Gallup Refinery

Ruth A. Cade

Ruth Cade
Vice-President

Attachments

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Tables

TABLE 1. MKTF WELLS CVOCs AND MNA ANALYTICAL DATA 2018-2020
MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Well ID	Date Sampled	PCE (mg/L)	TCE (mg/L)	cis-1,2-DCE (mg/L)	1,1-DCA (mg/L)	1,2-DCA (mg/L)	1,1-DCE (mg/L)	Vinyl Chloride (mg/L)	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylene (mg/L)	BTEX (mg/L)	TPH-GRO (mg/L)	TPH-DRO (mg/L)	Chloride (mg/L)	Fe, Dissolved (mg/L)	Fe, Total (mg/L)	Mn, Dissolved (mg/L)	MN, Total (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	DO (mg/L)	ORP (mV)	pH	T (C)
MKTF-2	12/18/20	ND	<.001	ND	0.0291	-	0.00876	0.0241	0.885	0.161	0.0119	ND	1.0579	9.8	4.55	3020	1.03	2.56	6.46	6.14	ND	185	7.24	191.7	6.9	11.5
	09/21/20	ND	<.001	0.0019	0.021	<.001	0.0014	0.027	4	0.52	0.033	0.0063	4.5593	7.9	2.1	1000	0.22	0.99	1.9	2	ND	64	0.21	285.1	6.7	14.76
	02/25/20	ND	<.001	ND	0.0065	-	0.0018	0.005	0.78	0.57	0.01	0.048	1.408	-	1.8	1300	0.34	2	3	3	ND	160	5.77	127.3	8.7	NM
	11/19/19	<0.005	<0.005	0.0031	0.015	0.0047	0.0014	0.017	0.36	0.046	0.003	<0.0075	0.409	2.4	0.65	1900	0.48	5.7	2.5	2.9	<0.5	330	3.52	145	7.6	14.3
	08/23/19	<0.02	<0.02	<0.02	0.027	0.012	<0.02	0.028	0.99	0.078	0.012	<0.03	1.08	3.9	3.1	2000	2.4	9.1	2	2.3	<0.5	150	3.01	-104.1	7.1	13.35
	05/06/19	<0.02	<0.02	<0.02	0.019	0.0064	0.0064	0.019	0.95	0.043	0.019	0.11	1.122	5.3	3.5	1600	3	3.9	1.8	1.9	<0.5	61	1.74	-92.2	6.9	12.31
	03/28/19	<0.02	<0.02	<0.02	0.016	0.0069	0.0073	0.013	0.62	0.01	0.016	0.13	0.776	4.1	3.8	1400	0.42	1.6	1.6	1.5	<1.0	52	1.92	46.1	8.3	11.18
	11/28/18	<0.01	<0.01	0.0086	0.044	<0.01	0.007	0.028	5.5	0.51	0.082	0.17	6.262	18	2.9	570	0.078	0.24	0.75	0.74	<0.5	5.6	-	-	7.7	12.95
	08/20/18	<0.01	<0.01	0.0099	0.042	0.0078	0.024	0.0071	2.5	0.14	0.031	0.031	2.702	7.8	1.3	510	0.027	0.2	0.51	0.52	<0.5	11	-	-	7.2	14.8
	05/01/18	<0.01	0.0018	0.016	0.033	0.0048	0.011	0.0063	2.9	0.24	0.039	0.12	3.299	9.1	3.2	520	0.03	0.36	0.57	0.62	<0.5	15	-	-	7.5	11.8
	02/06/18	<0.005	0.003	0.014	0.041	<0.005	0.018	0.0037	2.6	0.25	0.049	0.089	2.988	7.7	2.8	520	0.022	0.57	0.55	0.61	<1.0	20	-	-	8.4	10.26
MKTF-9	03/03/20	-	-	-	-	-	-	-	3.2	0.2	0.012	0.059	3.471	6.3	1	290	1.4	2.4	4.1	4	ND	46	1.91	51.2	8.0	11.22
	11/18/19	<0.01	<0.01	0.011	0.011	<0.01	0.015	<0.01	3.7	0.23	0.014	0.069	4.013	10	1.0	220	2.4	3.4	4.2	4.3	<0.5	25	1.46	29.8	7.4	16.1
	08/23/19	<0.02	<0.02	0.012	0.014	<0.02	0.017	<0.02	3.5	0.27	0.021	0.098	3.889	12	3.9	230	3.8	4.5	4.4	4.5	<0.5	12			6.9	14.84
	05/13/19	<0.01	<0.01	<0.01	0.0068	<0.01	0.0063	<0.01	3.2	0.28	0.025	0.095	3.6	8.4	3.1	250	3.2	3.8	4.6	4.8	<0.5	8.1	2.41	-74.3	6.5	14.27
	03/26/19	<0.02	<0.02	0.02	0.0091	<0.02	0.0091	<0.02	2.2	0.22	0.019	0.098	2.537	8.2	2.5	240	3.9	4.4	4.6	4.2	<0.5	10	1.58	-59.9	7.9	12.1
	11/28/18	<0.02	<0.02	0.02	0.022	<0.02	0.034	<0.02	3.3	0.19	0.02	0.073	3.583	9.1	1.8	260	0.82	1.9	4.1	3.9	<0.5	24	-	-	7.3	13.85
	09/04/18	<0.02	<0.02	0.021	0.09	<0.02	0.028	<0.02	2.7	0.25	0.019	0.084	3.053	11	2.4	260	0.94	1.8	4.4	4.2	<0.5	17	-	-	NM	NM
	05/02/18	0.0028	0.0032	0.023	0.026	<0.01	0.036	<0.01	2.8	0.28	0.025	0.098	3.203	8.2	2.6	250	1.4	2.3	3.9	4.4	0.21	22	-	-	NM	NM
	02/14/18	0.002	0.0029	0.026	0.015	<0.01	0.028	<0.01	2.7	0.25	0.024	0.084	3.058	8.7	2.2	220	1.3	2.3	4	3.9	<0.5	27	-	-	6.9	11.30
MKTF-10	12/18/20	ND	ND	ND	0.04	-	ND	ND	4.67	1.8	0.284	8.6	15.354	-	5.54	937	7.25	10.7	4.81	5.07	ND	ND	2.87	220.4	6.9	11.2
	03/03/20	ND	ND	0.0041	0.047	-	0.0066	0.0089	4.8	1.7	0.65	8.2	15.35	40	1.3	970	7.2	12	5.4	5.5	ND	ND	1.61	3	7.8	11.84
	10/30/19	<0.01	<0.01	0.039	0.031	<0.01	0.0059	0.01	5.5	1.7	0.57	7.2	14.97	40	0.35	1000	14	15	6.2	6.3	<0.5	<2.5	1.4	-1.2	7.2	13.6
	08/22/19	<0.01	<0.01	0.034	0.037	<0.01	0.0075	0.01	4.6	1.6	0.66	7.4	14.26	35	3	960	7.9	11	5.4	5.6	0.1	<2.5	-	-	7.0	18.34
	05/13/19	<0.05	<0.05	<0.05	0.027	<0.05	0.013	0.023	5.5	1.7	0.9	7.9	16	48	3.5	460	8.4	8.9	3.4	3.6	<0.5	<2.5	1.78	-87.1	6.2	15.95
	03/26/19	<0.1	<0.1	0.05	0.04	<0.1	<0.1	0.042	5	1.7	0.86	7.9	15.46	50	2.6	390	7	8.9	3.1	3.1	<0.5	0.4	1.16	-24.4	7.9	11.9
	11/20/18	<0.02	<0.02	0.058	<0.02	<0.02	0.0051	0.0074	11	1.9	1.9	8	22.8	53	2.8	320	6.1	8.3	2.9	3	<0.5	<2.5	-	-	7.3	12.68
	09/04/18	<0.05	<0.05	0.047	<0.05	<0.05	0.012	0.018	10	1.8	2.4	8.1	22.3	57	2.5	340	6.8	7.7	2.9	2.8	<0.5	<2.5	-	-	NM	NM
	05/02/18	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	13	2.1	4.9	9.6	29.6	100	3.7	380	9.2	11	3.3	3.9	<0.5	<2.5	-	-	NM	NM
	02/14/18	<0.05	<0.05	0.066	<0.05	<0.05	<0.05	0.018	10	1.8	3.7	8.3	23.8	74	2.6	390	9.7	12	3.7	3.6	<0.5	<2.5	-	-	NM	NM
MKTF-13	10/29/19	-	-	<0.02	-	<0.02	<0.02	-	4.7	0.6	0.11	2.6	8.01	23	7.3	290	15	20	4.6	4.7	<0.5	0.59	0.85	-8.4	7.2	13.8
	08/20/19	-	-	-	-	-	-	-	0	0	0	0	0			-	-	-	-	-	-	-	-	-	NM	NM
	05/09/19	-	-	<0.02	-	<0.02	<0.02	-	3.2	0.32	0.12	2.6	6.24	19	63	400	26	35	8.2	6.1	<0.5	1.1	-	-	NM	NM
	03/26/19	-	-	<0.02	-	<0.02	<0.02	-	3.5	0.6	0.14	3.5	7.74	27	8.1	390	24	25	5.1	4.7	<1.0	0.75	-	-	NM	NM
	11/28/18	-	-	<0.02	-	<0.02	<0.02	-	4.5	0.53	0.13	2.8	7.96	24	4.5	220	10	16	4.4	4.4	<0.5	<2.5	-	-	7.1	14.17
	08/30/18	-	-	<0.02	-	<0.02	<0.02	-	3.5	0.65	0.12	3.2	7.47	26	5.5	210	16	19	5.1	4.7	0.12	<2.5	-	-	NM	NM
	05/10/18	-	-	<0.001	-	<0.005	0.0025	-	4.8	0.87	0.15	4	9.82	28	30	190	14	17	4.6	4.6	0.21	1.2	-	-	NM	NM
MKTF-16	12/23/20	ND	ND	ND	ND	-	ND	ND	14.7	1.32	0.129	ND	16.149	-	-	-	-	10.7	-	2.54	-	-	0.98	53.8	6.8	14.2
	10/30/19	<0.1	<0.1	<0.1	0.069	<0.1	<0.1	<0.1	15	1.5	0.095	0.43	17.025	33	0.24	1700	15	17	0.62	5.5	<0.5	<2.5	-	-	NM	NM
	08/22/19	<0.1	<0.1	<0.1	0.064	<0.1	<0.1	<0.1	9.8	0.48	0.043	0.11	10.433	20	3.6	1800	21	24	0.55	7.1	<0.5	<2.5	-	-	6.8	22.88
	05/14/19	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	14	0.71	0.11	0.62	15.44	30	3.4	960	5.8	5.8	0.62	2.6	<0.5	0.68	0.97	-78	6.2	15.96
	02/20/19	<0.1	<0.1	<0.1	0.053	<0.1	<0.1	<0.1	21	1.4	0.19	1.6	24.19	48	2.2	590	2	5.8	0.61	1.7	<0.5	0.41	2.1	-55.1	7.7	13.47
	11/29/18	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	17	0.89	0.12	0.72	18.73	34	2.6	620	2.7	4.1	0.69	1.5	<0.5	0.64	-	-	NM	NM
	08/31/18	<0.1	<0.1	<0.1	0.047	<0.1	<0.1	<0.1	17	1.3	0.13	1.4	19.83	50	3.3	650	1.8	3.6	0.64	1.8	<1.0	1.4	-	-	6.9	23.9
	05/11/18	<0.05	<0.05	<0.05	0.036	<0.05	<0.05	<0.05	19	1.6	0.17	2	22.77	47	2.9	840	3.4	4.3	0.64	1.9	0.099	1.2	-	-	7.0	18.6
	02/15/18	<0.01	<0.01	<0.01	0.0062	<0.01	<0.01	0.0058	1.8	0.015	0.024	0.23	2.069	8.4	2.4	760	0.095	18	0.04	0.37	0.13	57	-	-	6.9	15.24
MKTF-17	10/29/19	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	12	1.1	23	3.1	39.2	78	0.7	240	0.45	4.8	2.5	3.5	<0.5	6.2	2.27	169.9	7.5	14.0
	08/20/19	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.87	0.64	0.0026	0.078	1.5906	7.6	3.3	140	0.37	3	4.3	2.8	<0.5	14	-	-	7.0	15.03
	05/09/19	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	2.2	0.49	0.0022	0.15	2.8422	9.1	7.6	100	0.27	5.4	4.3	3	<0.5	15	1	-93.8	6.4	11.94
	03/26/19	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.98	0.09	<0.005	0.021	1.091	7	1.9	130	0.23	2.2	4.6	2.7	<0.5	48	3.75	2.7	7.7	10.99
	11/28/18	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0036	0.025	<0.005	<0.0075	0.0286	3	1.6	110	0.27	2	5.7	2.5	<0.5	120	-	-	7.6	13.56
	08/24/18	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.0027	0.12	<0.005	<0.0075	0.1227	4.7	<1.0	110	0.39	1.7	5.3	2.4	<0.5	160	-	-	7.3	17.3
	05/04/18	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.047	0.14	0.0011	0.002	0.1901	7.1	1.4	130	0.17	1.8	7.4	2.7	0.054	68	-	-	7.1	13.8
	02/16/18	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.22	0.21	0.00098	<0.0075	0.43098	3.7	1.36	100	0.13	1.7	4.9	2.9	<0.5	52	-	-	7.0	13.00

TABLE 1. MKTF WELLS CVOCs AND MNA ANALYTICAL DATA 2018-2020
MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Well ID	Date Sampled	PCE (mg/L)	TCE (mg/L)	cis-1,2-DCE (mg/L)	1,1-DCA (mg/L)	1,2-DCA (mg/L)	1,1-DCE (mg/L)	Vinyl Chloride (mg/L)	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylene (mg/L)	BTEX (mg/L)	TPH-GRO (mg/L)	TPH-DRO (mg/L)	Chloride (mg/L)	Fe, Dissolved (mg/L)	Fe, Total (mg/L)	Mn, Dissolved (mg/L)	MN, Total (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	DO (mg/L)	ORP (mV)	pH	T (C)
MKTF-19	10/29/19	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.6	0.61	0.013	0.61	2.833	17	1	130	10	15	2.4	2.4	<0.5	0.5	1.1	13.9	7.3	14.5
	08/19/19	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.4	0.72	<0.02	0.69	2.81	18	13	140	11	19	2.3	2.7	<0.5	<2.5	-	-	6.9	14.10
	05/09/19	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.8	0.77	<0.02	0.61	3.18	19	11	140	11	15	2.4	2.7	<0.5	0.31	-	-	NM	NM
	03/26/19	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.3	0.71	<0.02	0.61	2.62	17	8.7	140	9.9	11	2.2	2.6	<0.5	0.34	0.98	-58	7.3	8.91
	11/28/18	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.9	0.63	<0.02	0.57	3.1	15	7.8	140	8.3	7.5	2.2	2.4	<0.5	<2.5	-	-	7.1	13.7
	08/24/18	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	1.7	0.71	0.0043	0.74	3.1543	22	7.9	120	10	15	2.3	2.4	<0.5	<2.5	-	-	NM	NM
	05/04/18	<0.005	<0.005	0.002	<0.005	<0.005	<0.005	<0.005	2	0.87	0.0057	0.82	3.6957	23	9.3	130	10	11	2.4	2.4	<0.5	1.2	-	-	NM	NM
	02/16/18	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.9	0.74	0.0037	0.64	3.2837	16	11	120	9.6	10	2.4	2.3	<0.5	<2.5	-	-	NM	NM
MKTF-22	10/24/19	<0.02	<0.02	<0.02	0.013	<0.02	0.013	<0.02	3.4	0.27	<0.02	<0.03	3.67	9	0.28	190	6.8	12	2.9	2.9	<0.5	2.9	1.88	39.9	7.3	12.6
	08/20/19	<0.02	<0.02	0.0089	0.013	<0.02	0.017	<0.02	3.2	0.26	0.0087	0.014	3.4827	8.2	2.4	200	6.8	8.5	2.6	2.9	<0.5	4.7	-	-	7.0	12.40
	05/09/19	<0.02	<0.02	0.012	0.011	<0.02	0.015	<0.02	3.5	0.33	0.0091	<0.03	3.8391	11	2.6	170	7.3	11	2.6	3.1	<0.5	13	2.07	-81.4	6.4	12.45
	03/26/19	<0.02	<0.02	0.0098	0.01	<0.02	0.014	<0.02	2.4	0.19	<0.02	<0.03	2.59	10	2.9	150	2.3	8.7	2.5	2.6	<0.5	7.6	1.89	-32	7.5	11.27
	11/28/18	<0.02	<0.02	0.011	<0.02	<0.02	0.014	<0.02	3	0.17	0.0084	<0.03	3.1784	11	2	130	1.4	12	2.5	2.5	<0.5	5.8	-	-	7.0	12.75
	08/30/18	<0.02	<0.02	0.008	<0.02	<0.02	0.0081	<0.02	2.2	0.12	0.0056	<0.03	2.3256	11	3.1	110	3	7.4	2.4	2.5	1.7	3.8	-	-	7.1	14.4
	05/10/18	<0.01	<0.01	0.0097	<0.01	<0.01	0.0082	<0.01	2.5	0.15	0.0088	0.014	2.6728	11	3.5	110	1.4	4.4	2.4	2.5	0.15	5.8	-	-	7.2	13.8
	02/08/18	<0.01	<0.01	0.0078	<0.01	<0.01	0.0068	<0.01	2.3	0.14	0.0093	0.018	2.4673	10	2.9	110	1	8.3	2.2	2.5	<1.0	5.2	-	-	5.3	12.62
MKTF-24	12/18/20	<0.005	ND	ND	0.0393	-	ND	0.0332	5.02	0.223	ND	ND	5.243	-	2.47	893	0.248	7.25	2.39	2.84	ND	21.8	6.25	211.5	7.0	10.8
	09/19/20	<0.02	ND	ND	0.041	<0.02	0.0061	0.037	6.1	0.24	0.024	ND	6.364	15	0.38	950	0.26	32	1.9	4.4	-	35	2.65	238.9	7.6	12.35
	02/25/20	ND	ND	ND	0.038	-	0.02	0.028	2.9	0.083	0.011	ND	2.994	7.2	0.71	940	0.08	1.9	1.9	2.2	0.12	27	1.52	81	9.5	12.87
	10/23/19	<0.01	<0.01	<0.02	0.033	0.0093	0.011	0.037	5	0.31	0.024	<0.03	5.334	17	<0.4	660	0.59	0.9	2.4	2.3	<0.5	20	2.27	189.4	7.4	13.0
	08/23/19	<0.01	<0.02	0.0086	0.053	<0.02	0.019	0.038	4.1	0.24	0.022	0.012	4.374	15	0.94	800	1.6	5.3	2.2	2.1	<0.5	34	-	-	7.3	14.0
	05/06/19	<0.01	<0.01	<0.02	0.047	0.0066	0.014	0.022	3	0.12	0.014	<0.03	3.134	8.6	0.65	1000	5.7	8.3	2.3	2.6	<0.5	42	2.12	-81.9	6.7	14.32
	02/25/19	<0.01	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	NM	NM
	11/18/18	<0.01	<0.01	0.0093	0.076	<0.02	0.019	0.028	4.8	0.2	0.021	<0.03	5.021	16	1.5	520	0.1	0.7	1.8	2	<0.5	27	-	-	7.3	12.68
	08/20/18	<0.1	<0.02	0.011	0.074	0.0082	0.022	0.032	4.8	0.32	0.025	<0.03	5.145	23	1.4	560	0.33	1.2	1.8	1.8	<0.5	30	-	-	7.1	12.9
	05/01/18	<0.05	<0.02	0.022	0.066	0.0083	0.016	0.031	5.5	0.3	0.029	0.0065	5.8355	23	1.4	500	0.26	1.3	1.9	2.1	0.17	29	-	-	7.1	12.3
	02/06/18	<0.1	<0.02	0.017	0.082	<0.02	0.027	0.037	6.3	0.41	0.03	0.015	6.755	21	1.1	430	0.24	0.78	2.2	2.2	<1.0	30	-	-	8.3	12.43
MKTF-25	12/18/20	ND	0.0097	0.0149	0.0918	-	0.0613	ND	0.629	ND	ND	ND	0.629	-	1.86	844	ND	4.07	2.98	3.2	ND	68	4.8	165	7.1	11.9
	02/27/20	ND	0.012	0.027	0.1	-	0.063	0.0042	0.42	ND	ND	ND	0.42	2.5	0.32	980	0.13	5.6	3.2	3.4	-	76	6.28	91.5	8.4	9.86
	10/23/19	<0.005	0.011	0.027	0.11	0.0091	0.059	0.0033	0.37	0.00081	<0.005	<0.0075	0.37081	3	<0.4	1400	0.28	10	5.4	5.8	<0.5	73	2.66	179.1	7.3	12.8
	08/27/19	0.0016	0.013	0.025	0.13	0.01	0.052	<0.005	0.13	<0.005	<0.005	<0.0075	0.13	1.7	<1.0	1100	0.25	1.8	3.6	3.9	<0.5	68	-	-	6.8	14.93
	05/06/19	<0.01	0.012	0.035	0.14	0.0061	0.05	0.007	0.37	<0.01	<0.01	<0.015	0.37	3.6	0.4	860	0.21	4.7	1.8	2.2	<0.5	52	1.6	50.1	6.6	10.81
	02/14/19	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	NM	NM
	11/15/18	<0.01	0.0068	0.029	0.13	<0.01	0.027	<0.01	1.7	0.0029	0.0059	<0.015	1.7088	5	<1.0	630	0.048	2.9	2.9	3.1	<0.5	50	-	-	7.3	12.28
	08/17/18	<0.01	0.006	0.052	0.14	0.0085	0.049	<0.01	4.5	0.026	0.017	<0.015	4.543	17	1	540	0.97	12	2.4	3	<0.5	23	-	-	7.1	14.5
	05/06/18	0.0027	0.026	0.053	0.23	<0.005	0.11	0.04	3.4	0.15	0.015	0.009	3.574	12	1.1	500	0.75	2.6	2.4	2.7	<1.0	28	-	-	7.1	10.5
	02/05/18	0.0023	0.025	0.05	0.22	0.01	0.11	0.003	2	0.11	0.01	0.003	2.123	16	0.58	520	0.7	4.3	2.6	3.2	<1.0	27	-	-	6.9	10.70

Notes:

- = not sampled
BTEX = benzene, toluene, ethylbenzene, xylene
C = centigrade
DCA = dichloroethane
DCE = dichloroethene
DO = dissolved oxygen
Fe = iron
ID = identification
mg/L = milligrams per liter
Mn = manganese

MTBE = methyl tert-butyl ether
mV = millivolts
ND = non-detect
NM = not measured
ORP - oxidation reduction potential measured using an silver/silver chloride reference cell
PCE = tetrachloroethene
T = temperature
TCE = trichloroethene
TPH-DRO = total petroleum hydrocarbons - diesel range organics
TPH-GRO = total petroleum hydrocarbons - gasoline range organics

- pH, ORP, and temperature were measured during well purging prior to the sampling date

TABLE 2. MONITORED NATURAL ATTENUATION ASSESSMENT EPA SCORING SYSTEM
MARATHON GALLUP REFINERY, GALLUP NEW MEXICO

Analysis	Concentration in Most Contaminated Zone	Significance	Applicability to the Existing Data Set	Scoring Value
Oxygen	<0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations	DO data collected in a bucket during well purging. Not as accurate as a flow-through cell	3
Oxygen	>5 mg/L	Not tolerated; however, VC may be oxidized aerobically	DO data collected in a bucket during well purging. Not as accurate as a flow-through cell	-3
Nitrate	<1 mg/L	At higher concentrations may compete with reductive pathway	In data set	2
Iron II	>1 mg/L	Reductive pathway possible; VC may be oxidized under Fe(III)-reducing conditions	Ferrous iron not sampled for; dissolved (field filtered) is used	3
Sulfate	<20 mg/L	At higher concentrations may compete with reductive pathway	In data set	2
Sulfide	>1 mg/L	Reductive pathway possible	Not currently analyzed.	3
Methane	<0.5 mg/L >0.5 mg/L	VC oxidizes Ultimate reductive daughter product, VC Accumulates	Not currently analyzed.	0 3
ORP	<50 millivolts (mV) <-100mV	Reductive pathway possible Reductive pathway likely	ORP data collected in a bucket during well purging. Not as accurate as a flow-through cell	1 2
pH	5 < pH < 9 5 > pH >9	Optimal range for reductive pathway Outside optimal range for reductive pathway	In data set	0 -2
TOC	> 20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	Not currently analyzed; inferred from total BTEX and TPH	2
Temperature	> 20 C	At T >20 C biochemical process is accelerated	In data set	1
CO2	>2x background	Ultimate oxidative daughter product	Not currently analyzed.	1
Alkalinity	>2x background	Results from interaction between CO2 and aquifer minerals	Not currently analyzed.	1
Chloride	>2x background	Daughter product of organic chlorine	In data set, but very high background in shallow water at the refinery due to other releases.	2
Hydrogen	>1 nM/L	Reductive pathway possible, VC may accumulate	Not currently analyzed	3
Hydrogen	<1 nM/L	VC oxidized	Not currently analyzed.	0
Volatile Fatty Acids	> 0.1 mg/L	Intermediates resulting from biodegradation of more complex compounds; carbon and energy source	Not currently analyzed.	2
BTEX	> 0.1 mg/L	Carbon and energy source; drives dechlorination	In data set	2
PCE	Present	Material released	Not included in MNA due to low/infrequent concentrations.	0
TCE	Present	Material released Daughter product of PCE	In data set	0 2

TABLE 2. MONITORED NATURAL ATTENUATION ASSESSMENT EPA SCORING SYSTEM
MARATHON GALLUP REFINERY, GALLUP NEW MEXICO

Analysis	Concentration in Most Contaminated Zone	Significance	Applicability to the Existing Data Set	Scoring Value
DCE	Present	Material released Daughter product of TCE If cis is > 80% of total DCE it is likely a daughter product 1,1-DCE can be chemical reaction product of TCA	In data set	0 2
VC	Present	Material released Daughter product of DCE	In data set	0 2
1,1,1-TCA	Present	Material released	Not included in MNA due to low/infrequent concentrations.	0
DCA	Present	Daughter product of TCA under reducing conditions	1,1,1-TCA not in MNA analysis (not released)	2
Ethene /Ethane	>0.01mg/L >0.1 mg/L	Daughter product of VC/ethene	Not currently analyzed.	2 3

Notes:
BTEX = sum of benzene, toluene, ethylbenzene and xylene concentrations
C = centigrade
CO_2 = carbon dioxide
DCA = dichloroethane
DCE = dichloroethene
DO -dissolved oxygen
mg/L = milligram/liter
mV = millivolts
nM/L = nanomoles/liter
ORP = oxidation reduction potential
PCE = tetrachloroethene
TCA = trichloroethane
TCE = trichloroethene
TOC = total organic carbon

Source : EPA 1998

TABLE 3. MONITORED NATURAL ATTENUATION EPA SCORING RESULTS
MARATHON GALLUP REFINERY, GALLUP NEW MEXICO

Well	DO, mg/L		Nitrate, mg/L		Iron II, mg/L		Sulfate, mg/L		ORP, mV		pH		TOC, mg/L		T, C		BTEX, mg/L		TCE, mg/L		DCE, mg/L		VC, mg/L		Total Score	Evaluation
	Average	Score	Average	Score	Average	Score	Average	Score	Average	Score	Average	Score	Average	Score	Average	Score	Average	Score	Average	Score	Average	Score	Average	Score		
MKTF-2	3.34	0	<1	2	0.73	0	95.78	0	85.6	0	7.54	0	12.63	0	12.7	0	2.33	2	0.0024	0	0.02	2	0.016	2	8	Limited
MKTF-9	1.84	0	<1	2	2.13	3	21.23	0	-13.3	1	7.28	0	14.76	0	13.4	0	3.38	2	0.00305	0	0.04	2	ND	0	10	Limited
MKTF-10	1.76	0	<1	2	8.36	3	0.40	2	22.1	1	7.19	0	77.00	2	13.6	0	18.99	2	ND	0	0.05	2	0.017	2	16	Adequate
MKTF-13	0.85	0	<1	2	17.50	3	0.91	2	-8.4	1	7.18	0	50.98	2	14.0	0	6.75	2	ND	0	0.00	2	ND	0	14	Limited
MKTF-16	1.35	0	<1	2	6.47	3	10.22	2	-26.4	1	6.89	0	52.67	2	17.8	0	16.29	2	ND	0	ND	0	0.006	2	14	Limited
MKTF-17	2.34	0	<1	2	0.29	0	60.40	0	26.3	1	7.20	0	23.26	2	13.7	0	5.69	2	ND	0	ND	0	ND	0	7	Limited
MKTF-19	1.04	0	<1	2	9.98	3	0.59	2	-22.1	1	7.16	0	30.17	2	12.8	0	3.08	2	ND	0	0.00	2	ND	0	14	Limited
MKTF-22	1.95	0	<1	2	3.75	3	6.10	2	-24.5	1	6.84	0	15.64	0	12.8	0	3.03	2	ND	0	0.02	2	ND	0	12	Limited
MKTF-24	2.96	0	<1	2	0.94	0	29.58	0	127.8	0	7.52	0	21.94	2	12.8	0	4.56	2	ND	0	0.02	2	0.032	2	10	Limited
MKTF-25	3.84	0	<1	2	0.42	0	51.67	0	121.4	0	7.15	0	9.86	0	12.0	0	1.39	2	0.0135	0	0.10	2	0.012	2	8	Limited

Notes:
Scoring ranges for evidence of anaerobic biodegradation (EPA 1998):

Score	**Interpretation**
0 to 5	Inadequate
6 to 14	Limited
15 to 20	Adequate
>20	Strong

BTEX = benzene, toluene, ethylbenzene, xylene
C = centigrade
DCA = dichloroethane
DCE = dichloroethene
DO = dissolved oxygen
mg/L = milligrams per liter
mV = millivolts
ND = not detected; values set at half the detection limit for averaging
ORP = oxidation reduction potential measured using an silver/silver chloride reference cell
T = temperature
TOC - total organic carbon
TCE = trichloroethene
VC = vinyl chloride

TABLE 4. SUMMARY OF MANN-KENDALL CVOCs TREND ANALYSIS 2014-2020
MARATHON GALLUP REFINERY, GALLUP NEW MEXICO

				Descriptive Analysis											Mann-Kendall Trend Analysis				
Analyte	Location	First Sample Date	Last Sample Date	Sample Size	Number of Detects	% Detects	Sample Mean	Sample Median	Sample Std. Dev.	Minimum Detected	Maximum Detected	Minimum MDL	Maximum MDL	Number of Outliers	Serial Correlation	Seasonality	*p*-value	τ	Trend
1,1-Dichloroethane	MKTF-02	4/8/2014	12/18/2020	26	26	100.00%	0.0453	0.0455	0.021	0.0065	0.098	1.100E-04	4.000E-03	0	YES	NO	0.0000	-0.637	Decreasing
1,1-Dichloroethane	MKTF-09	4/14/2014	3/3/2020	24	24	100.00%	0.0222	0.0230	0.008	0.0068	0.035	1.100E-04	8.000E-03	0	YES	NO	0.0000	-0.493	Decreasing
1,1-Dichloroethane	MKTF-10	4/11/2014	12/18/2020	25	13	52.00%	0.0357	0.0390	0.021	0.027	0.078	1.409E-03	4.000E-02	0	YES	NO	0.4080	-0.127	None
1,1-Dichloroethane	MKTF-16	4/10/2014	12/23/2020	25	12	48.00%	0.0360	0.0400	0.022	0.0062	0.081	2.200E-03	5.000E-02	0	NO	NO	0.1803	0.209	None
1,1-Dichloroethane	MKTF-22	4/10/2014	10/24/2019	21	6	28.57%	0.0060	0.0040	0.004	0.0017	0.015	1.000E-03	8.000E-03	0	NO	NO	0.1010	0.298	None
1,1-Dichloroethane	MKTF-24	4/8/2014	12/18/2020	26	26	100.00%	0.0864	0.0810	0.038	0.033	0.2	4.000E-04	1.250E-02	0	YES	NO	0.0000	-0.812	Decreasing
1,1-Dichloroethane	MKTF-25	4/8/2014	12/18/2020	24	24	100.00%	0.2230	0.2200	0.110	0.0918	0.61	5.200E-04	2.000E-02	0	NO	NO	0.0000	-0.659	Decreasing
1,1-Dichloroethene	MKTF-02	4/8/2014	12/18/2020	26	24	92.31%	0.0254	0.0210	0.025	0.0014	0.11	9.900E-05	4.108E-03	0	YES	NO	0.0000	-0.625	Decreasing
1,1-Dichloroethene	MKTF-09	4/14/2014	3/3/2020	24	24	100.00%	0.0337	0.0310	0.017	0.0063	0.074	9.900E-05	4.108E-03	0	YES	NO	0.0000	-0.547	Decreasing
1,1-Dichloroethene	*MKTF-10*	*4/11/2014*	*12/18/2020*	*25*	*6*	*24.00%*	*0.0074*	*0.0075*	*0.003*	*0.0059*	*0.013*	*1.300E-03*	*1.250E-02*	*0*	*YES*	*NO*	*0.0450*	*0.257*	*Increasing*
1,1-Dichloroethene	*MKTF-16*	*4/10/2014*	*12/23/2020*	*25*	*0*	*0.00%*	*0.0112*	*0.0099*	*0.010*	--	--	*8.100E-04*	*5.000E-02*	*0*	--	--	--	--	--
1,1-Dichloroethene	MKTF-22	4/10/2014	10/24/2019	21	13	61.90%	0.0065	0.0068	0.005	0.0051	0.017	8.100E-04	4.108E-03	0	YES	YES	0.0425	0.650	Increasing
1,1-Dichloroethene	MKTF-24	4/8/2014	12/18/2020	26	24	92.31%	0.0351	0.0350	0.021	0.0061	0.088	1.200E-04	1.250E-02	0	YES	NO	0.0000	-0.849	Decreasing
1,1-Dichloroethene	MKTF-25	4/8/2014	12/18/2020	24	24	100.00%	0.0978	0.0960	0.046	0.027	0.24	3.800E-04	2.500E-03	0	NO	NO	0.0016	-0.467	Decreasing
1,2-Dichloroethane	MKTF-02	4/8/2014	12/18/2020	26	21	80.77%	0.0068	0.0048	0.007	0.002	0.034	1.200E-04	4.000E-03	0	NO	NO	0.2981	-0.150	None
1,2-Dichloroethane	*MKTF-09*	*4/14/2014*	*3/3/2020*	*24*	*0*	*0.00%*	*0.0025*	*0.0023*	*0.002*	--	--	*1.200E-04*	*8.000E-03*	*0*	--	--	--	--	--
1,2-Dichloroethane	*MKTF-10*	*4/11/2014*	*12/18/2020*	*25*	*0*	*0.00%*	*0.0130*	*0.0097*	*0.012*	--	--	*1.946E-03*	*4.000E-02*	*0*	--	--	--	--	--
1,2-Dichloroethane	*MKTF-16*	*4/10/2014*	*12/23/2020*	*25*	*0*	*0.00%*	*0.0185*	*0.0130*	*0.013*	--	--	*2.300E-03*	*5.000E-02*	*0*	--	--	--	--	--
1,2-Dichloroethane	*MKTF-22*	*4/10/2014*	*10/24/2019*	*21*	*0*	*0.00%*	*0.0033*	*0.0035*	*0.002*	--	--	*1.100E-03*	*8.000E-03*	*0*	--	--	--	--	--
1,2-Dichloroethane	MKTF-24	4/8/2014	12/18/2020	26	16	61.54%	0.0128	0.0080	0.031	0.0056	0.163	2.600E-04	1.250E-02	0	NO	NO	0.8555	-0.030	None
1,2-Dichloroethane	MKTF-25	4/8/2014	12/18/2020	24	19	79.17%	0.0089	0.0090	0.006	0.0057	0.0321	2.600E-04	4.000E-03	0	NO	NO	0.5157	-0.101	None
cis-1,2-Dichloroethene	MKTF-02	4/8/2014	12/18/2020	26	20	76.92%	0.0104	0.0100	0.007	0.0019	0.03	8.100E-05	3.802E-03	0	YES	NO	0.0053	-0.289	Decreasing
cis-1,2-Dichloroethene	MKTF-09	4/14/2014	3/3/2020	24	22	91.67%	0.0205	0.0210	0.009	0.0096	0.036	8.100E-05	7.800E-03	0	YES	NO	0.0008	-0.308	Decreasing
cis-1,2-Dichloroethene	MKTF-10	4/11/2014	12/18/2020	25	17	68.00%	0.0333	0.0340	0.021	0.023	0.066	1.200E-03	2.000E-02	0	NO	NO	0.1164	0.235	None
cis-1,2-Dichloroethene	*MKTF-16*	*4/10/2014*	*12/23/2020*	*25*	*1*	*4.00%*	*0.0159*	*0.0120*	*0.013*	*0.0084*	*0.0084*	*2.000E-03*	*5.000E-02*	*0*	*NO*	*NO*	*0.7288*	*-0.071*	*None*
cis-1,2-Dichloroethene	MKTF-22	4/10/2014	10/24/2019	21	13	61.90%	0.0064	0.0078	0.004	0.0061	0.012	1.200E-03	7.500E-03	0	NO	NO	0.1424	0.248	None
cis-1,2-Dichloroethene	MKTF-24	4/8/2014	12/18/2020	26	19	73.08%	0.0225	0.0220	0.014	0.0086	0.057	1.200E-04	1.250E-02	0	YES	NO	0.0000	-0.791	Decreasing
cis-1,2-Dichloroethene	MKTF-25	4/8/2014	12/18/2020	24	24	100.00%	0.0427	0.0445	0.017	0.0149	0.1	2.000E-04	3.800E-03	0	NO	NO	0.0237	-0.337	Decreasing
Trichloroethene	MKTF-02	4/8/2014	12/18/2020	26	15	57.69%	0.0029	0.0026	0.002	0.0018	0.0073	1.600E-04	3.325E-03	0	YES	NO	0.0000	-0.532	Decreasing
Trichloroethene	MKTF-09	4/14/2014	3/3/2020	24	14	58.33%	0.0046	0.0043	0.003	0.0027	0.011	1.600E-04	5.200E-03	0	NO	NO	0.0007	-0.527	Decreasing
Trichloroethene	*MKTF-10*	*4/11/2014*	*12/18/2020*	*25*	*0*	*0.00%*	*0.0089*	*0.0082*	*0.005*	--	--	*1.663E-03*	*1.800E-02*	*0*	--	--	--	--	--
Trichloroethene	*MKTF-16*	*4/10/2014*	*12/23/2020*	*25*	*0*	*0.00%*	*0.0147*	*0.0110*	*0.010*	--	--	*1.100E-03*	*5.000E-02*	*0*	--	--	--	--	--
Trichloroethene	*MKTF-22*	*4/10/2014*	*10/24/2019*	*21*	*0*	*0.00%*	*0.0026*	*0.0033*	*0.001*	--	--	*1.100E-03*	*5.200E-03*	*0*	--	--	--	--	--
Trichloroethene	*MKTF-24*	*4/8/2014*	*12/18/2020*	*26*	*5*	*19.23%*	*0.0037*	*0.0034*	*0.002*	*0.0023*	*0.0052*	*1.900E-04*	*1.250E-02*	*0*	*YES*	*NO*	*0.0453*	*-0.237*	*Decreasing*
Trichloroethene	MKTF-25	4/8/2014	12/18/2020	24	23	95.83%	0.0224	0.0225	0.013	0.006	0.064	1.100E-04	2.600E-03	0	NO	NO	0.0008	-0.496	Decreasing
Vinyl Chloride	MKTF-02	4/8/2014	12/18/2020	26	19	73.08%	0.0082	0.0045	0.009	0.001	0.028	1.300E-04	3.582E-03	0	YES	NO	0.0000	0.542	Increasing
Vinyl Chloride	*MKTF-09*	*4/14/2014*	*3/3/2020*	*24*	*0*	*0.00%*	*0.0021*	*0.0018*	*0.001*	--	--	*1.300E-04*	*4.600E-03*	*0*	--	--	--	--	--
Vinyl Chloride	*MKTF-10*	*4/11/2014*	*12/18/2020*	*25*	*6*	*24.00%*	*0.0128*	*0.0100*	*0.007*	*0.0089*	*0.023*	*1.791E-03*	*2.300E-02*	*0*	*YES*	*NO*	*0.0373*	*0.290*	*Increasing*
Vinyl Chloride	*MKTF-16*	*4/10/2014*	*12/23/2020*	*25*	*1*	*4.00%*	*0.0147*	*0.0130*	*0.010*	*0.0058*	*0.0058*	*1.800E-03*	*5.000E-02*	*0*	*NO*	*NO*	*0.6274*	*0.094*	*None*
Vinyl Chloride	*MKTF-22*	*4/10/2014*	*10/24/2019*	*21*	*0*	*0.00%*	*0.0024*	*0.0022*	*0.001*	--	--	*1.100E-03*	*4.600E-03*	*0*	--	--	--	--	--
Vinyl Chloride	MKTF-24	4/8/2014	12/18/2020	26	17	65.38%	0.0178	0.0170	0.014	0.0049	0.038	1.100E-04	1.250E-02	0	YES	NO	0.0000	0.609	Increasing
Vinyl Chloride	MKTF-25	4/8/2014	12/18/2020	24	11	45.83%	0.0043	0.0023	0.009	0.00096	0.046	1.800E-04	4.600E-03	1	NO	NO	0.1009	0.271	None

Abbreviations:
MDL: Method Detection Limit
Std. Dev.: Standard Deviation

Notes:
All results are reported in mg/L.
Outlier and trend analyses were performed for all analyte-well pairs with sample size 4 or larger and at least one detected results above the MDL.
Italics: Trend analysis results based on data with less 25% detection rate should be considered with caution.
MDL = method detection limit
τ = test statistic, range -1 to 1
p = probability of no trend; trend present if $p < 0.05$,

TABLE 5. SUMMARY OF MANN-KENDALL MTBE TREND ANALYSIS 2014-2020
MARATHON GALLUP REFINERY, GALLUP NEW MEXICO

Analyte	Location	First Sample Date	Last Sample Date	Descriptive Analysis										Number of Outliers	Mann-Kendall Trend Analysis				
				Sample Size	Number of Detects	% Detects	Sample Mean	Sample Median	Sample Std. Dev.	Minimum Detected	Maximum Detected	Minimum MDL	Maximum MDL		Serial Correlation	Seasonality	*p*-value	τ	Trend
MTBE	MKTF-04	4/11/2014	3/3/2020	24	24	100.00%	1.8958	1.9000	0.393	1.2	2.5	1.700E-03	2.400E-02	0	YES	NO	0.1071	0.159	None
MTBE	MKTF-09	4/14/2014	3/3/2020	24	24	100.00%	0.6013	0.5300	0.214	0.31	1.2	8.700E-04	1.300E-02	0	YES	NO	0.0000	-0.522	Decreasing
MTBE	MKTF-16	4/10/2014	12/23/2020	25	25	100.00%	1.0636	0.8200	0.621	0.04	2.1	2.400E-03	7.400E-02	2	YES	NO	0.0000	-0.787	Decreasing
MTBE	MKTF-17	4/9/2014	10/29/2019	23	23	100.00%	1.9800	0.7700	2.153	0.28	7.4	8.700E-04	2.500E-02	0	YES	NO	0.1555	0.257	None
MTBE	MKTF-19	4/9/2014	10/29/2019	22	22	100.00%	9.4773	9.7000	1.131	7.8	12	8.700E-03	1.300E-01	0	YES	NO	0.4721	-0.074	None
MTBE	MKTF-20	4/11/2014	2/5/2020	21	20	95.24%	0.1241	0.1300	0.090	0.0057	0.38	2.100E-03	3.200E-02	0	NO	NO	0.2758	-0.178	None
MTBE	MKTF-21	4/11/2014	2/5/2020	20	20	100.00%	0.4887	0.5200	0.289	0.015	1.2	1.700E-03	1.300E-02	0	YES	NO	0.0000	-0.563	Decreasing
MTBE	MKTF-22	4/10/2014	10/24/2019	21	21	100.00%	5.4333	5.7000	1.593	2.6	8.8	9.122E-03	9.100E-02	0	YES	NO	0.5057	-0.095	None
MTBE	MKTF-23	9/23/2014	10/29/2019	9	9	100.00%	1.0200	1.1000	0.453	0.33	1.6	1.700E-03	4.561E-02	0	NO	NO	0.1138	0.457	None
MTBE	MKTF-24	4/8/2014	12/18/2020	26	26	100.00%	0.1543	0.1650	0.043	0.063	0.23	2.500E-04	1.850E-02	0	YES	NO	0.0000	-0.498	Decreasing
MTBE	MKTF-25	4/8/2014	12/18/2020	24	24	100.00%	0.3223	0.2450	0.227	0.12	0.88	5.000E-04	4.600E-03	0	YES	NO	0.0880	0.286	None

Abbreviations:
MDL: Method Detection Limit
Std. Dev.: Standard Deviation

Notes:
All results are reported in mg/L.
Outlier and trend analyses were performed for all analyte-well pairs with sample size 4 or larger and at least one detected results above the MDL.
MTBE = methyl tert-butyl ether
MDL = method detection limit
τ = test statistic, range -1 to 1
p = probability of no trend; trend present if $p < 0.05$,

TABLE 6. PROPOSED MNA GROUNDWATER QUARTERLY SAMPLING ANALYSES
MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Analyte	Method of Analysis	Significance for MNA	Utility for MNA Analyses
BTEX	Laboratory	Source of organics for reducing conditions	Monitor trends
MTBE	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends
PCE	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends
TCE	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends
cis-1,2- DCE	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends, degradation product of TCE
1,1-DCE	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends, degradation product of TCE
1-DCA	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends
1,2-DCA	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends, degradation product
Vinyl chloride	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends
Ethene	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends, degradation product of TCE
TBA	Laboratory	Decreasing trends indicate natural attenuation	Monitor trends, degradation product of MTBE
Chloride	Laboratory	End product of 1,1-DCA and 1,2-DCA degradation	Monitor trends, but dissolved salts may mask trends
Nitrate	Laboratory	Potential electron receptor for biodegradation	Presence indicates potential for biodegradation
Nitrite	Laboratory	Form of nitrate reduced by biodegradation	Presence indicates possible biodegradation
Sulfate/sulfide	Laboratory	Potential electron receptor for biodegradation	Monitor trends
Iron (ferric/ferrous)	Laboratory	Potential electron receptor for biodegradation	Monitor trends
Manganese	Laboratory	Potential electron receptor for biodegradation	Monitor trends
Temperature	Field	Rate of natural attenuation	Monitor trends
pH	Field	Neutral range 6-8 required for biodegradation	Monitor level and trends
DO	Field	Presence required for aerobic biodegradation	Monitor level and trends
ORP	Field	Indicates redox state for biodegradation	Monitor level and trends

Notes:
BTEX = benzene, toluene, ethylenzene, xylene
DCA = dichloroethane
DCE = dichloroethene
DO = dissolved oxygen
MNA = monitored natural attenuation
MTBE = methyl tert-butyl ether
ORP - oxidation reduction potential measured using an silver/silver chloride reference cell
PCE = tetrachloroethene
TCE = trichloroethene
TBA = tert-butyl alcohol

Figures

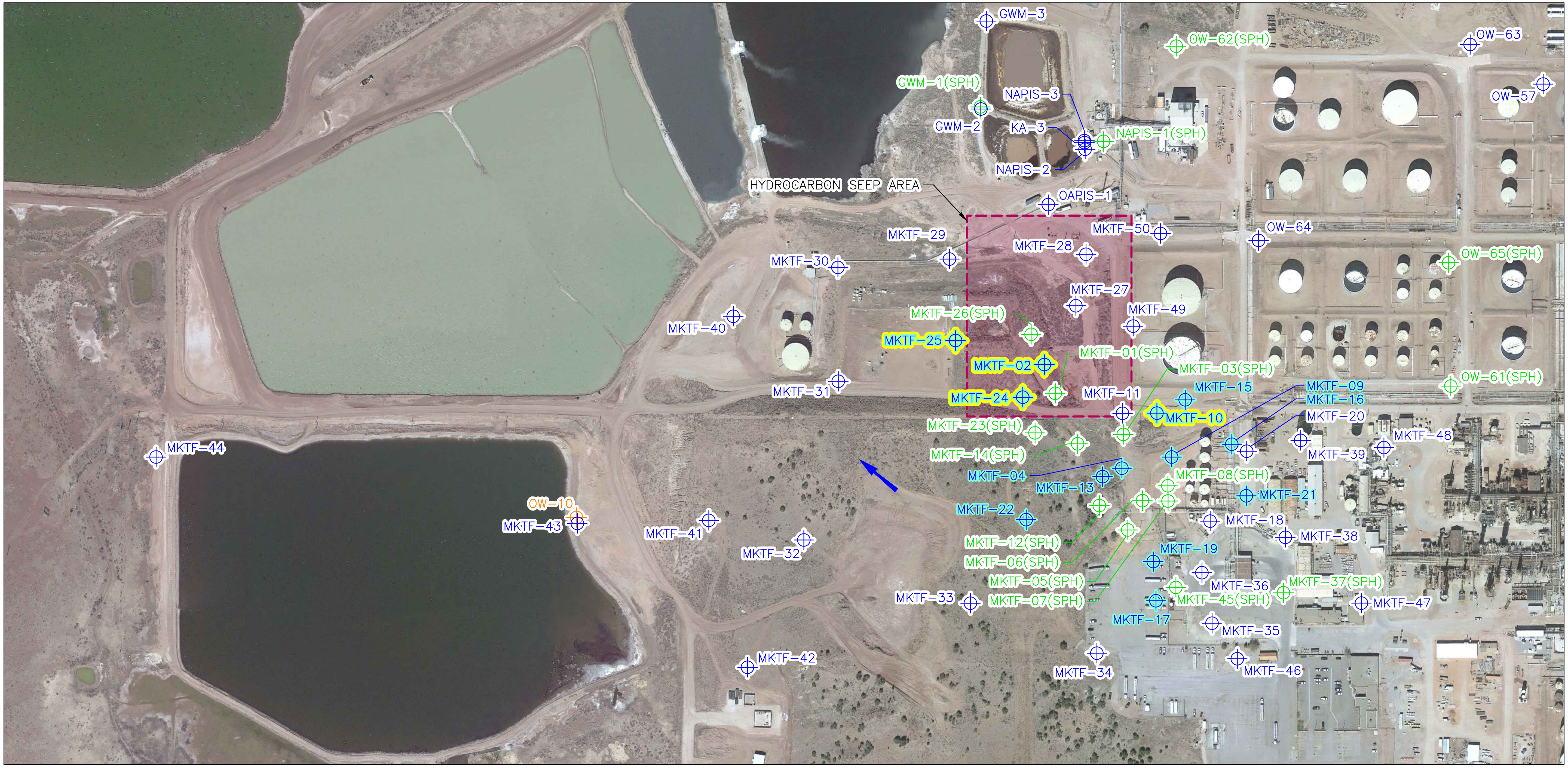
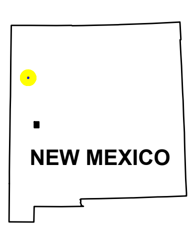


Image Citation: Google Earth Pro Imagery, Publication: March 2016.



QUADRANGLE LOCATION

NOTE:

SITE LEGAL DESCRIPTION - TOWNSHIP 15 NORTH, RANGE 15 WEST, SECTION 33

EXPLANATION

OW-10	SONSELA WELL AND DESIGNATION
MKTF-42	CHINLE/ALLUVIUM INTERFACE WELL AND DESIGNATION
MKTF-45	SPH MONITORING WELL AND DESIGNATION
MKTF-17	MKTF MNA WELL
MKTF-10	MONITORING WELL WITH CONSISTENT DETECTION OF VINYL CHLORIDE
	GENERAL GROUNDWATER FLOW DIRECTION
	HYDROCARBON SEEP AREA
SPH	SINGLE-PHASE HYDROCARBON (DETECTED DURING THIRD QUARTER 2020 SAMPLING EVENT)

N

0 300'

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FIGURE 1

HYDROCARBON SEEP AREA AND MNA WELL SET

**MARATHON PETROLEUM CORP.
GALLUP REFINING DIVISION
GALLUP, NEW MEXICO**

Drawn By: REP	Checked By: CF	Scale: 1" = 300'	Date: 11/23/20	File: 697-MNA-SITE-202011

\\TRIHYDRO.COM\CLIENTS\TON\MARATHON\CADD\GALLUP_REPORTS\HYDROCARBONSEEPAREA\MNA_EVALUATION\697-MNA-SITE-202011

LOCAL SURFACE TOPOGRAPHY SHOWING SWALE IN THE HYDROCARBON SEEP AREA NORTH VIEW, X5 VERTICAL EXAGGERATION

GEOLOGICAL MODEL CROSS-SECTION OF THE HYDROCARBON SEEP AREA EAST VIEW, X5 VERTICAL EXAGGERATION

EXPLANATION

GENERAL GROUNDWATER FLOW DIRECTION

N

0 ~250'

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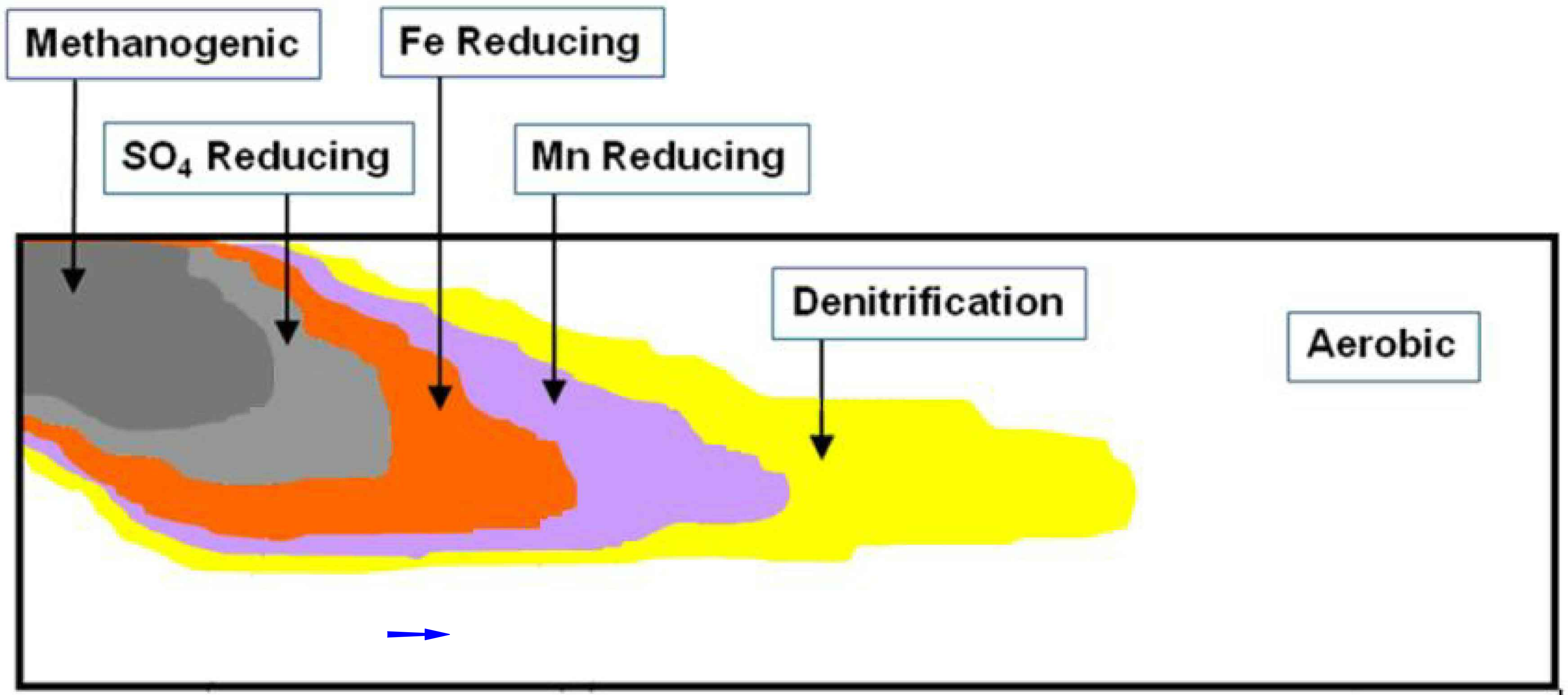
FIGURE 2

3D MODELING OF LOCAL GEOLOGY IN THE HYDROCARBON SEEP AREA

MARATHON PETROLEUM CORP.
GALLUP REFINING DIVISION
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: JP	Scale: 1" = ~250'	Date: 6/16/21	File: 697-MNA-3DMODEL-202011



EXPLANATION

	GENERAL GROUNDWATER FLOW DIRECTION
FE	IRON
MN	MANGANESE
SO4	SULFATE

Source: After ITRC 2010

M:\TON\MARATHON\CADD\GALLUP_REPORTS\HYDROCARBONSEEPAREA\MNA_EVALUATION\697-MNA-REDREGIME-202011

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FIGURE 3

REDUCING REGIMES IN A TYPICAL HYDROCARBON GROUNDWATER PLUME

**MARATHON PETROLEUM CORP.
GALLUP REFINING DIVISION
GALLUP, NEW MEXICO**

Drawn By: REP	Checked By: CF	Scale: NONE	Date: 11/23/20	File: 697-MNA-REDREGIME-202011

Reactions

Contaminant	RD	DC	ACM	ANCM	ADM	ANDM	DHC	AH
PCE	●							
TCE	●							
1,2-DCE	●					○		
VC	●					○		
1,1,2,2-TeCA	●	●					●	
1,1,2-TCA	●	●					◒	
1,2-DCA	●	●					◒	◒
1,1-DCA	●						◒	

Key:

- ● Highly Likely to occur
- ◒ Highly likely to occur, but a slow rate
- ○ May occur under specific conditions
- ☐ Highly Unlikely to occur

DCA - DICHLOROETHANE
DCE - DICHLOROETHENE
PCE - PERCHLOROETHENE
TCE - TRICHLOROETHENE
TeCA - TETRACHLOROETHANE
VC - VINYL CHLORIDE

REACTIONS

ACM	Aerobic Co-Metabolism
ANCM	Anaerobic Co-Metabolism
ADM	Aerobic Direct Metabolism
ANDM	Anaerobic Direct Metabolism
DHC	Dehydrochlorination (abiotic)
AH	Abiotic Hydrolysis
DC	Dichloroelimination (biotic)
RD	Reductive Dechlorination (hydrogenolysis)

Source: Adapted from TRUEX, ET AL 2007

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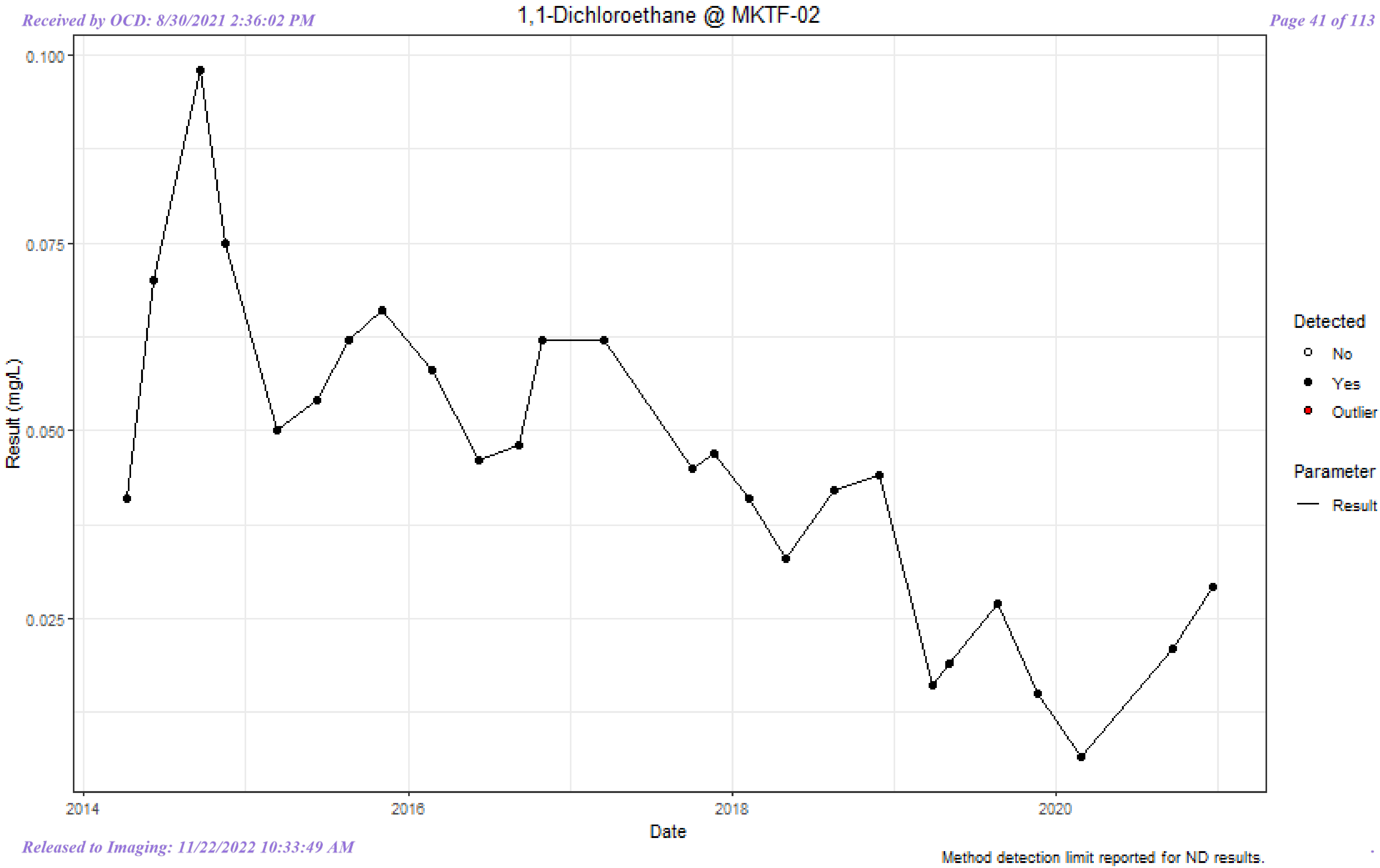
FIGURE 4

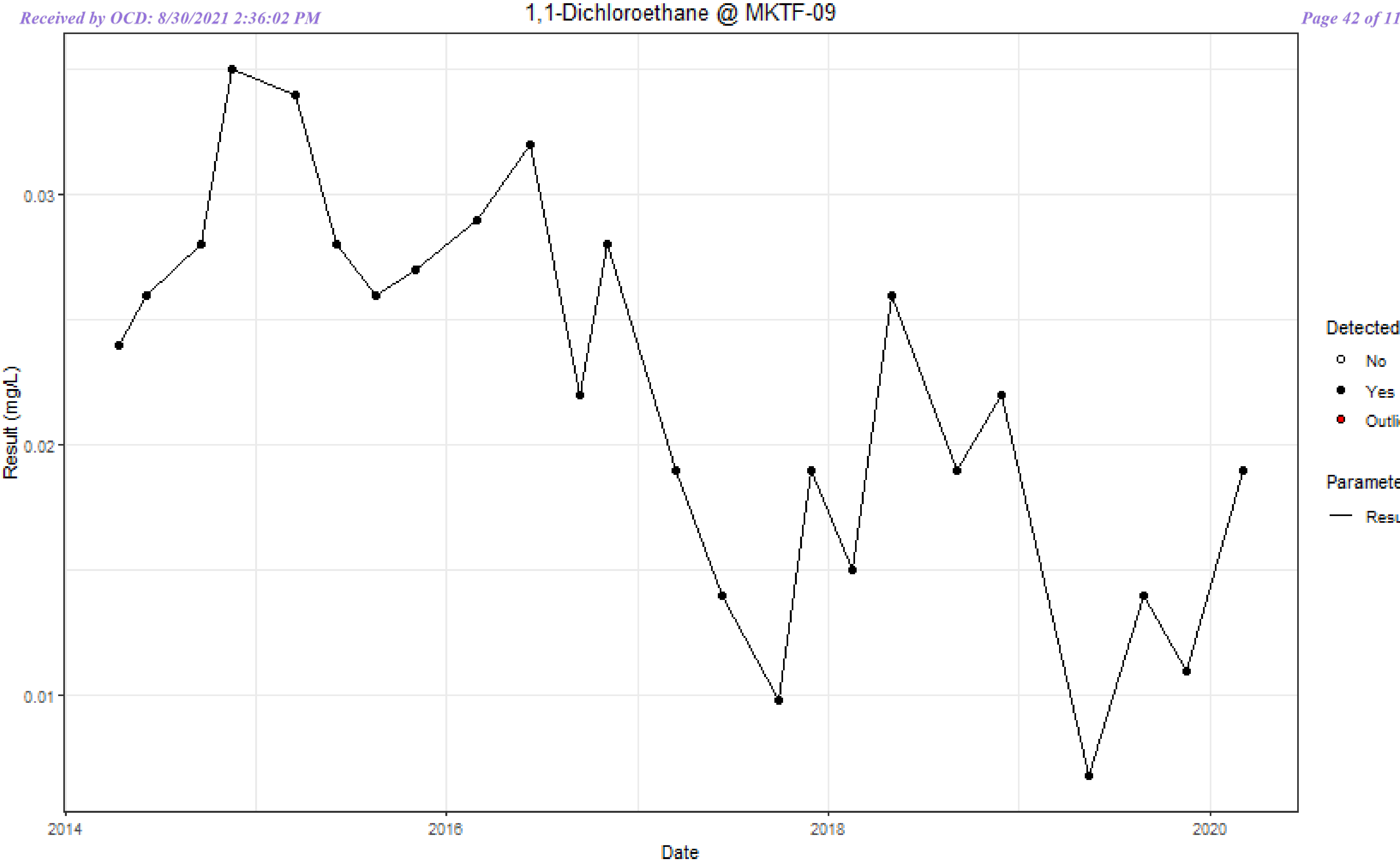
DEGRADATION REACTIONS IN ANAEROBIC CONDITIONS

**MARATHON PETROLEUM CORP.
GALLUP REFINING DIVISION
GALLUP, NEW MEXICO**

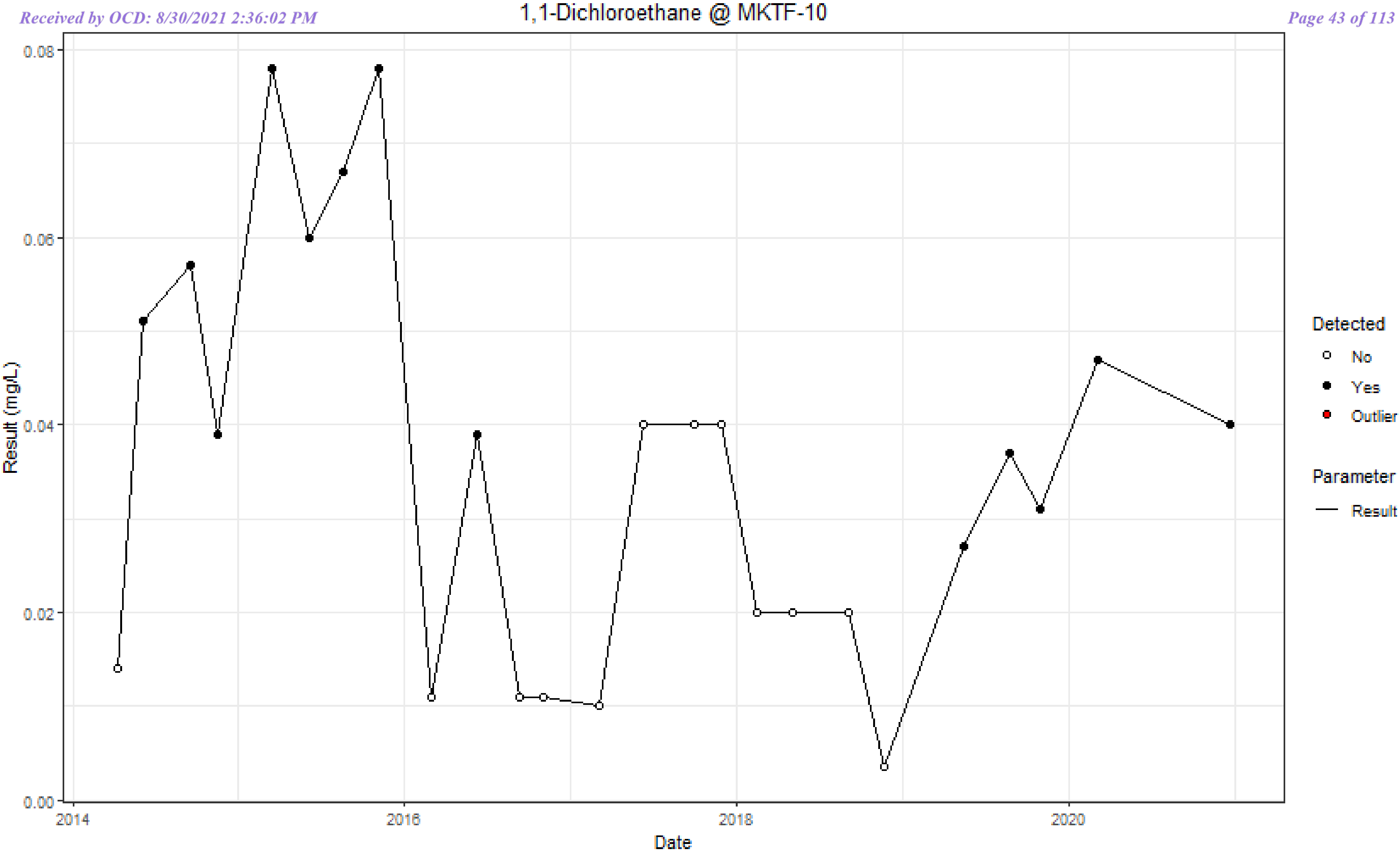
Drawn By: REP | Checked By: CF | Scale: NONE | Date: 11/23/20 | File: 697-MNA-DEGRADATION-202011

ATTACHMENT A – CVOC TIME SERIES PLOTS

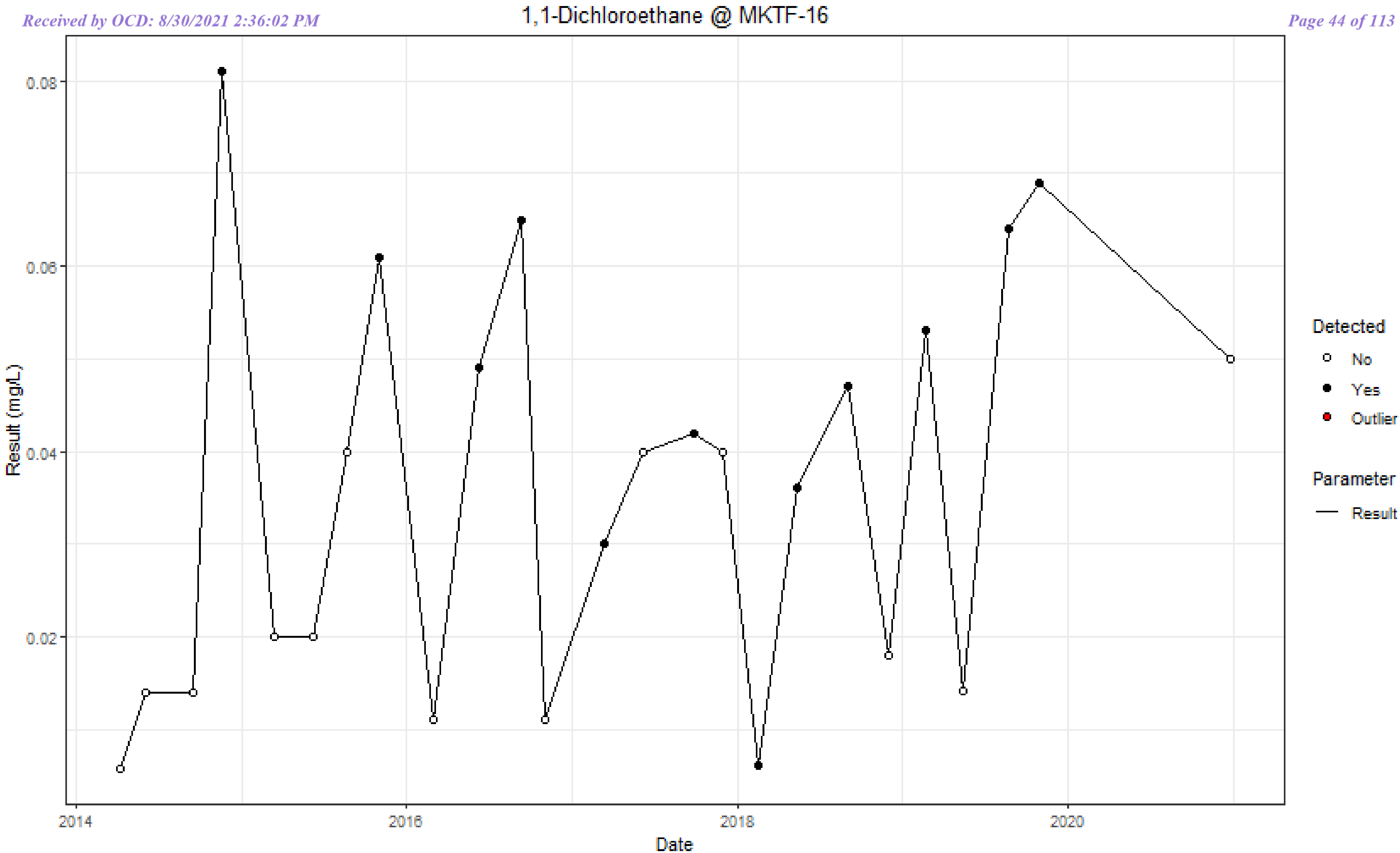

1,1-Dichloroethane @ MKTF-02
0.100
0.075
0.050
0.025
Result (mg/L)
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.



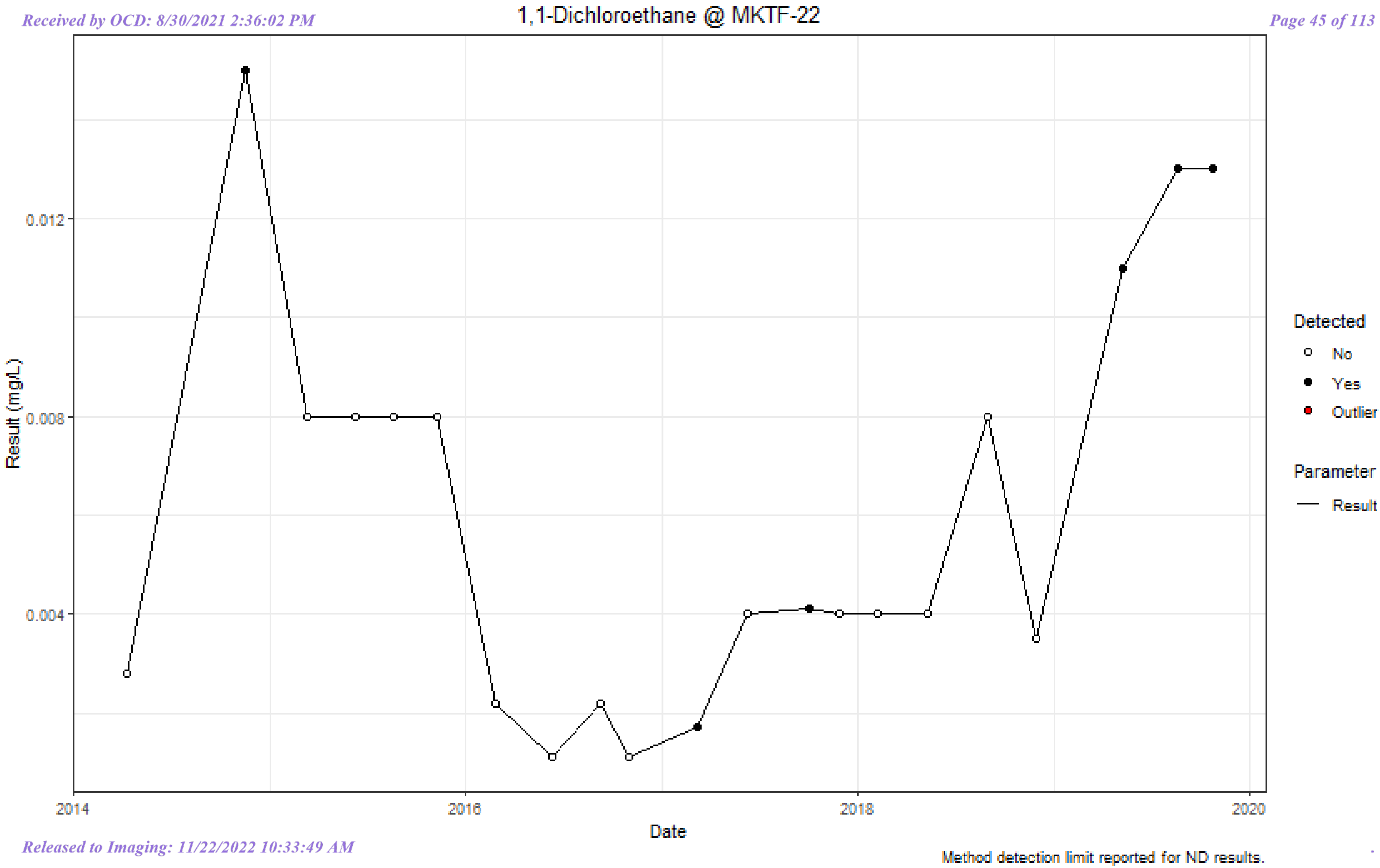
Method detection limit reported for ND results.



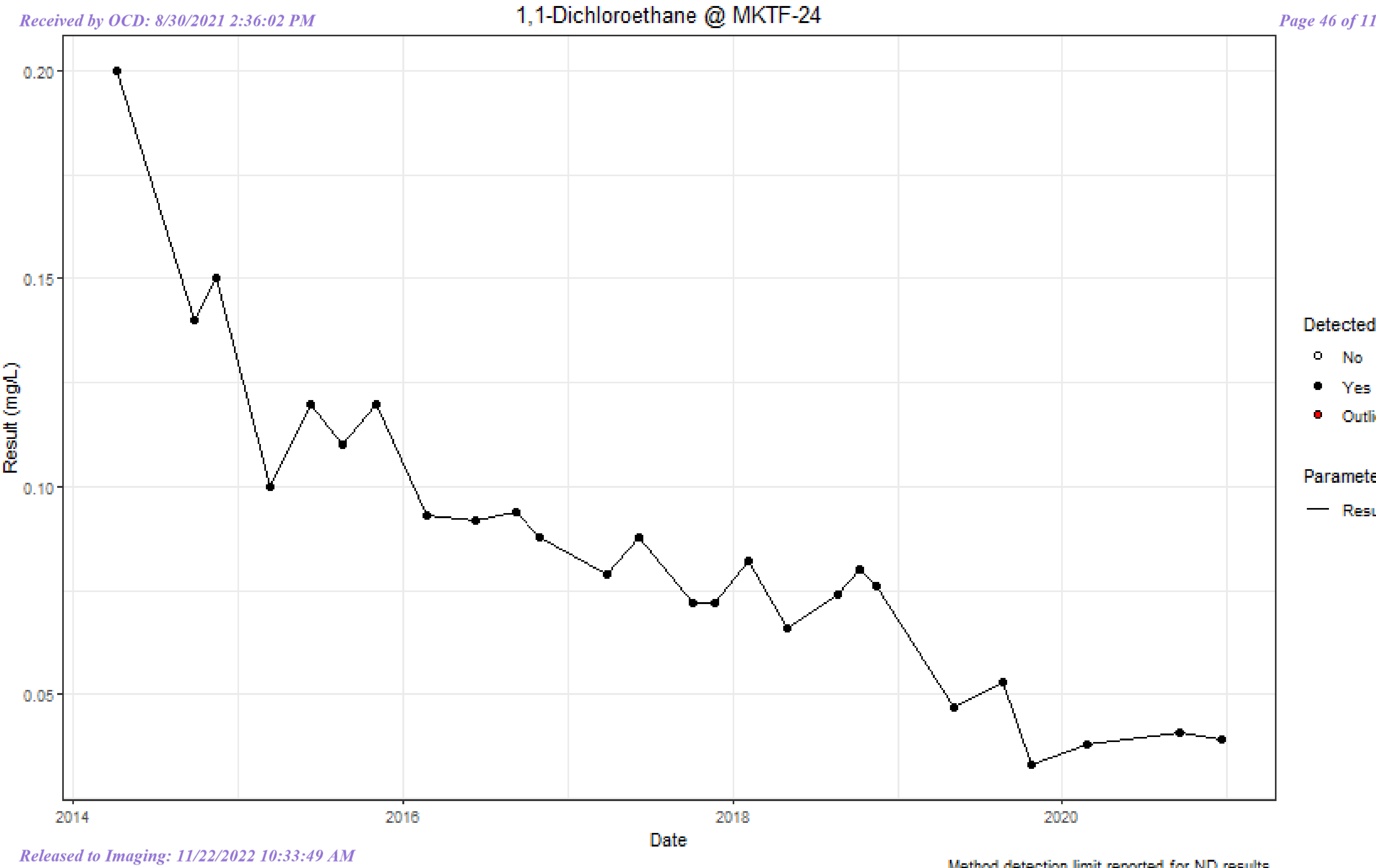
Method detection limit reported for ND results.



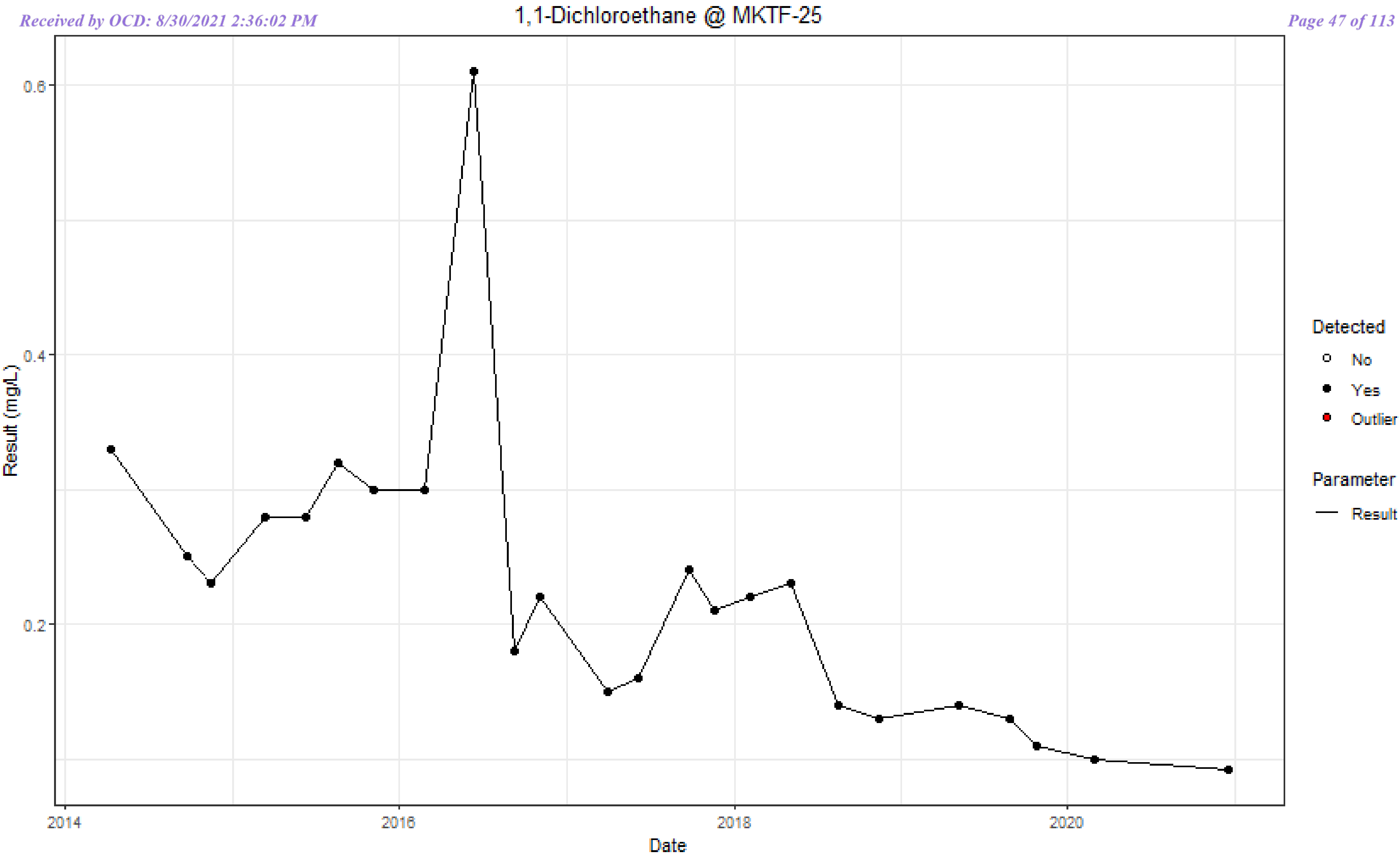
Method detection limit reported for ND results.


1,1-Dichloroethane @ MKTF-22
Result (mg/L)
0.012
0.008
0.004
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

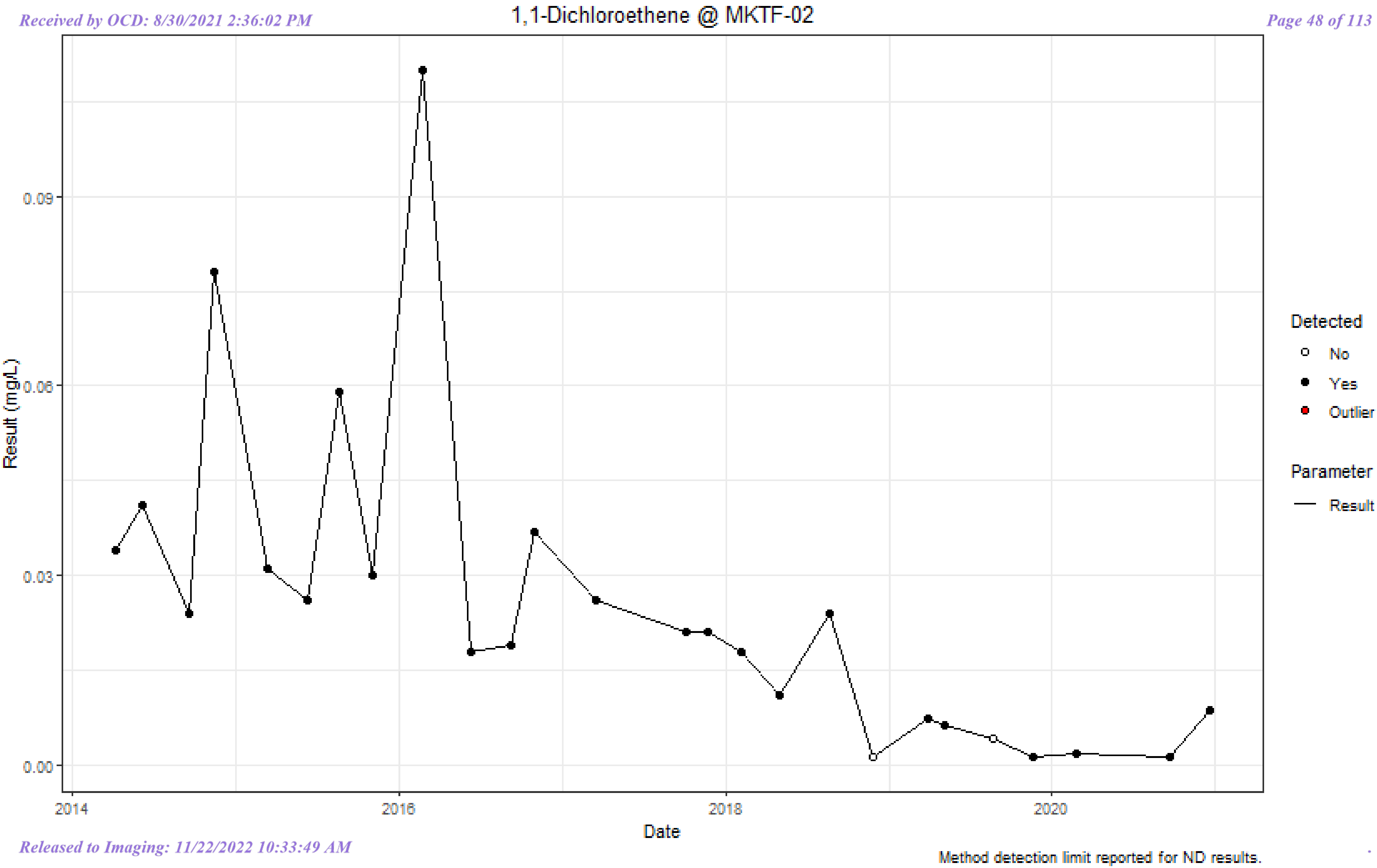
Received by OCD: 8/30/2021 2:36:02 PM



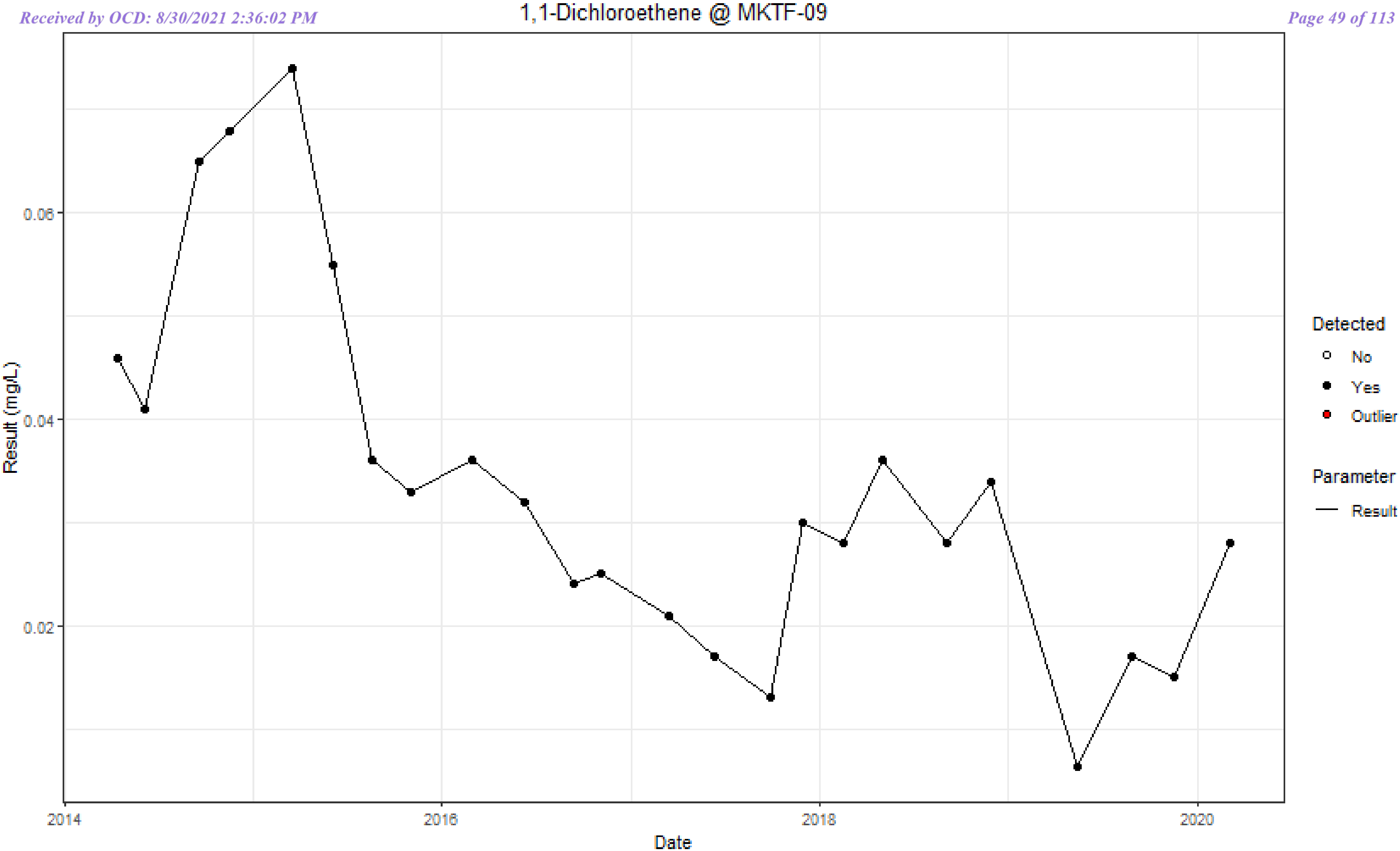
Released to Imaging: 11/22/2022 10:33:49 AM



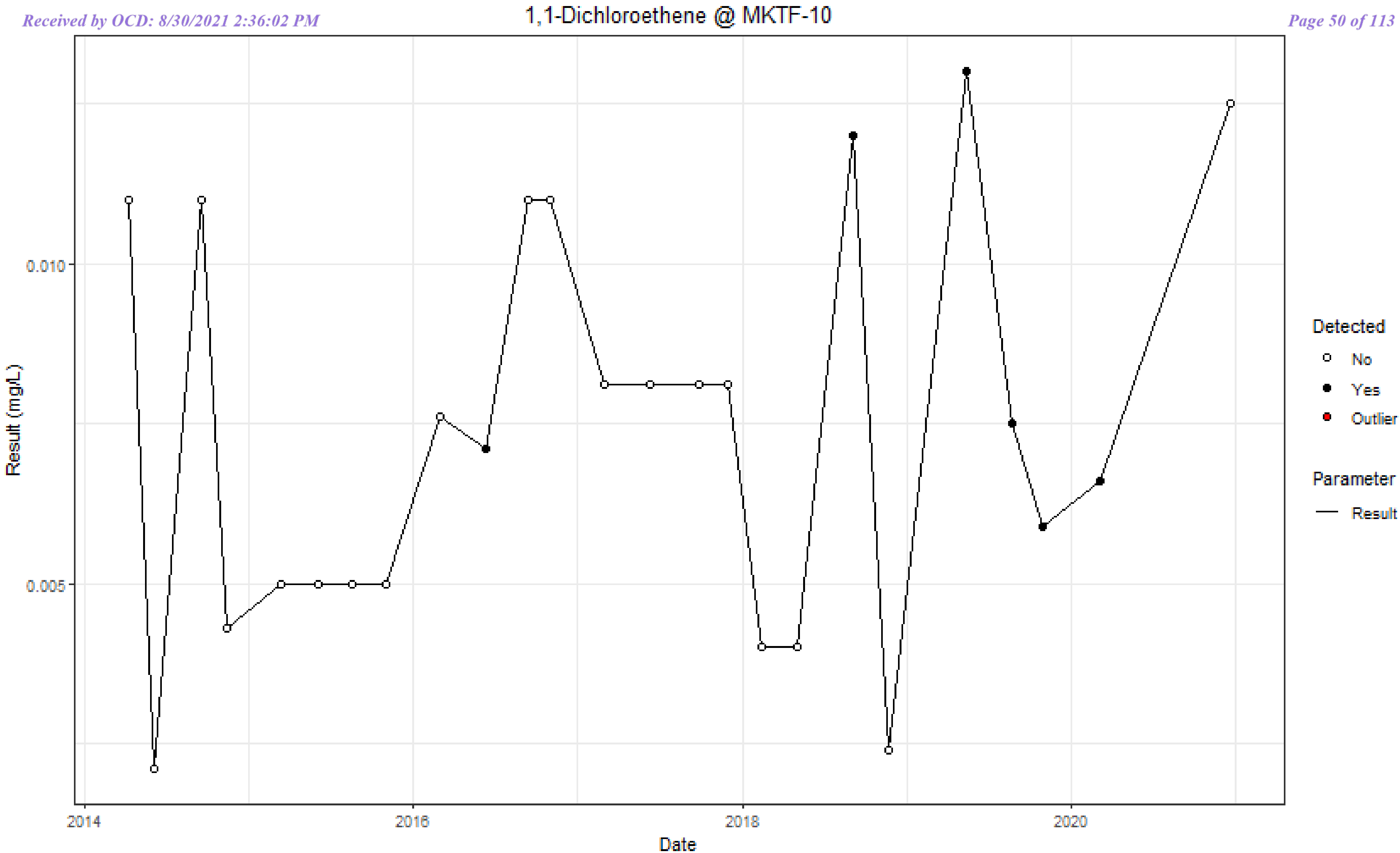
Method detection limit reported for ND results.



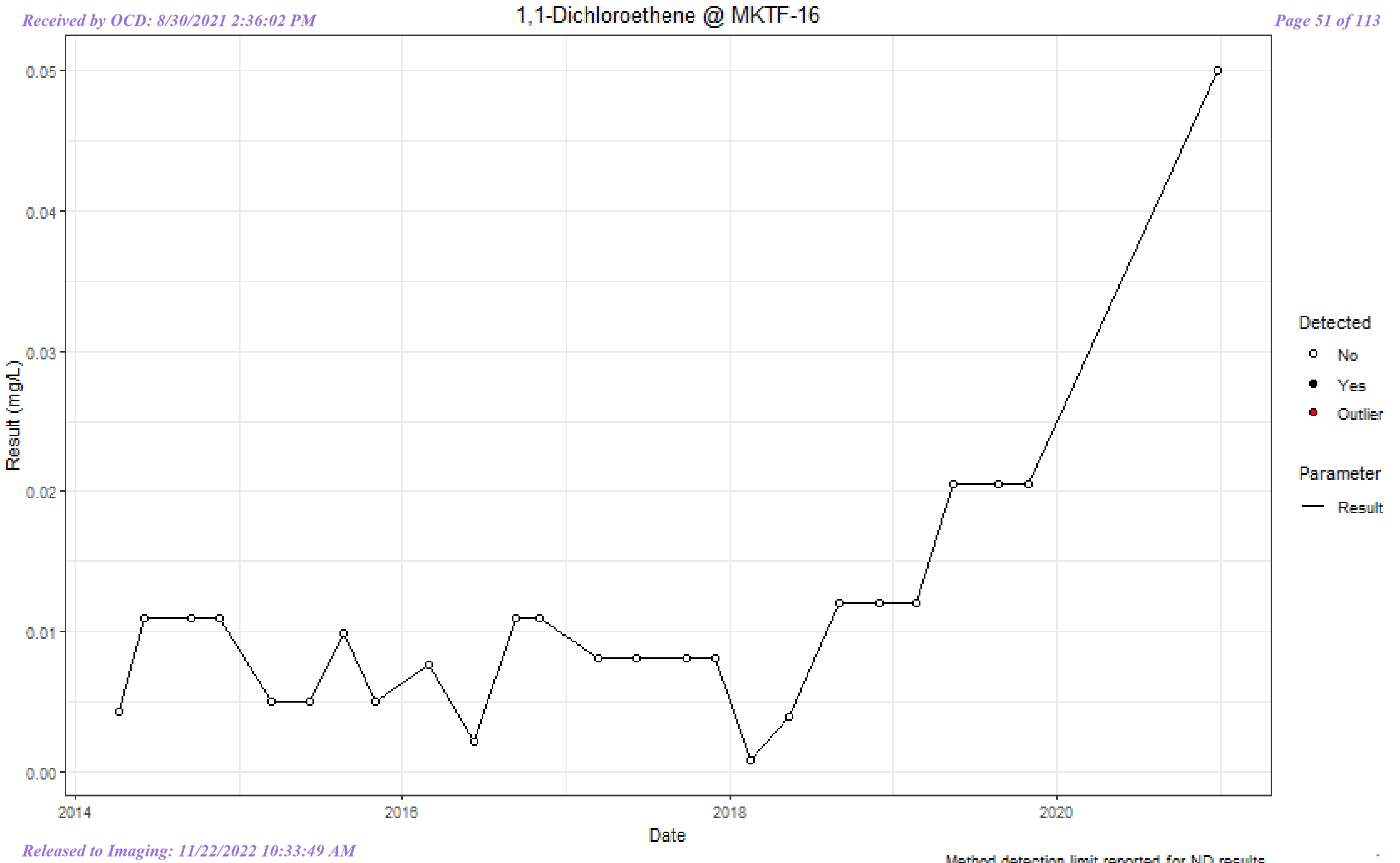
1,1-Dichloroethene @ MKTF-02
Result (mg/L)
0.00
0.03
0.06
0.09
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

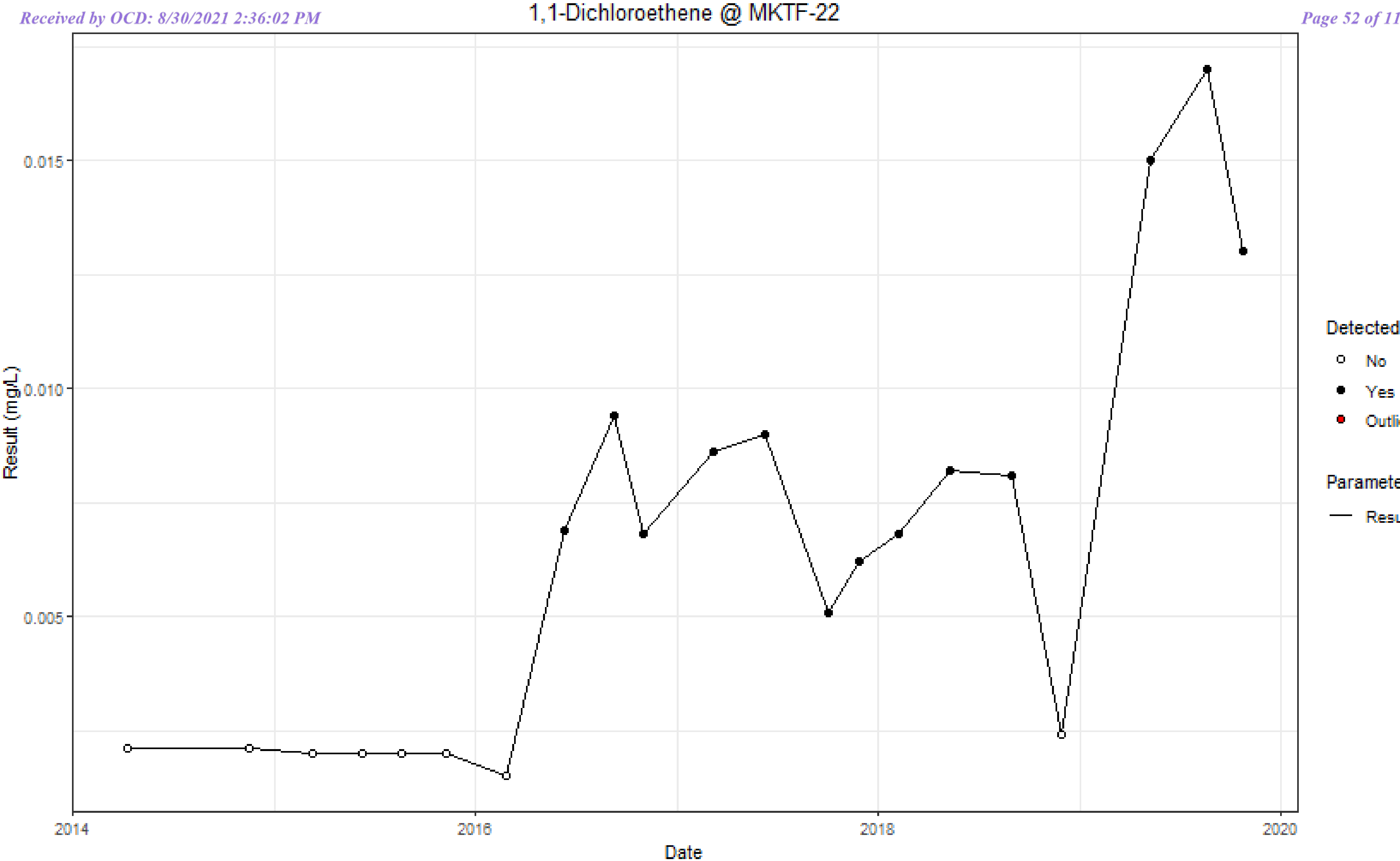


Method detection limit reported for ND results.



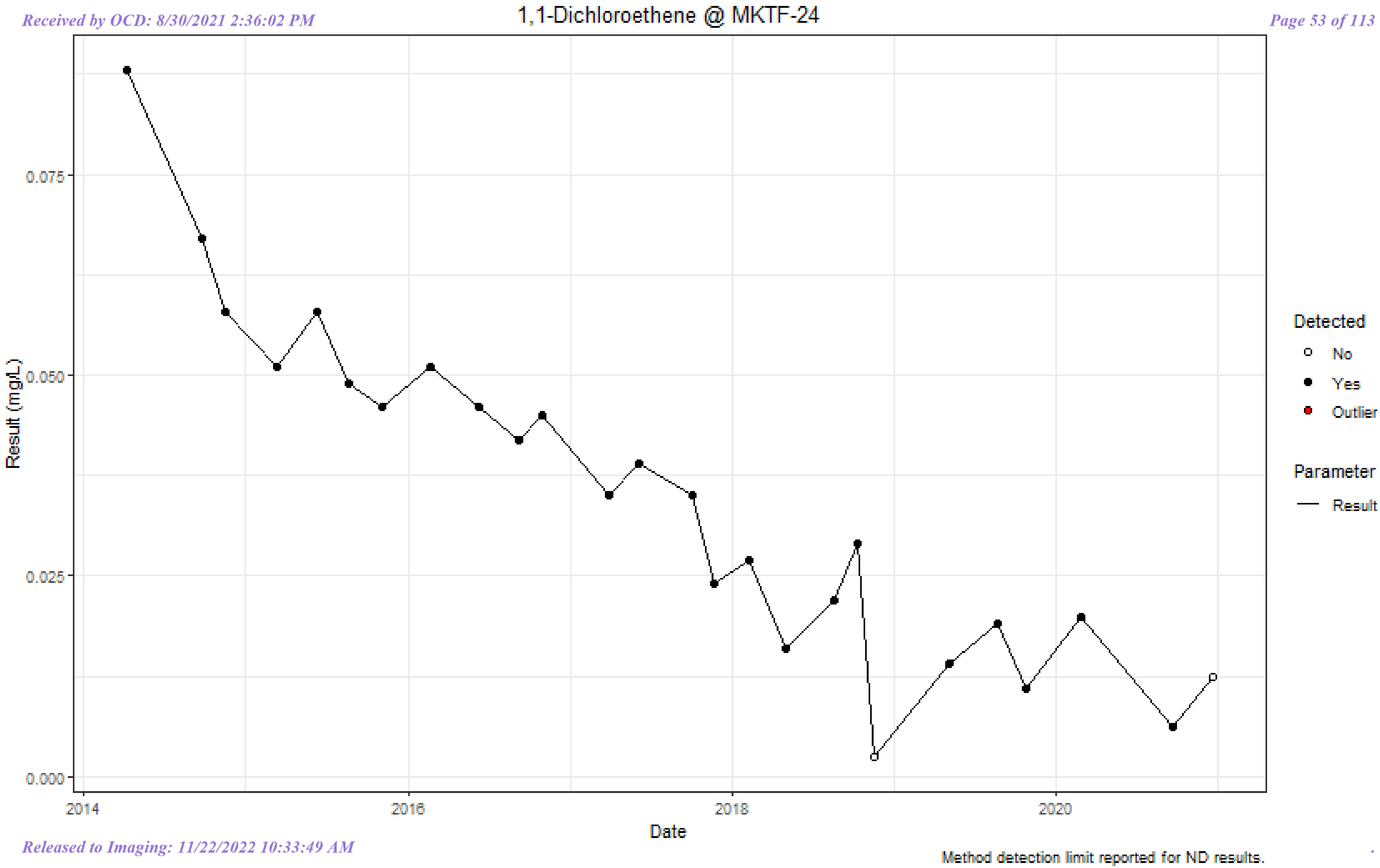
Method detection limit reported for ND results.


1,1-Dichloroethene @ MKTF-16
Result (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.



Method detection limit reported for ND results.

Received by OCD: 8/30/2021 2:36:02 PM



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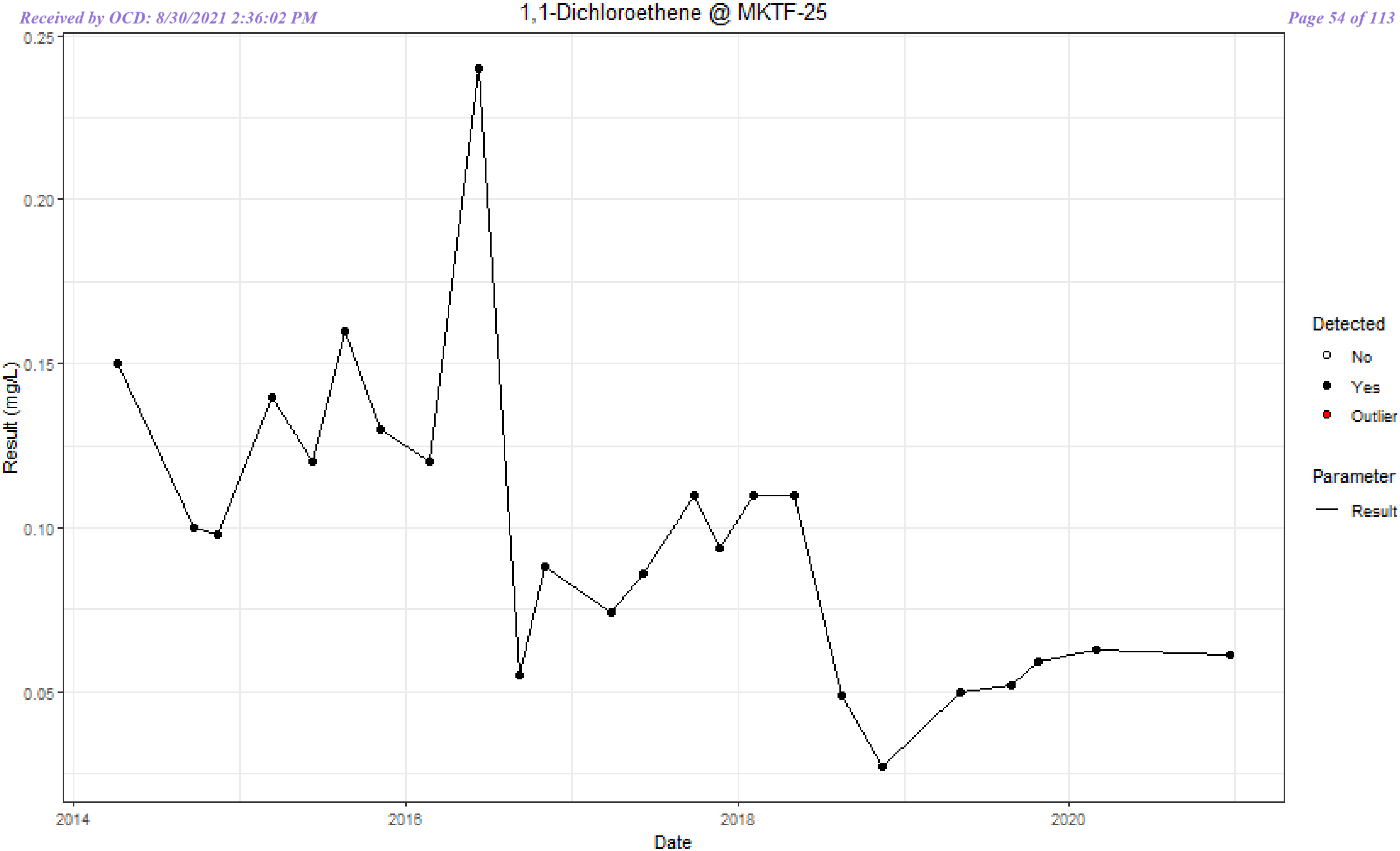
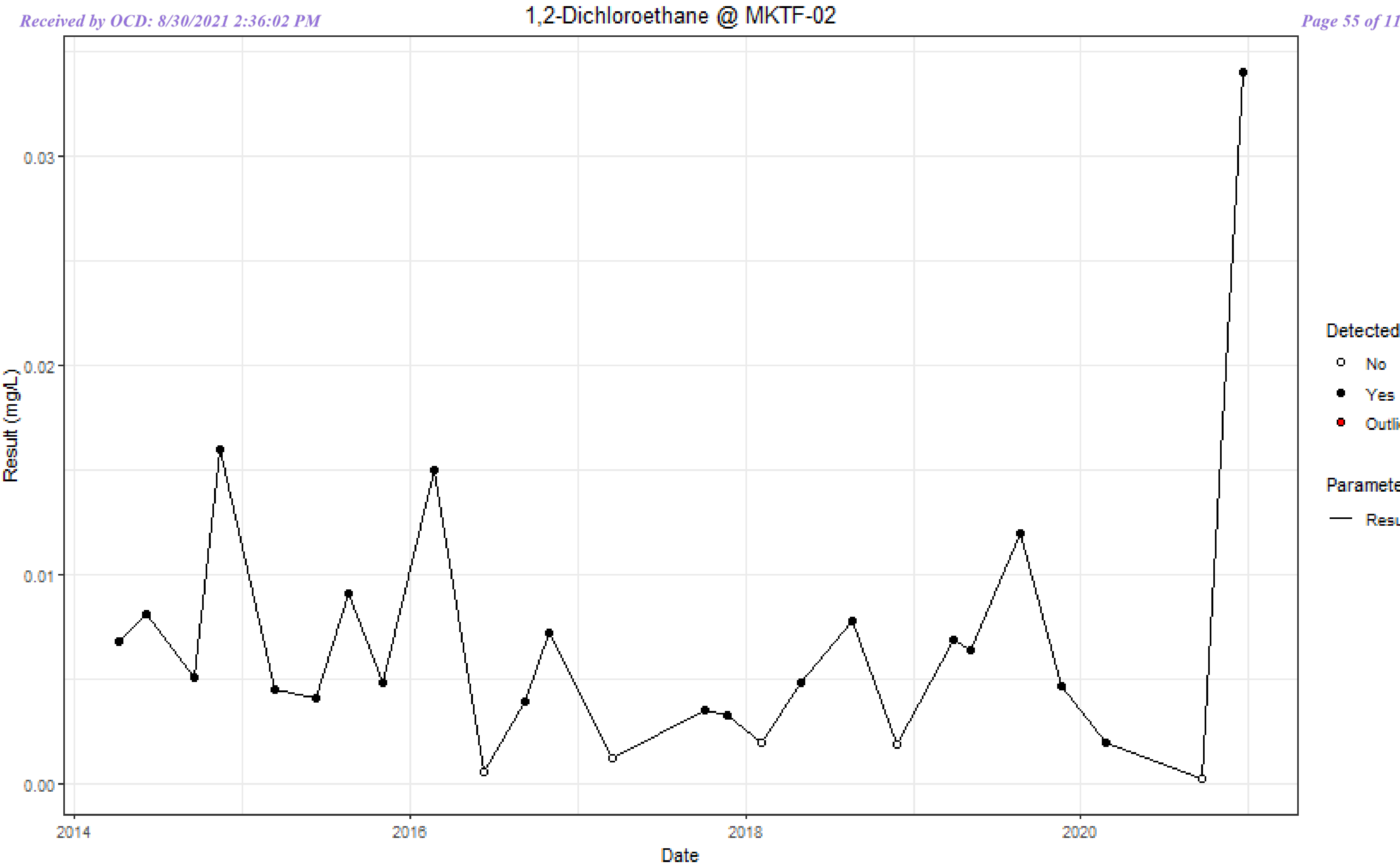
Received by OCD: 8/30/2021 2:36:02 PM

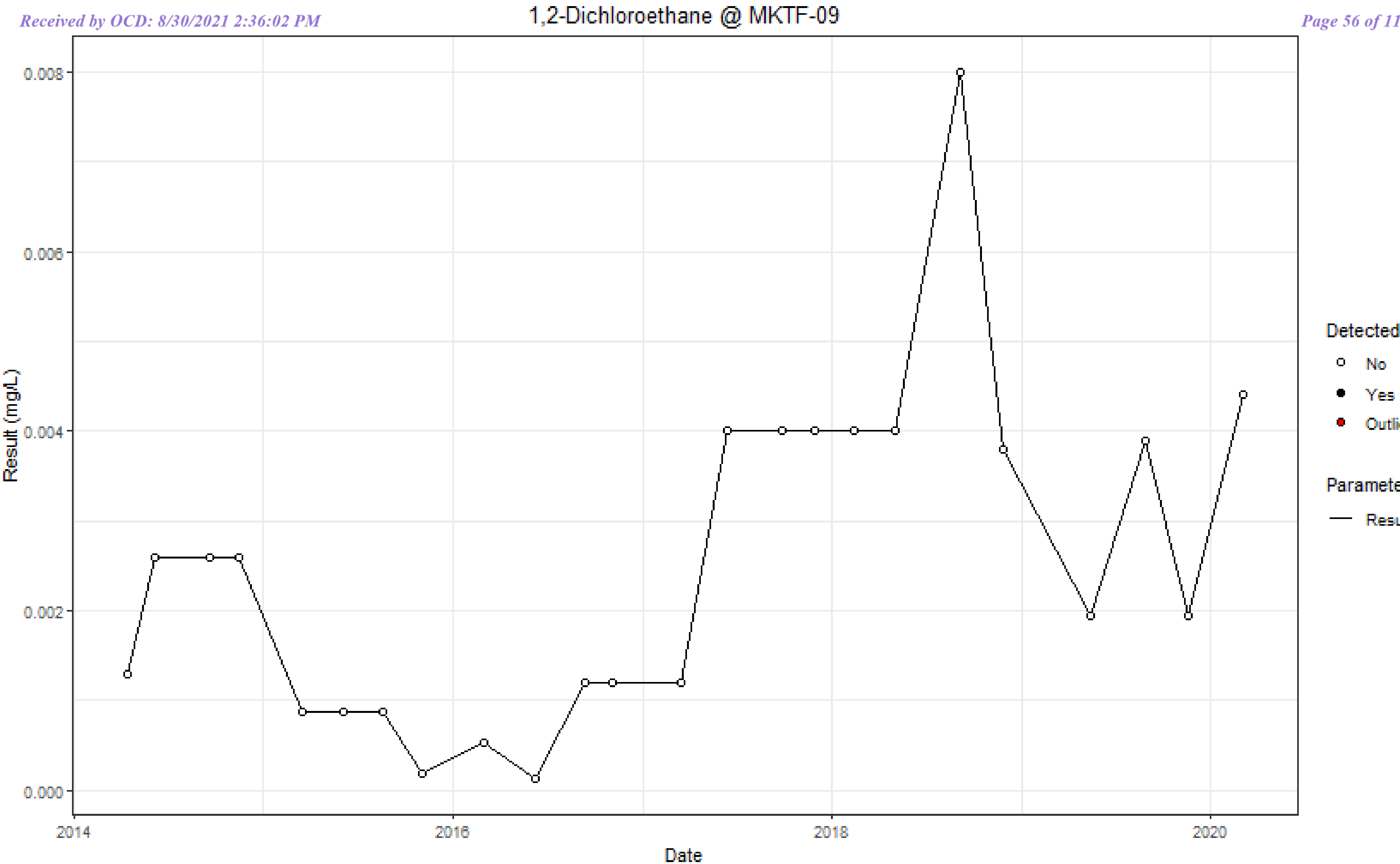


Method detection limit reported for ND results.

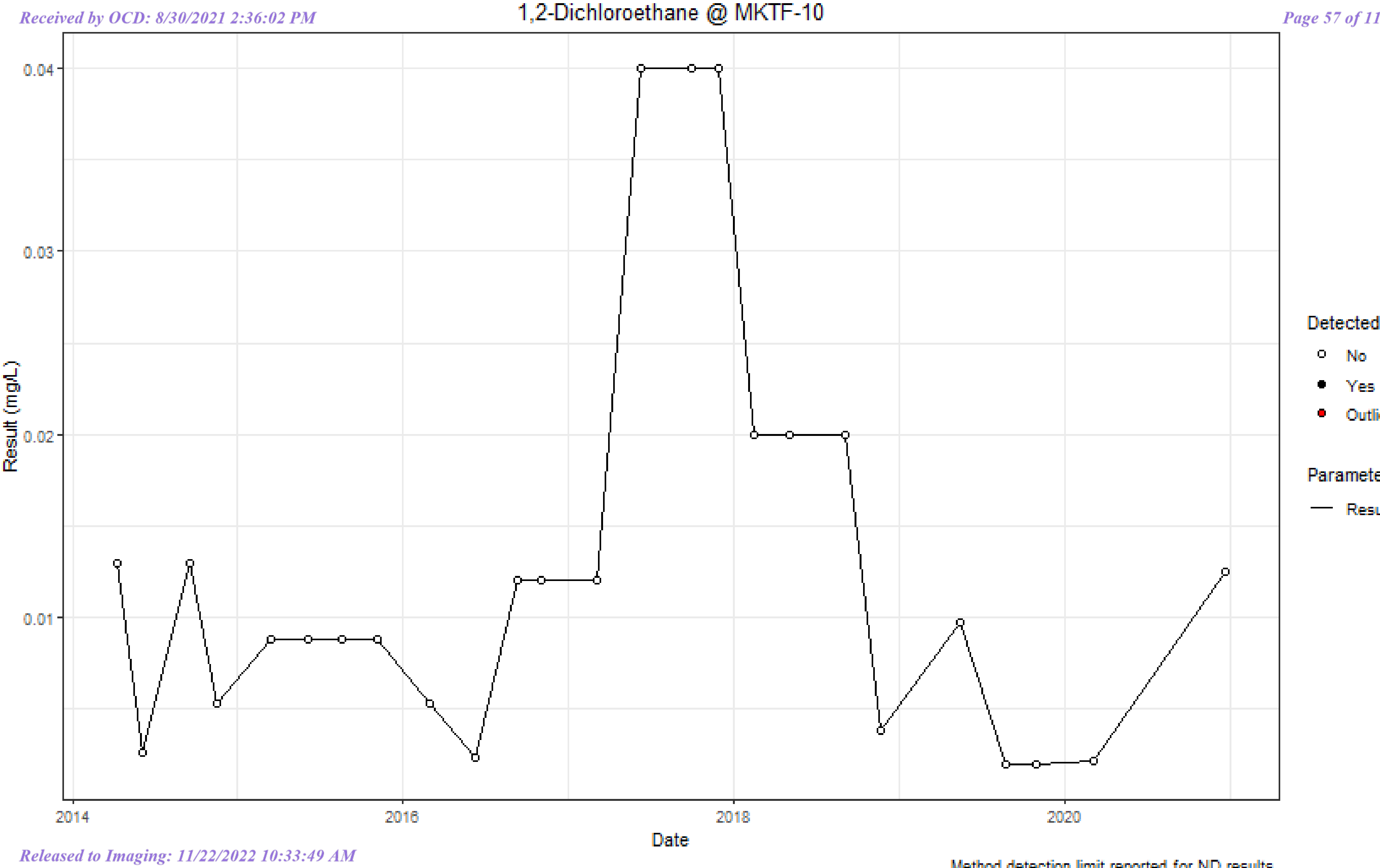
Released to Imaging: 11/22/2022 10:33:49 AM

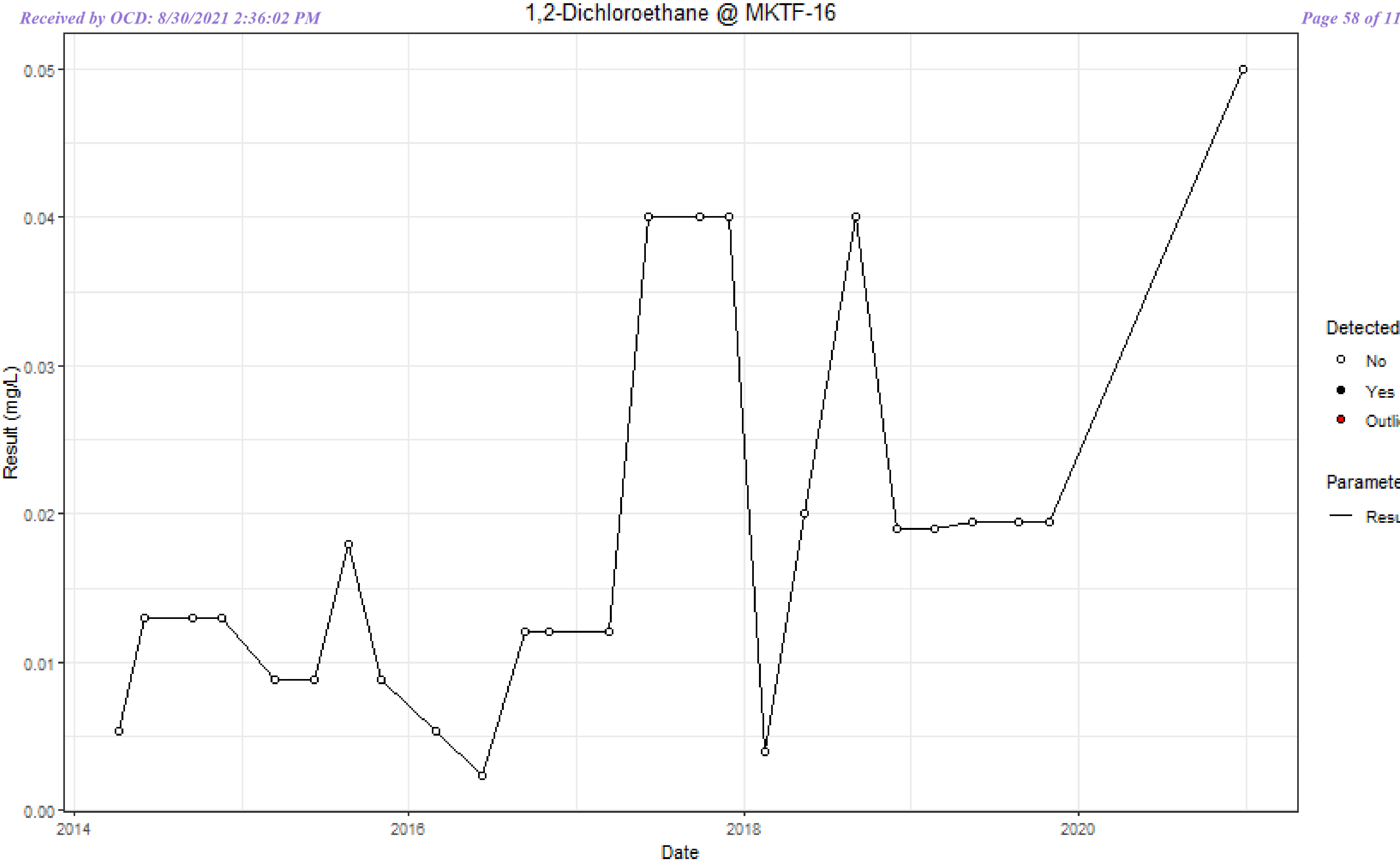


Method detection limit reported for ND results.

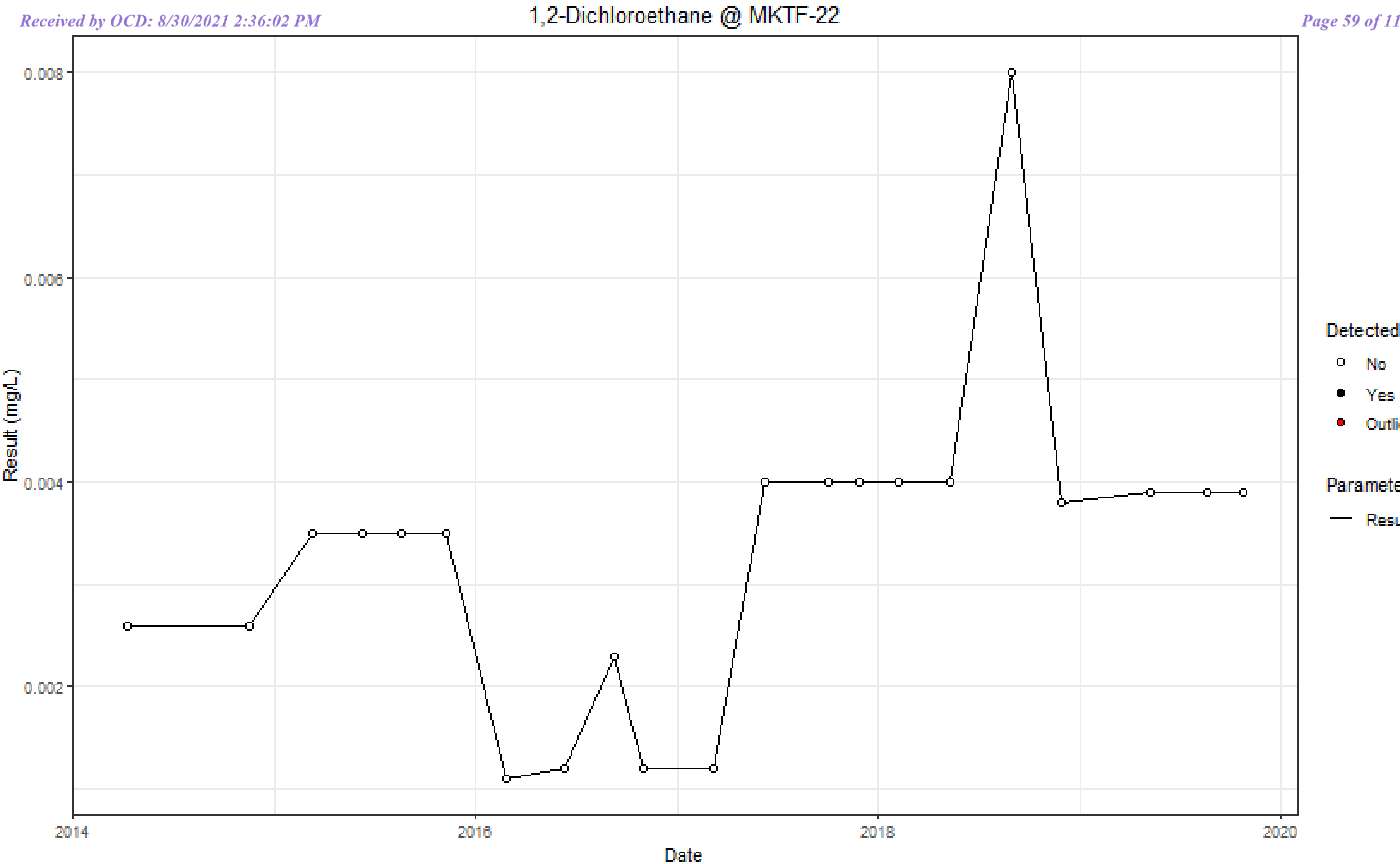


Method detection limit reported for ND results.

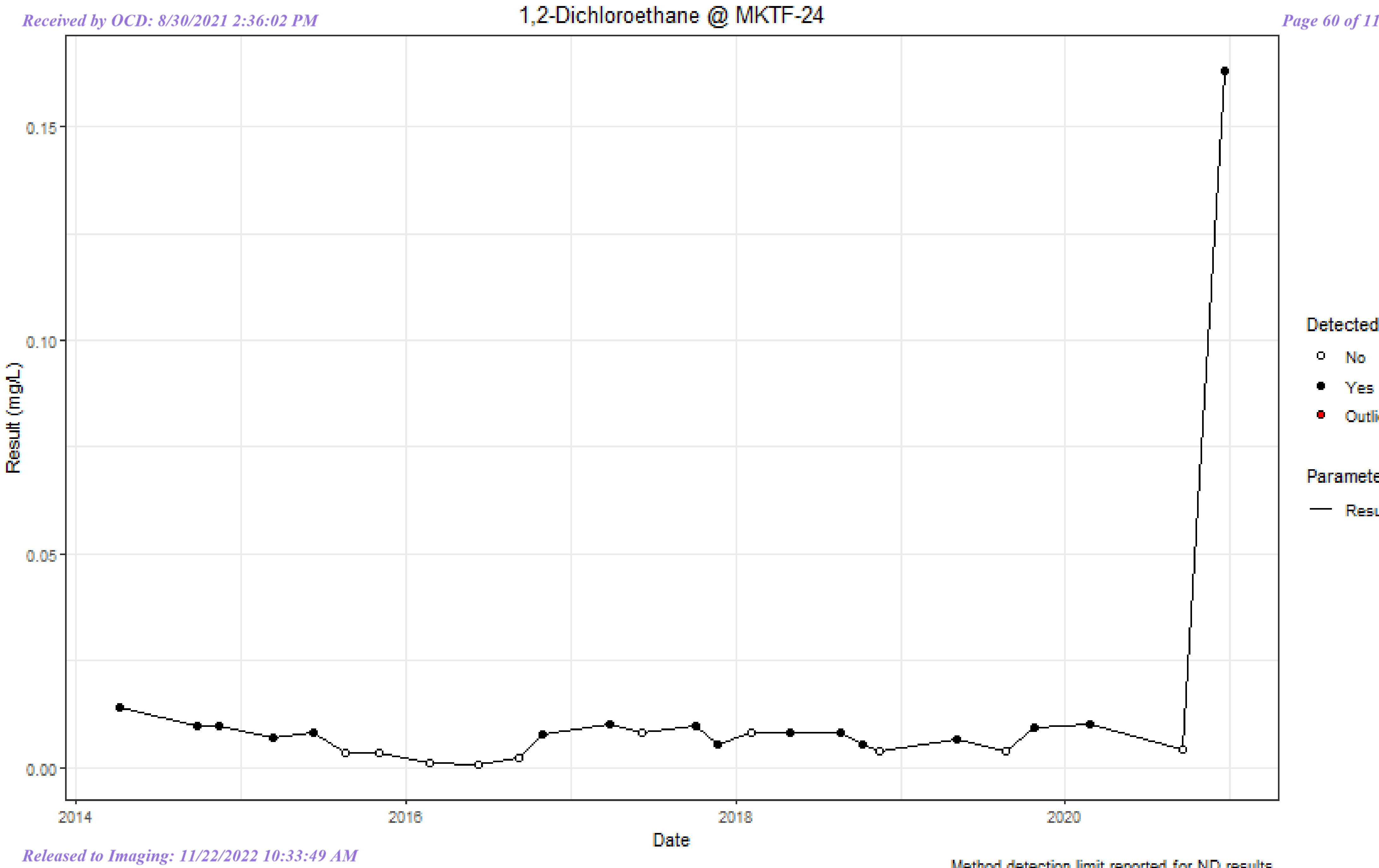

1,2-Dichloroethane @ MKTF-10
0.04
0.03
0.02
0.01
Result (mg/L)
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

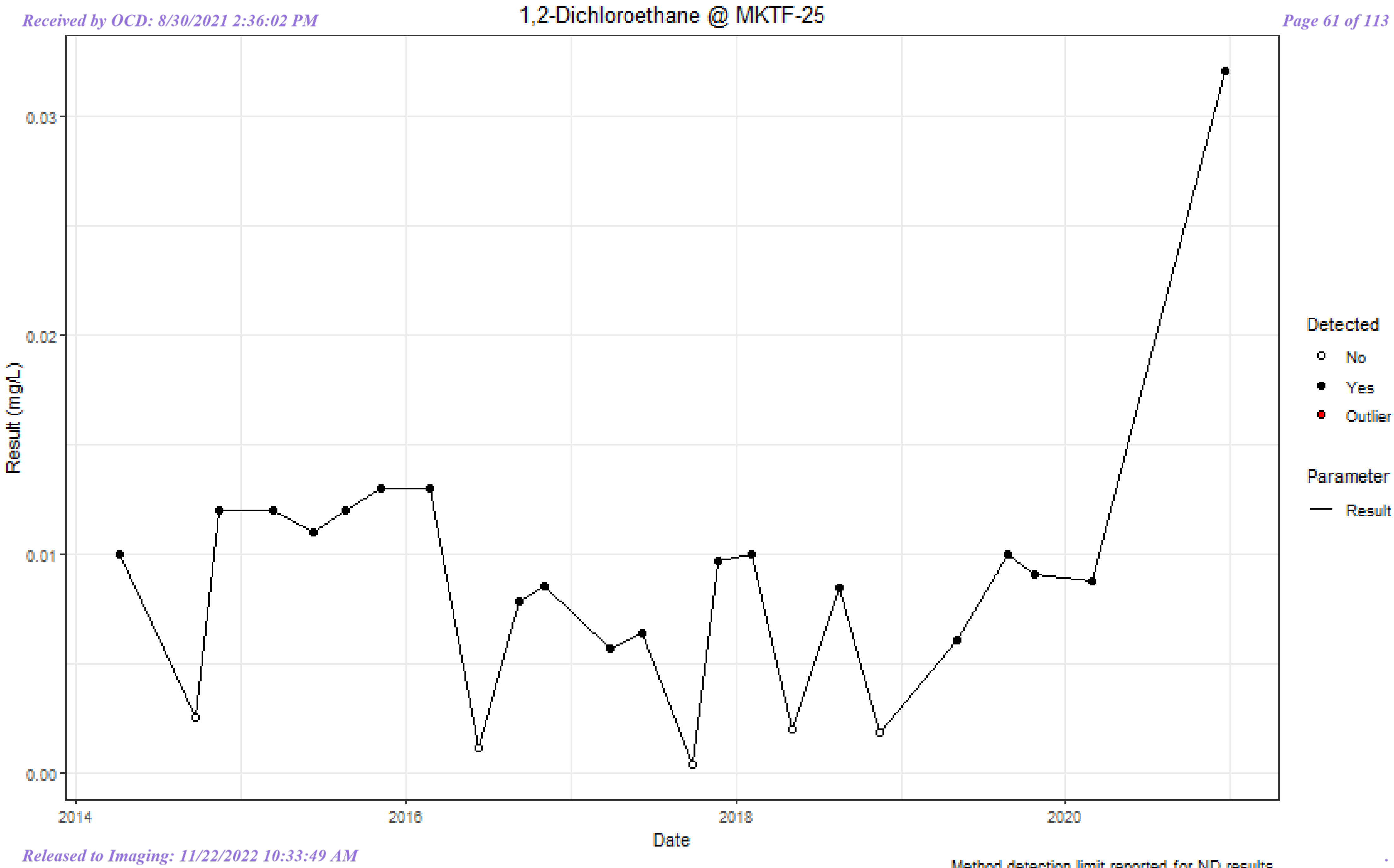


Method detection limit reported for ND results.

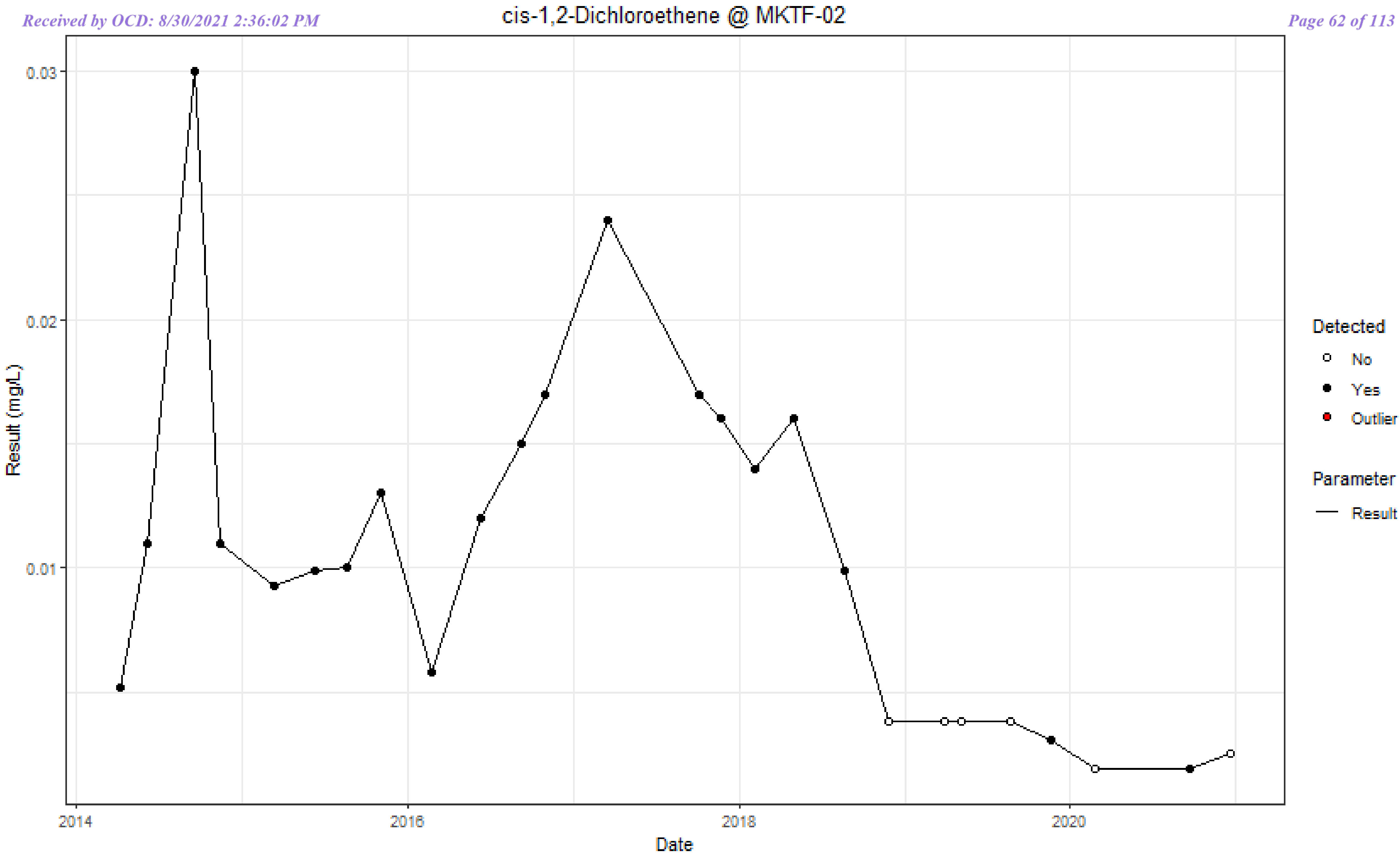


Method detection limit reported for ND results.

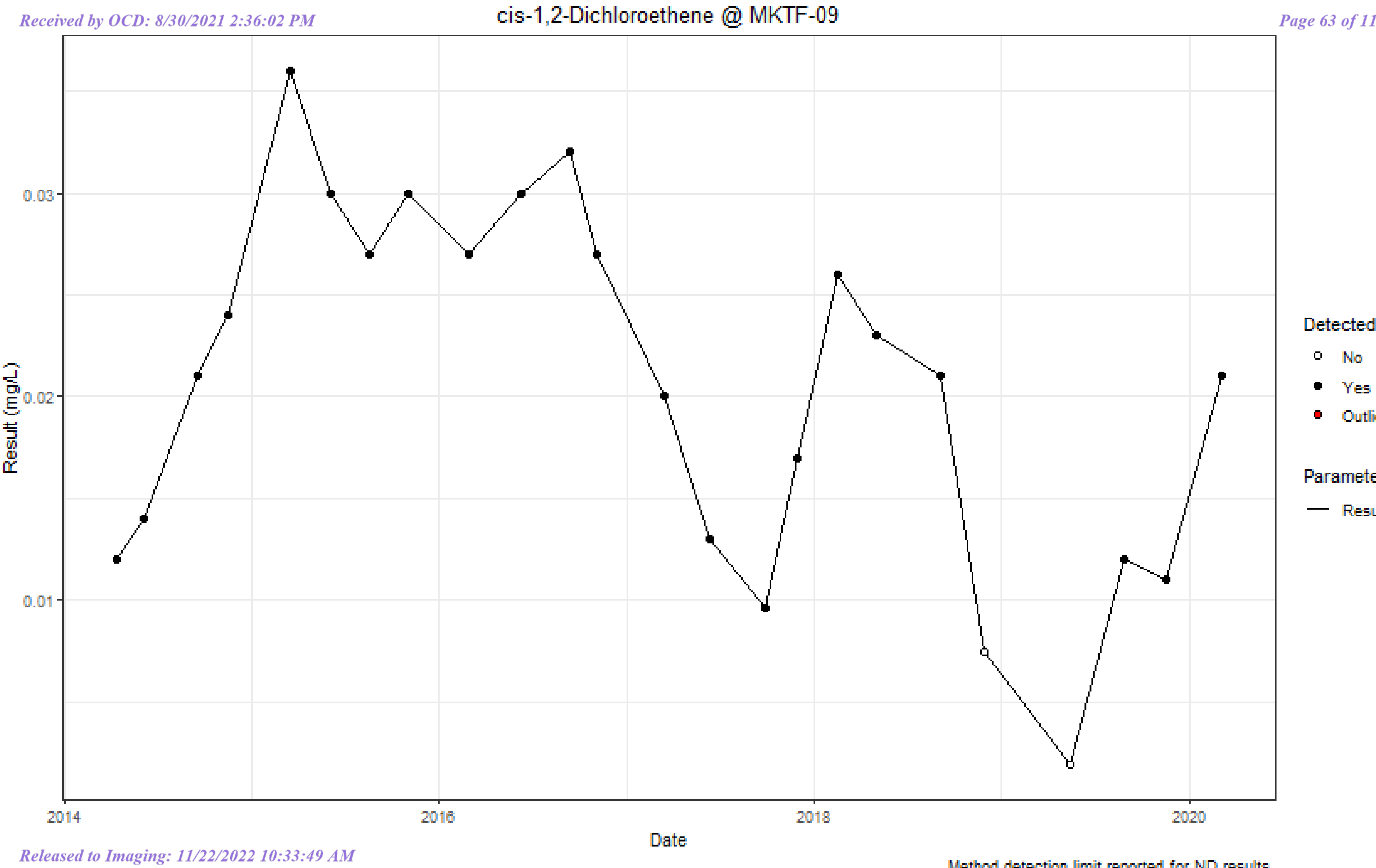

1,2-Dichloroethane @ MKTF-24
Result (mg/L)
0.15
0.10
0.05
0.00
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

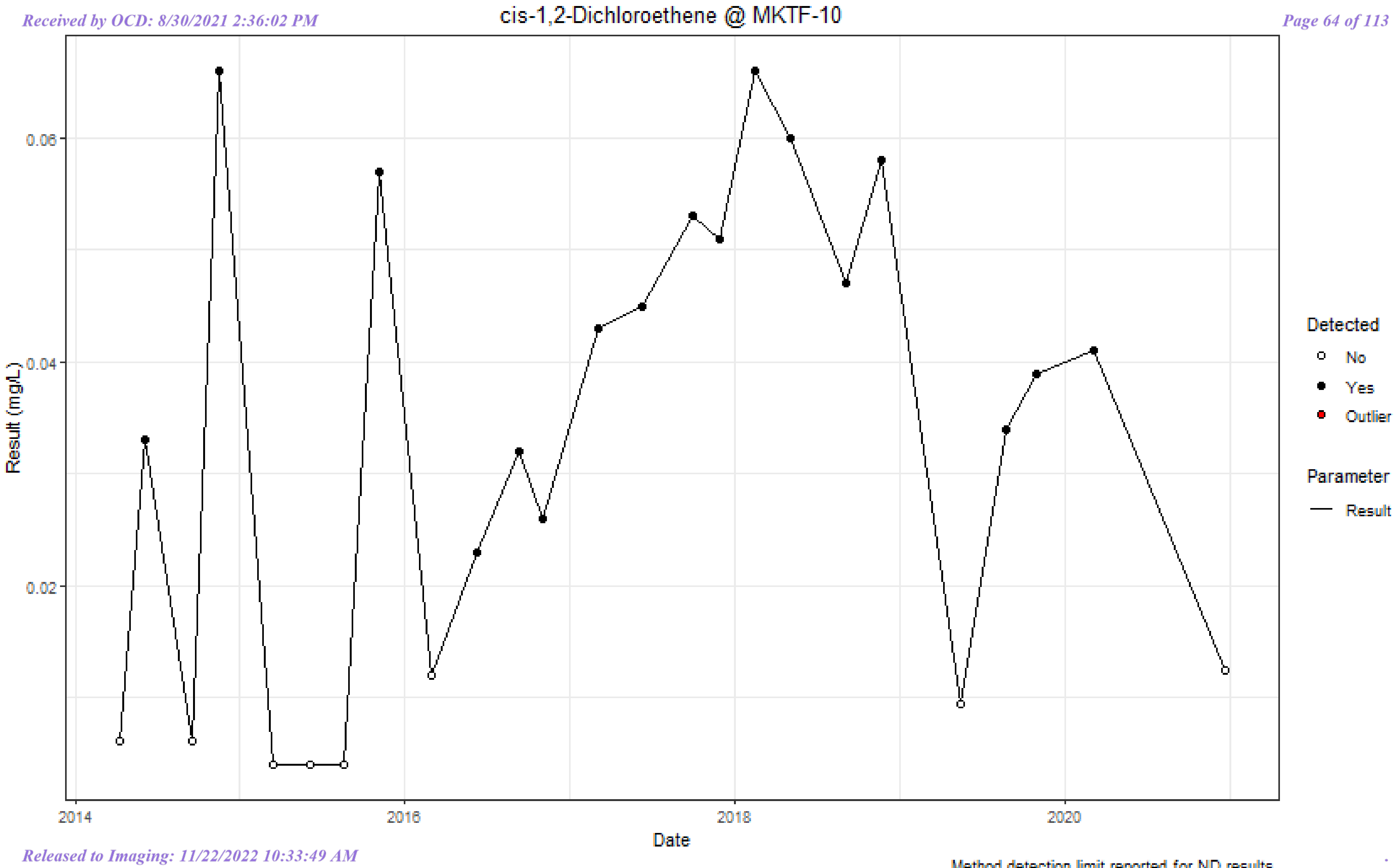


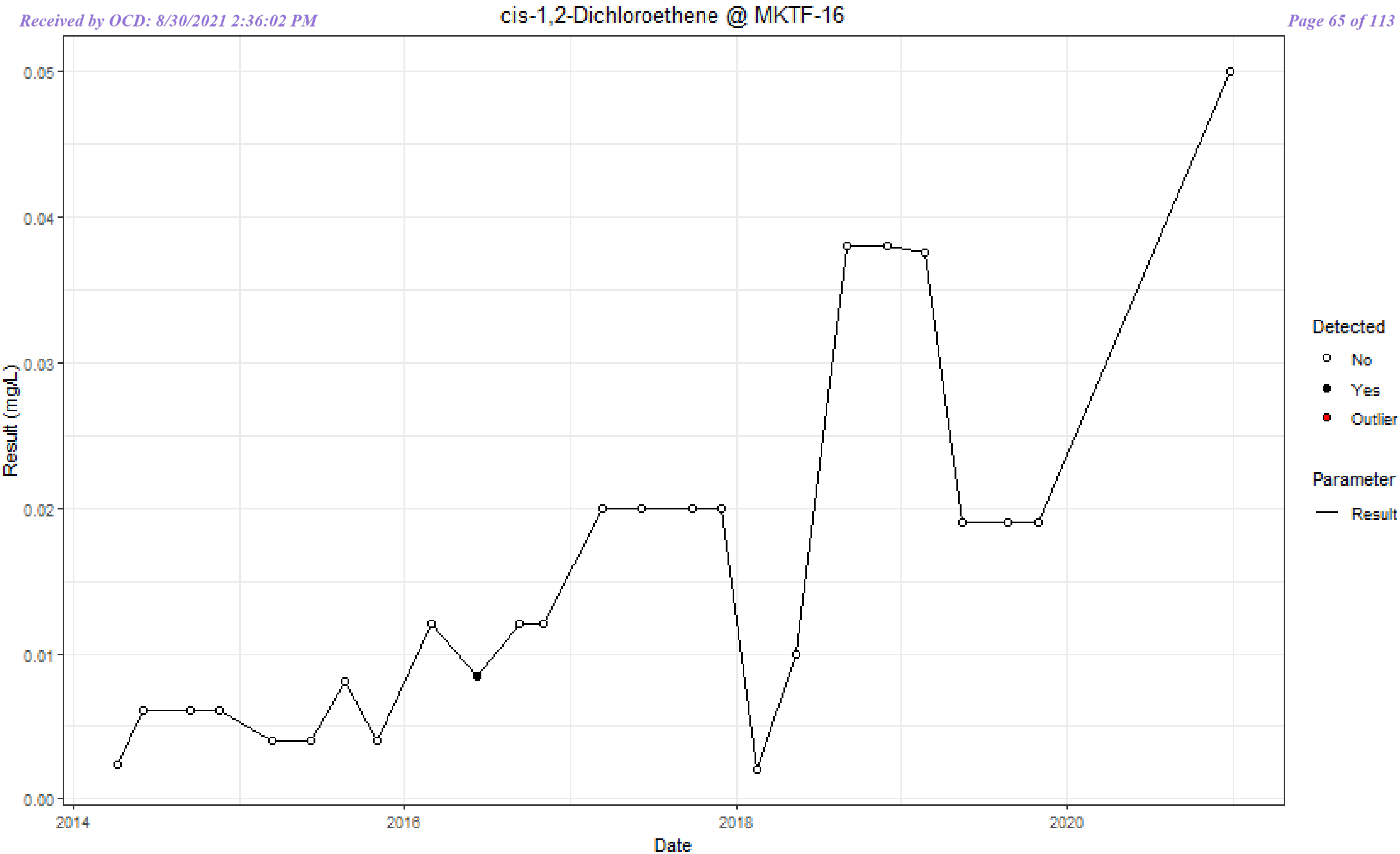
1,2-Dichloroethane @ MKTF-25
Result (mg/L)
0.00
0.01
0.02
0.03
Date
2014
2016
2018
2020
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.



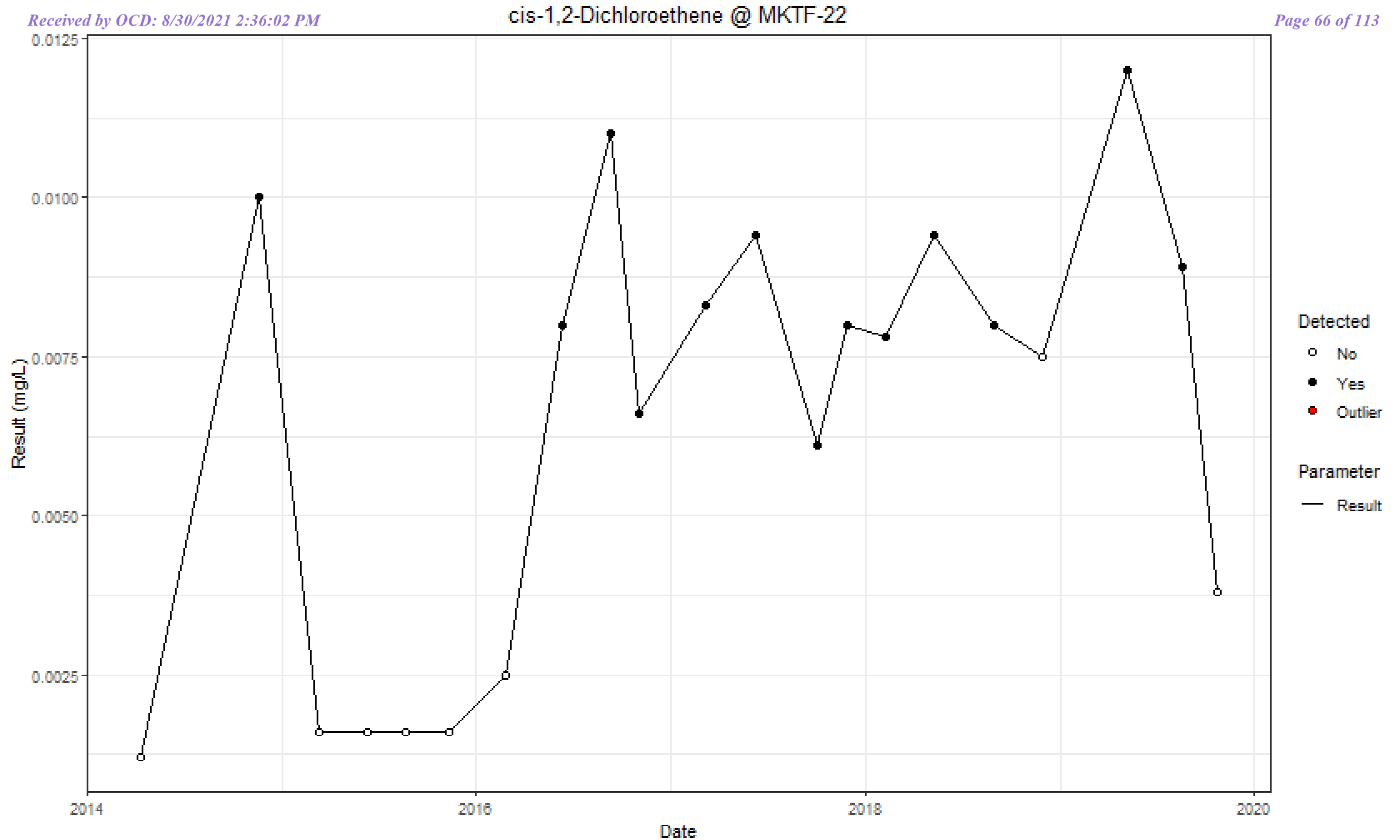
Method detection limit reported for ND results.


cis-1,2-Dichloroethene @ MKTF-09
Result (mg/L)
0.03
0.02
0.01
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

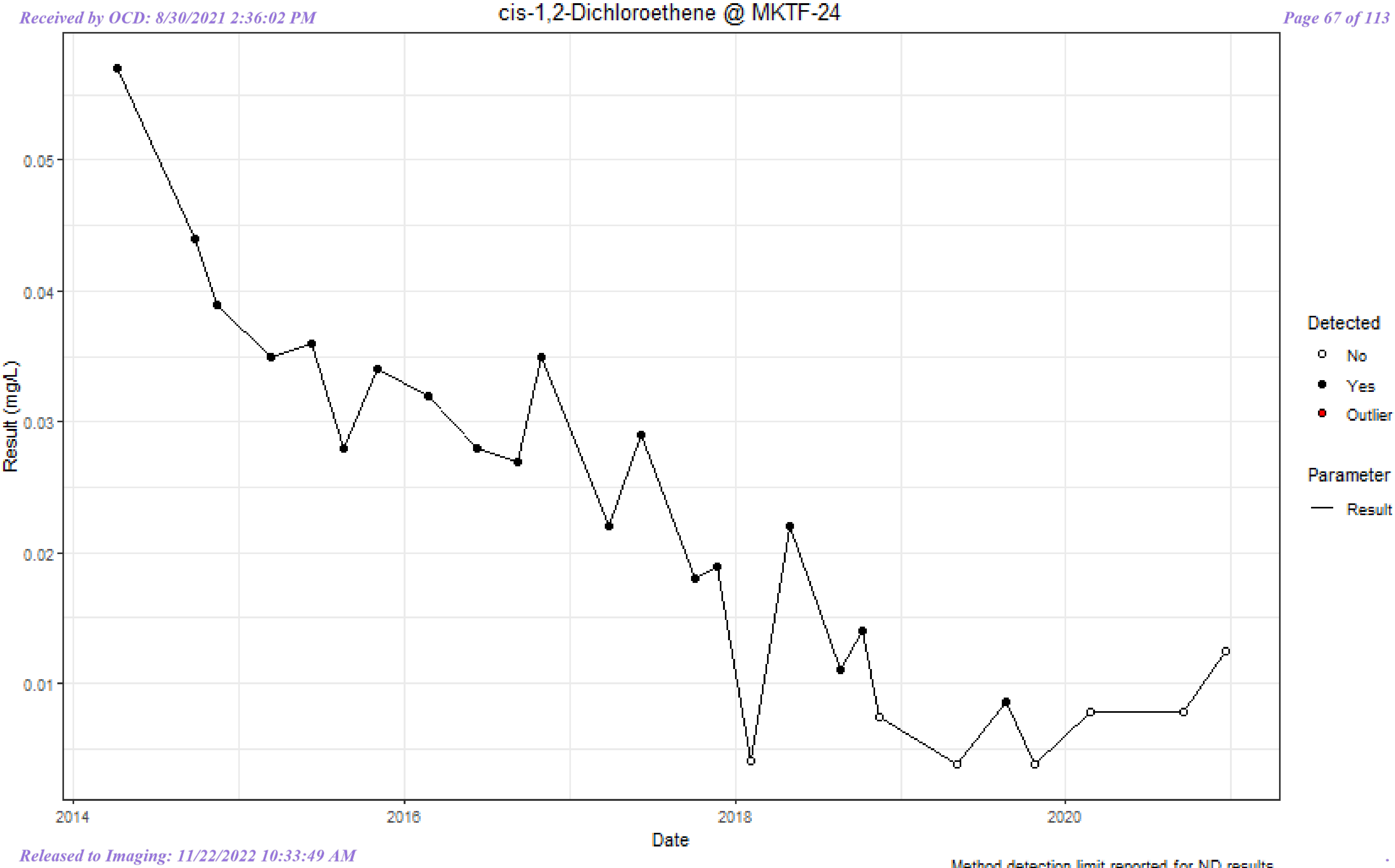

cis-1,2-Dichloroethene @ MKTF-10
Result (mg/L)
0.06
0.04
0.02
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

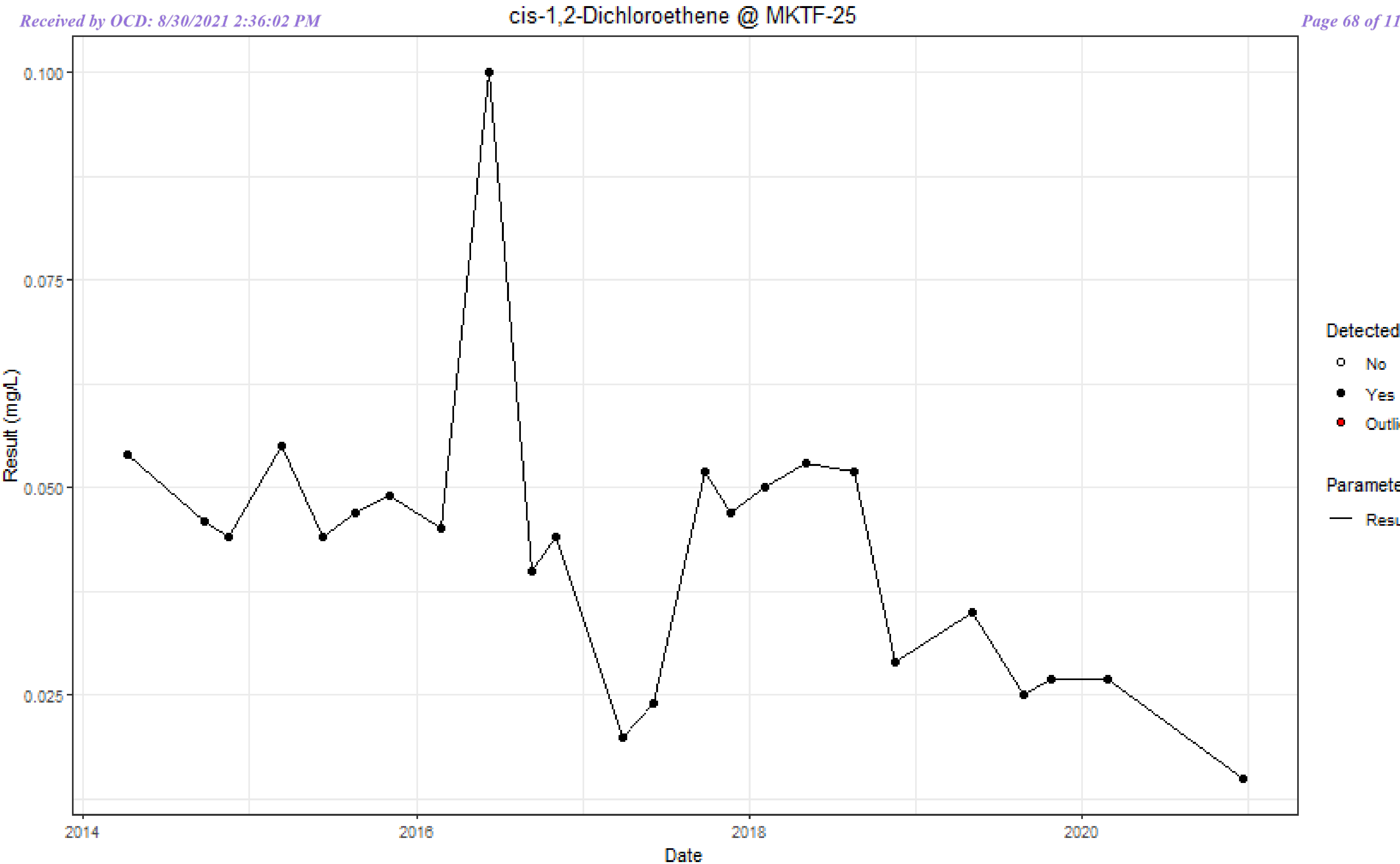


Method detection limit reported for ND results.

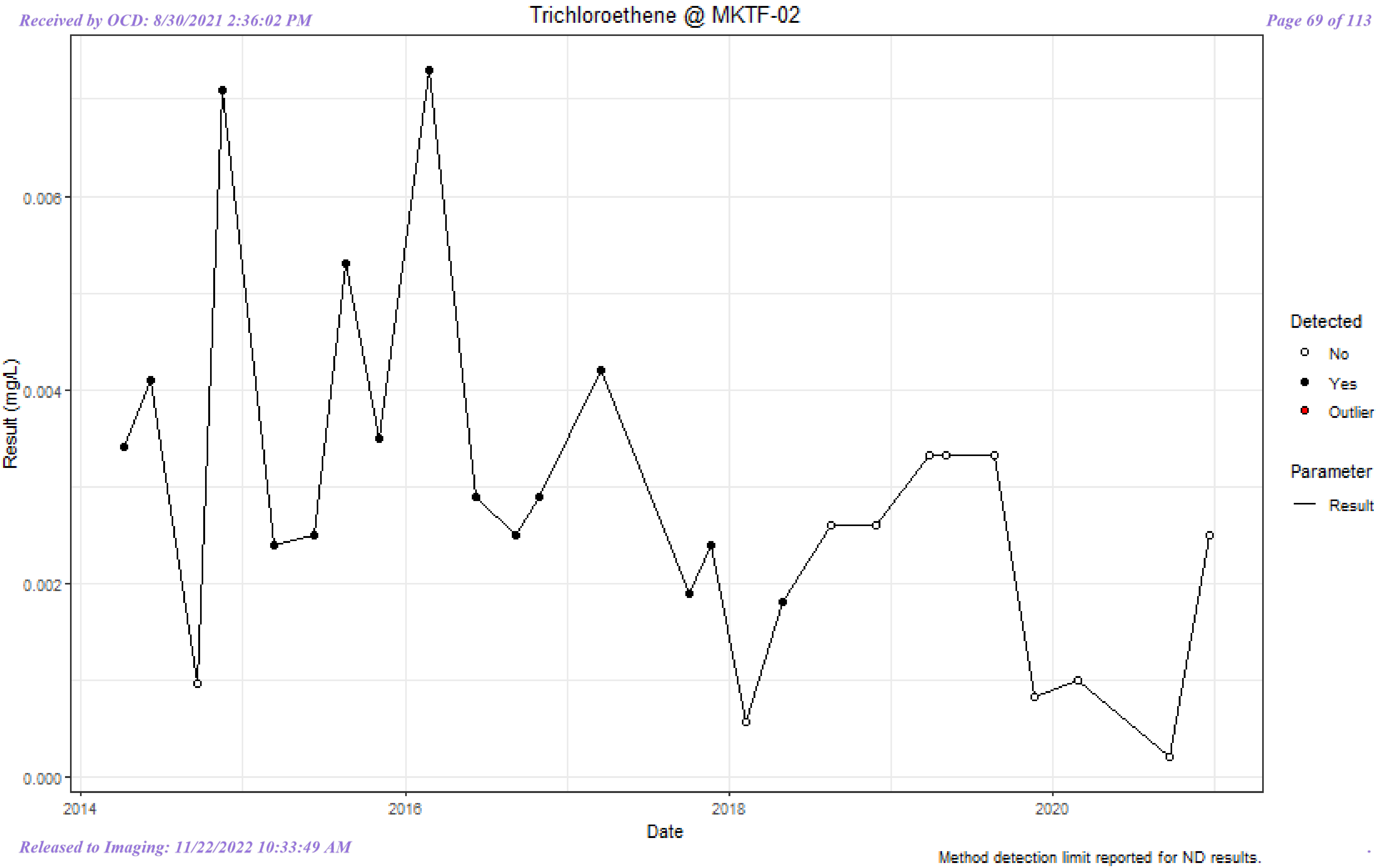


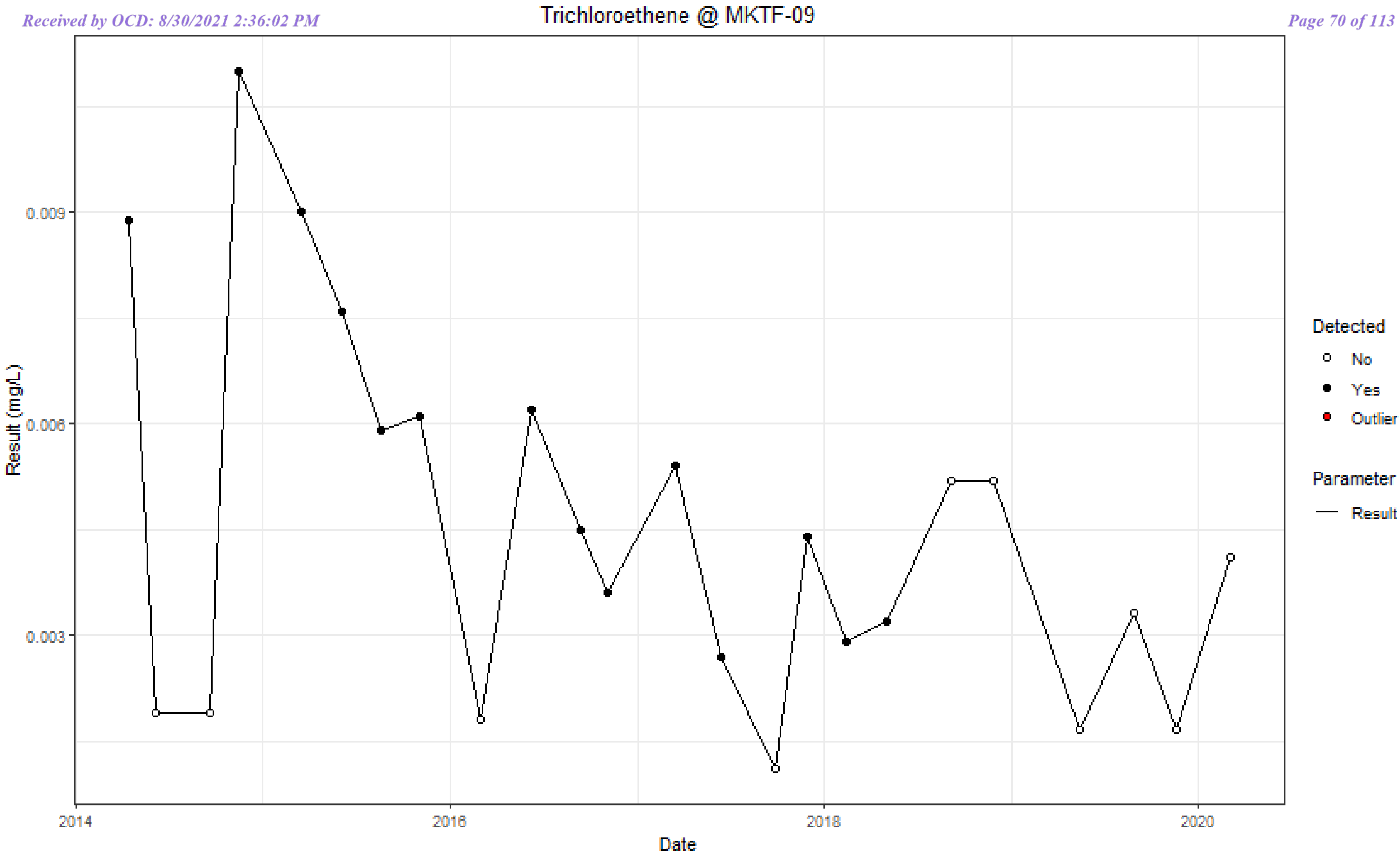
Method detection limit reported for ND results.


cis-1,2-Dichloroethene @ MKTF-24
Result (mg/L)
0.01
0.02
0.03
0.04
0.05
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.



Method detection limit reported for ND results.


Trichloroethene @ MKTF-02
Result (mg/L)
0.000
0.002
0.004
0.006
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.



Method detection limit reported for ND results.

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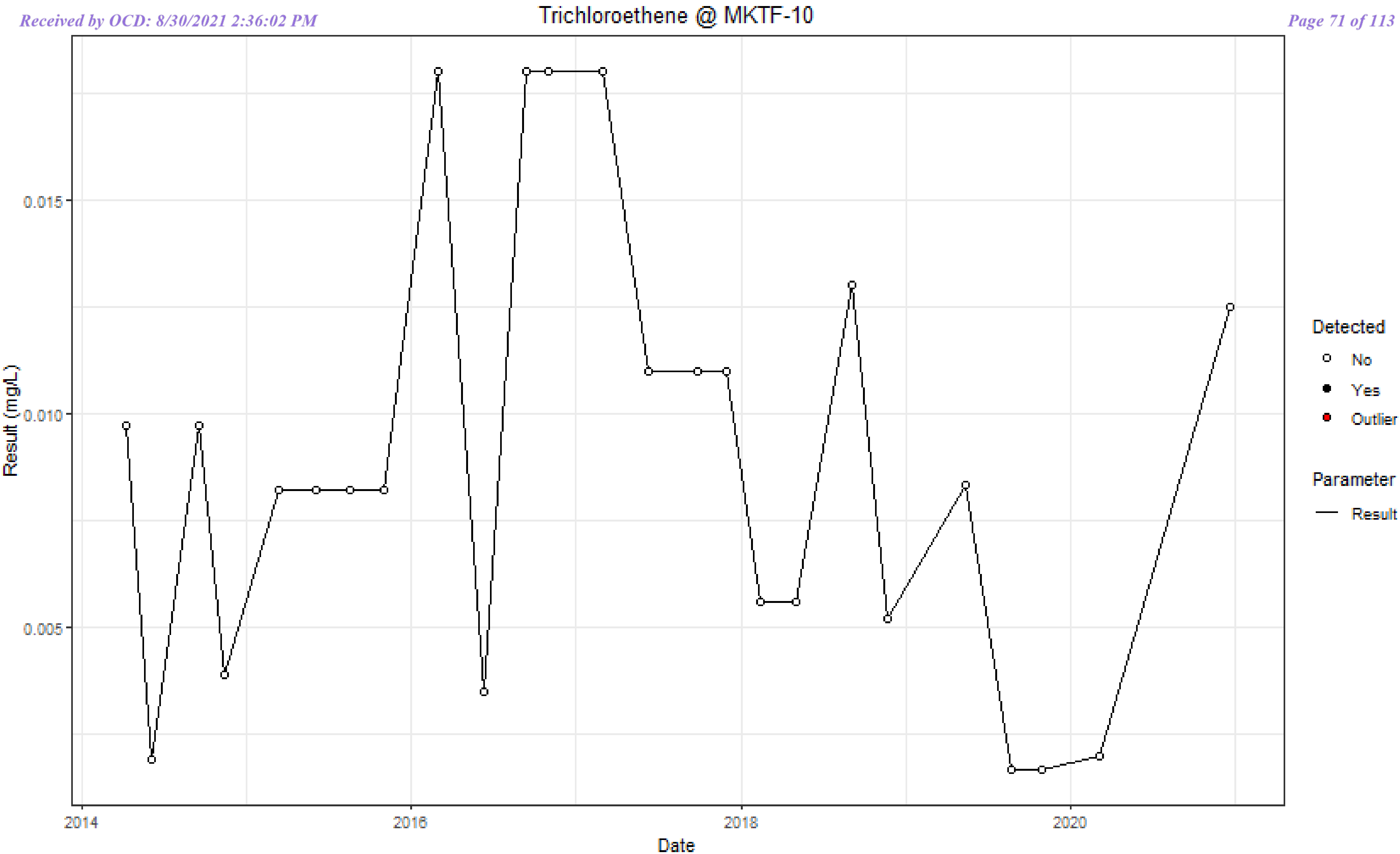
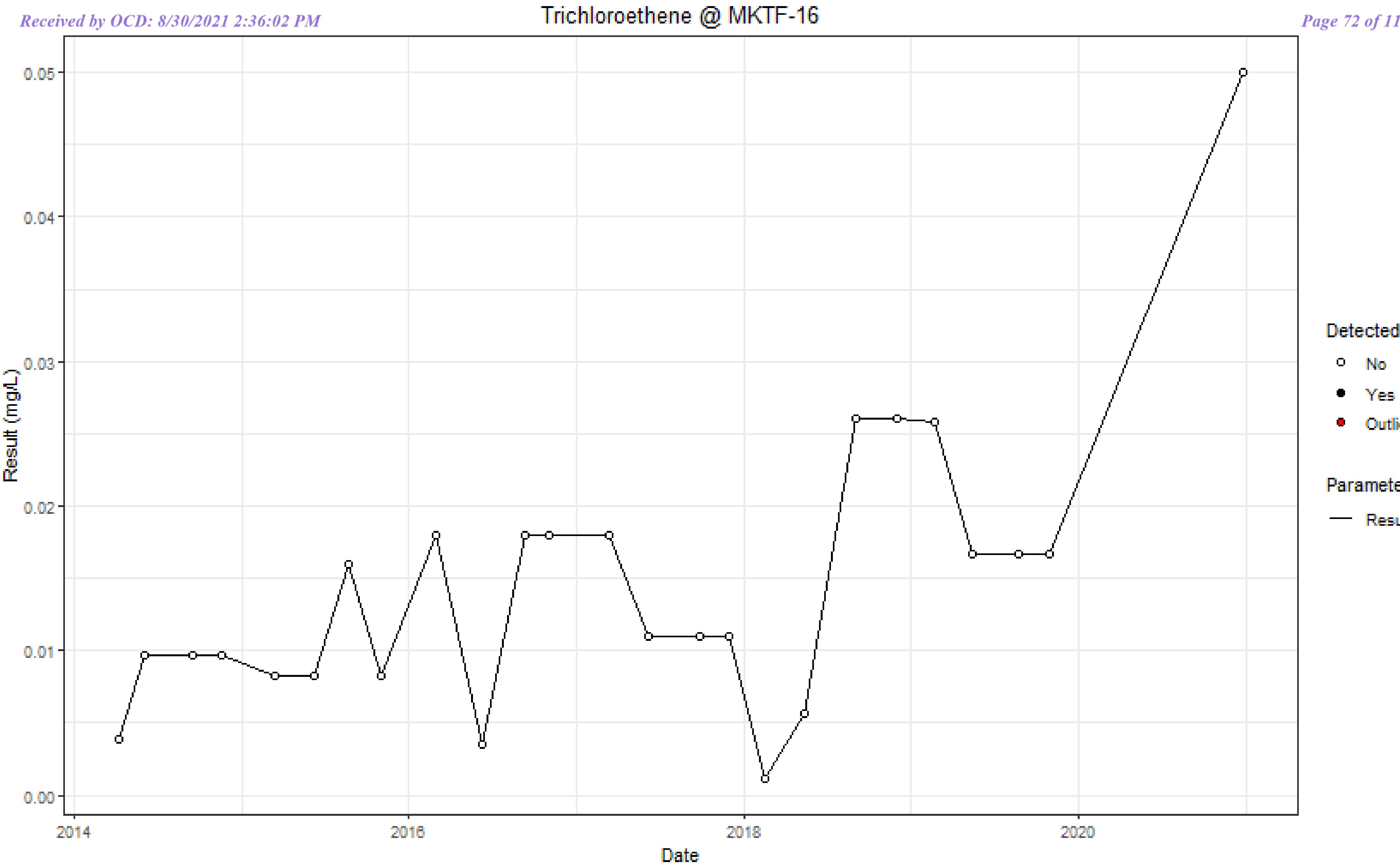


Method detection limit reported for ND results.

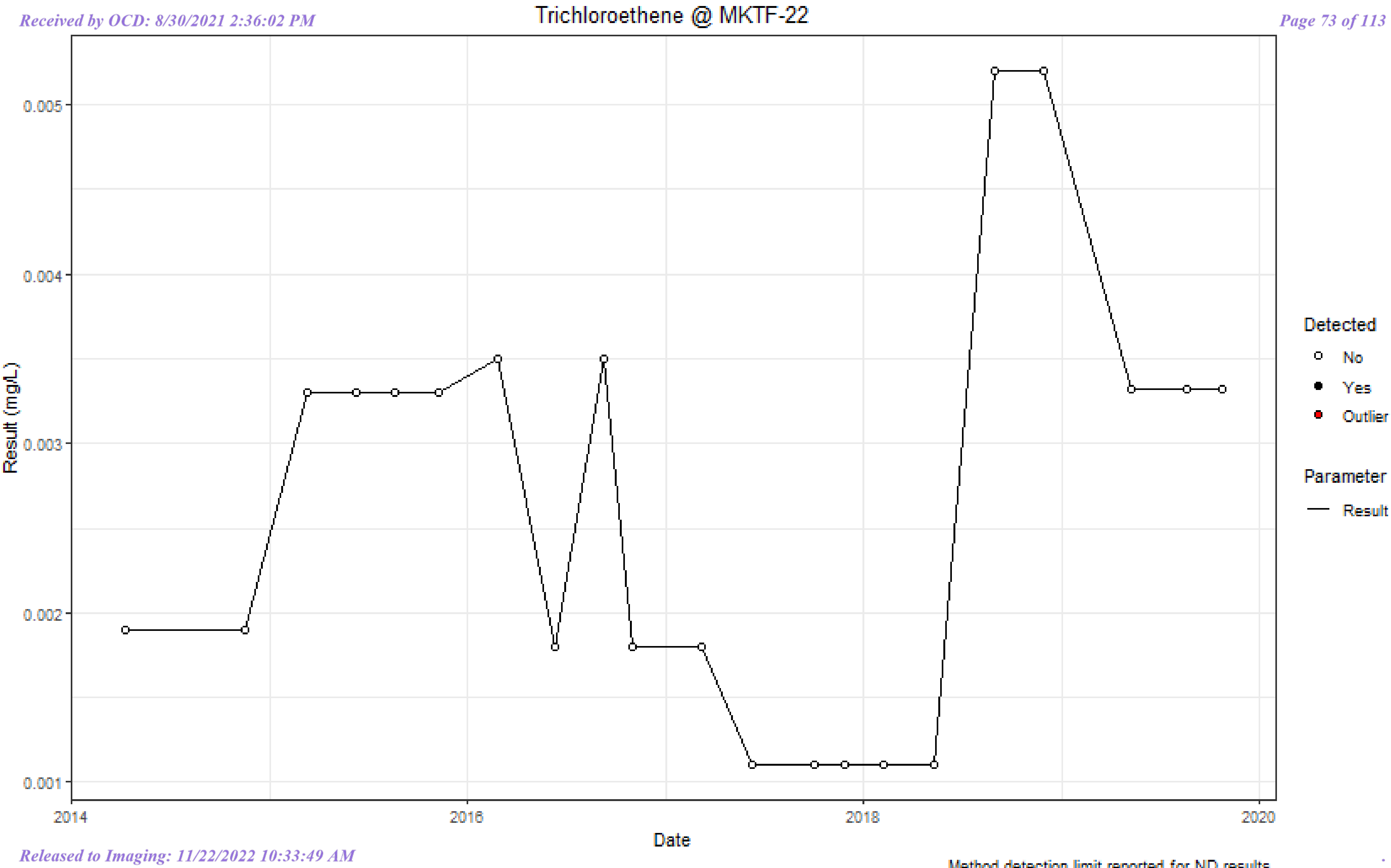
Released to Imaging: 11/22/2022 10:33:49 AM

Received by OCD: 8/30/2021 2:36:02 PM

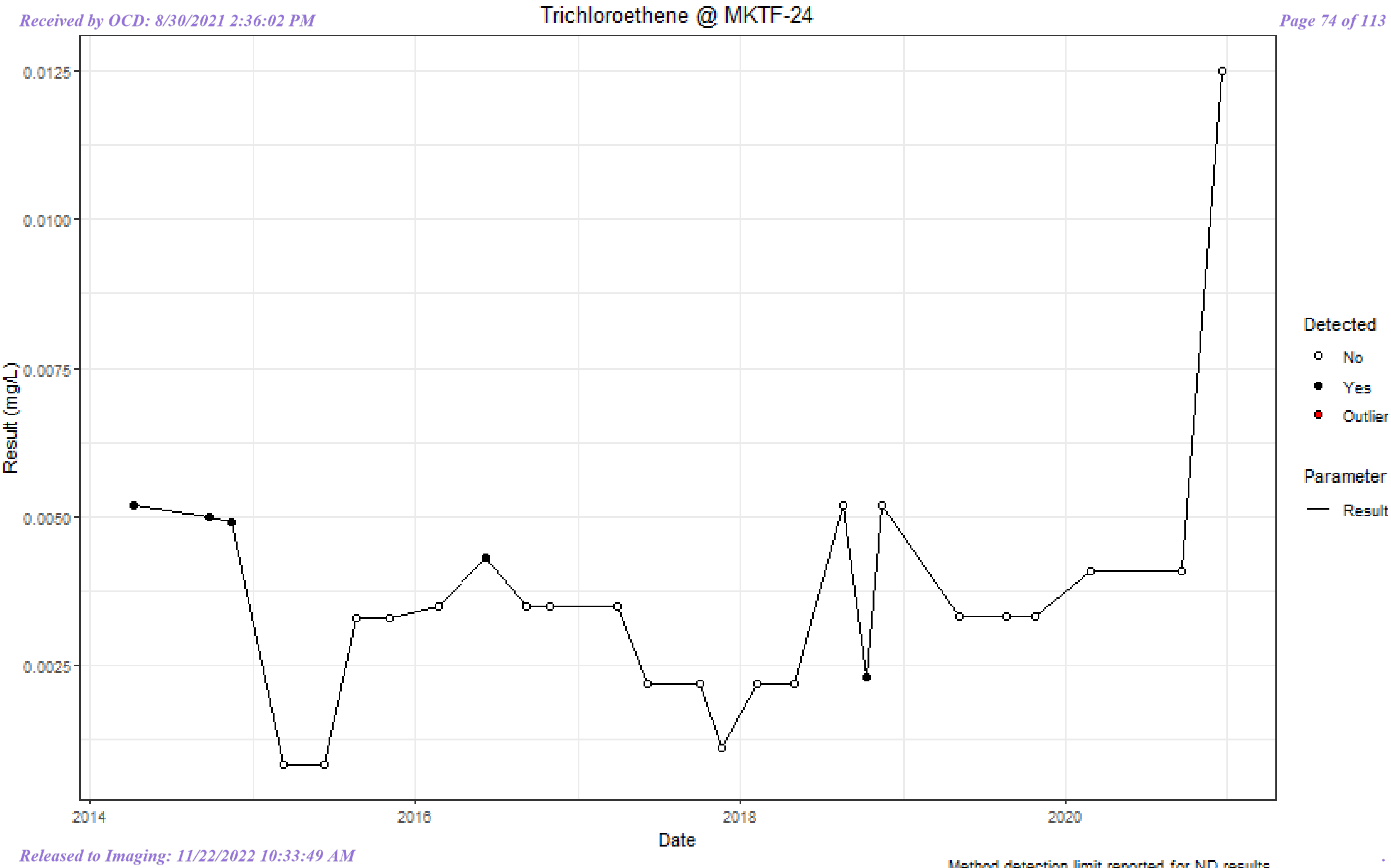


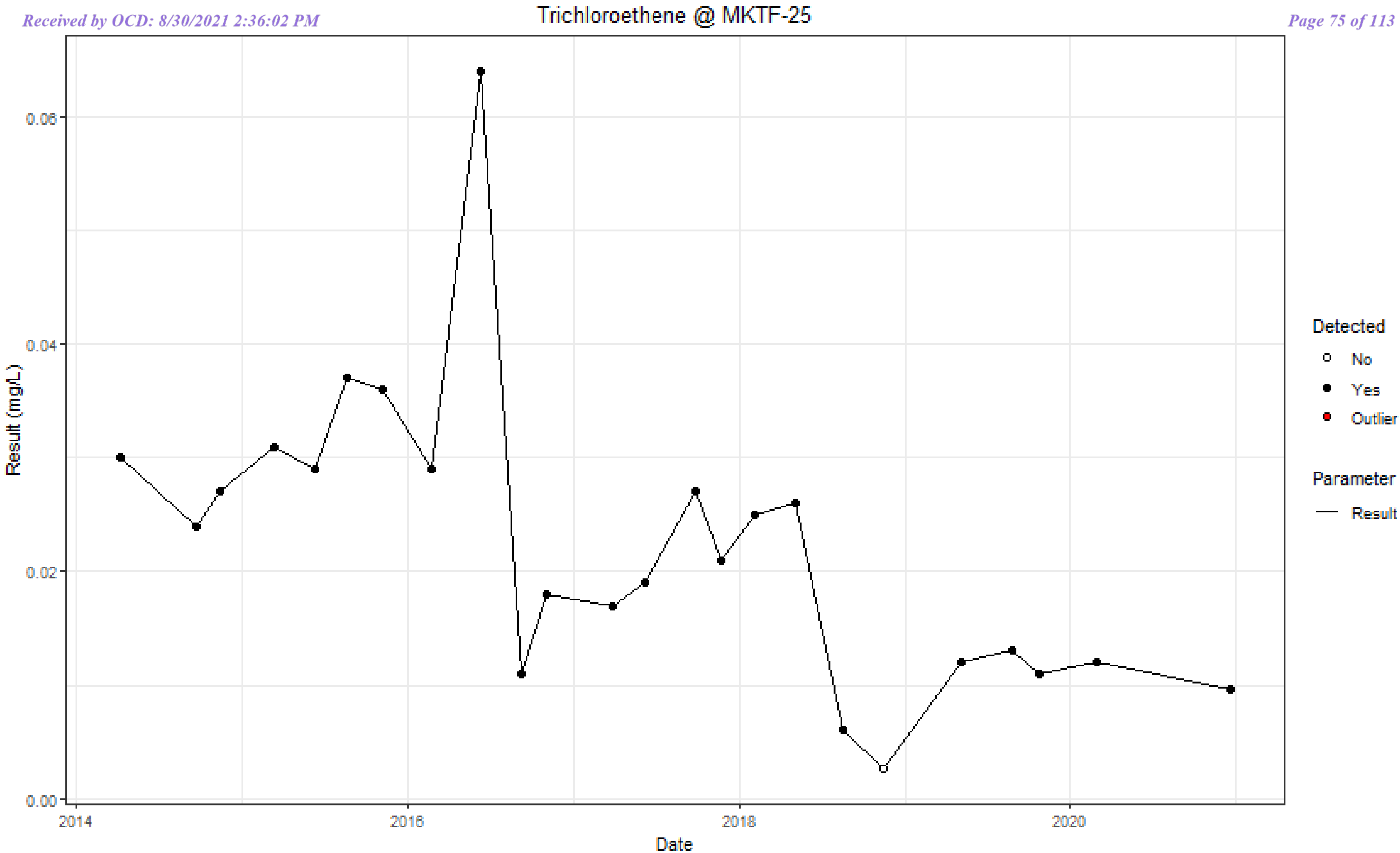
Method detection limit reported for ND results.

Released to Imaging: 11/22/2022 10:33:49 AM

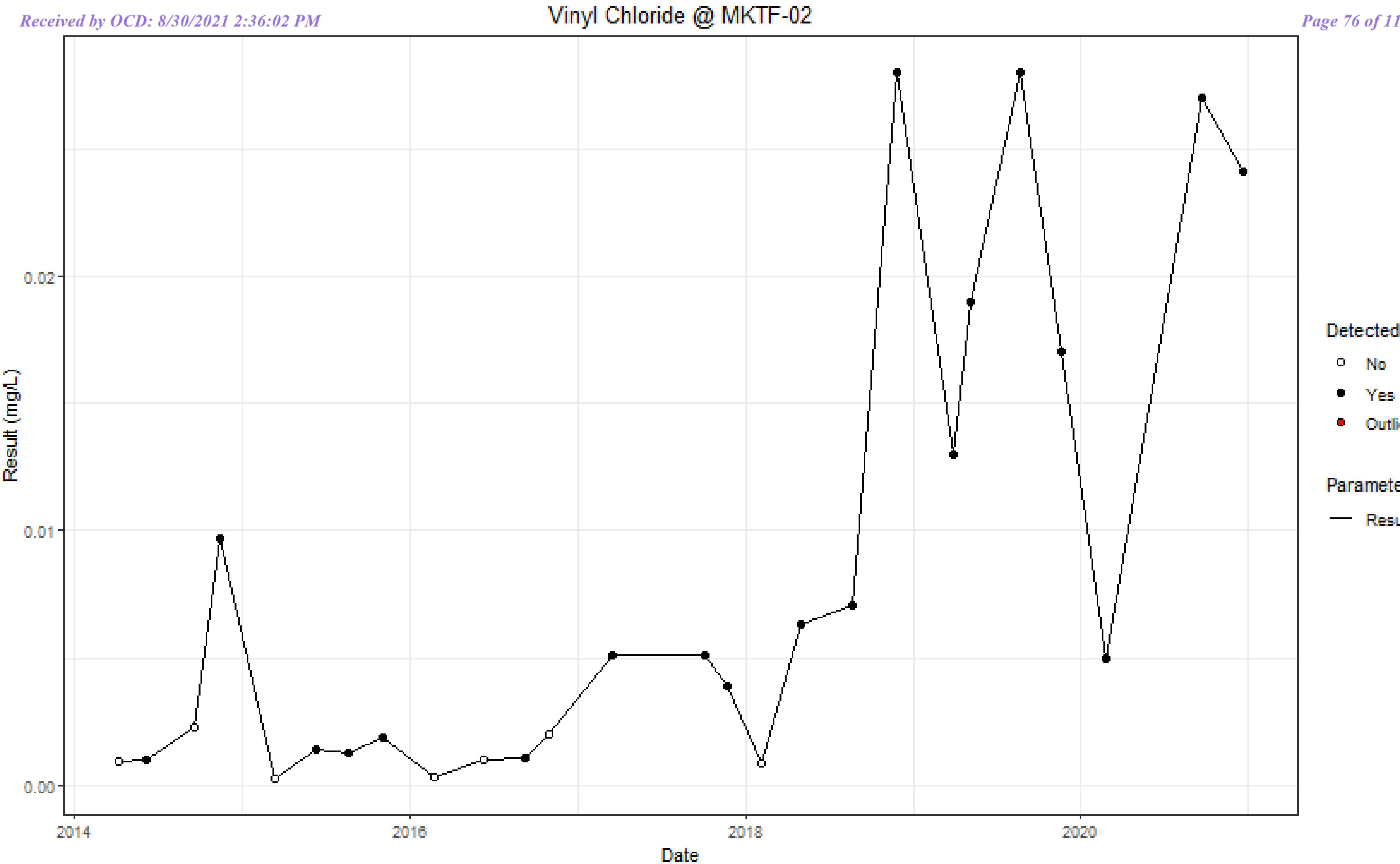


Trichloroethene @ MKTF-22
Result (mg/L)
0.005
0.004
0.003
0.002
0.001
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

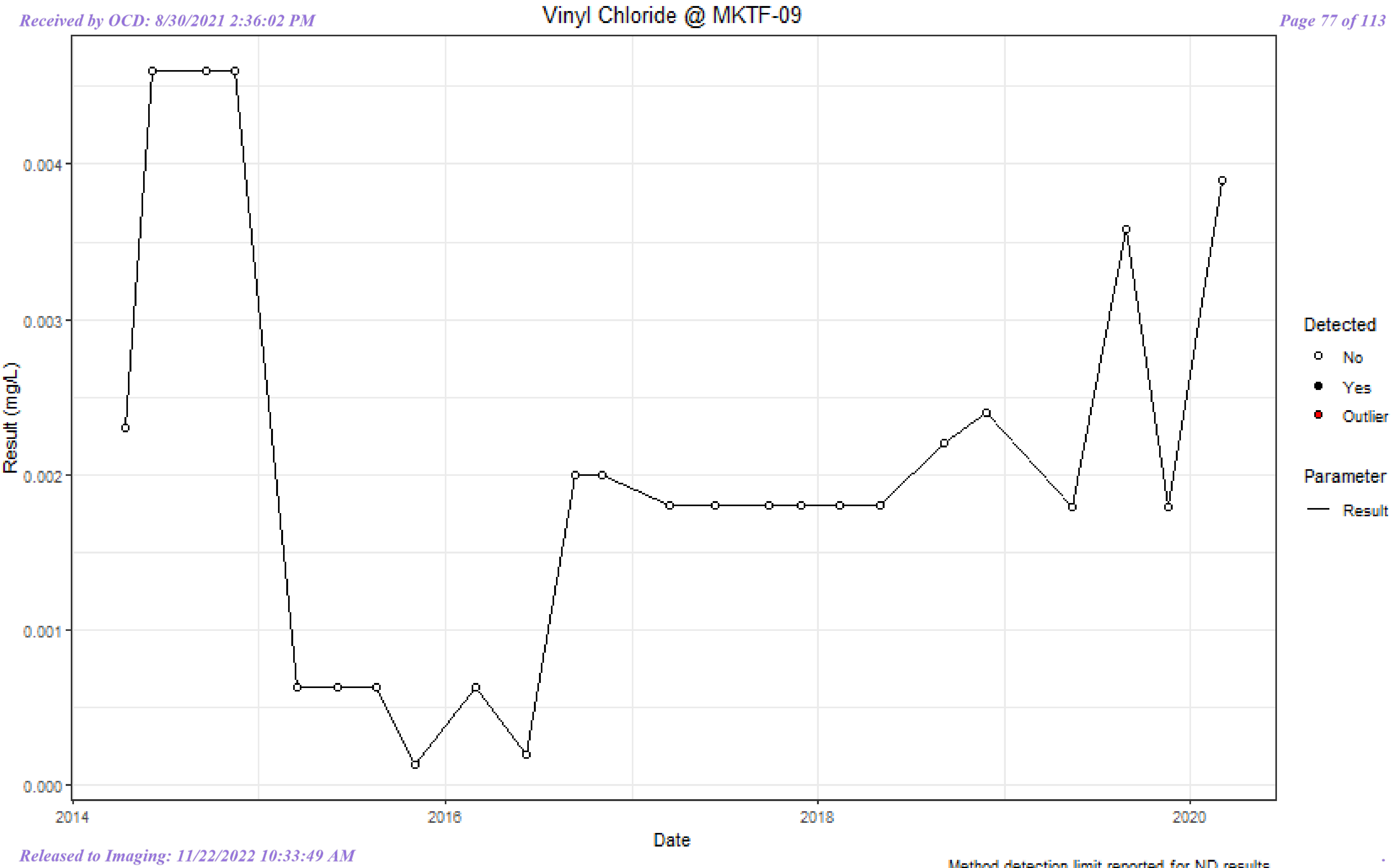

Trichloroethene @ MKTF-24
0.0125
0.0100
0.0075
0.0050
0.0025
Result (mg/L)
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

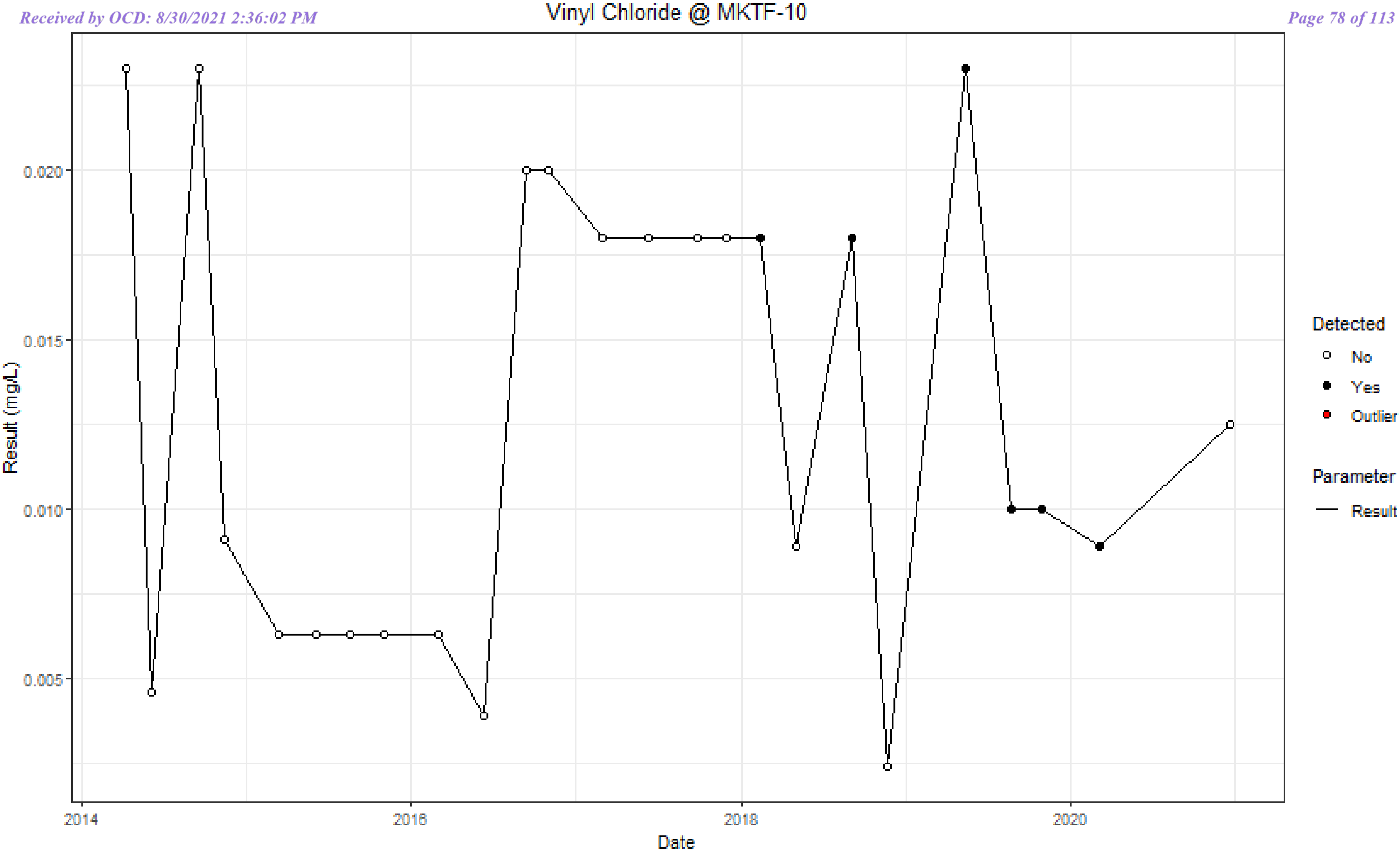


Method detection limit reported for ND results.

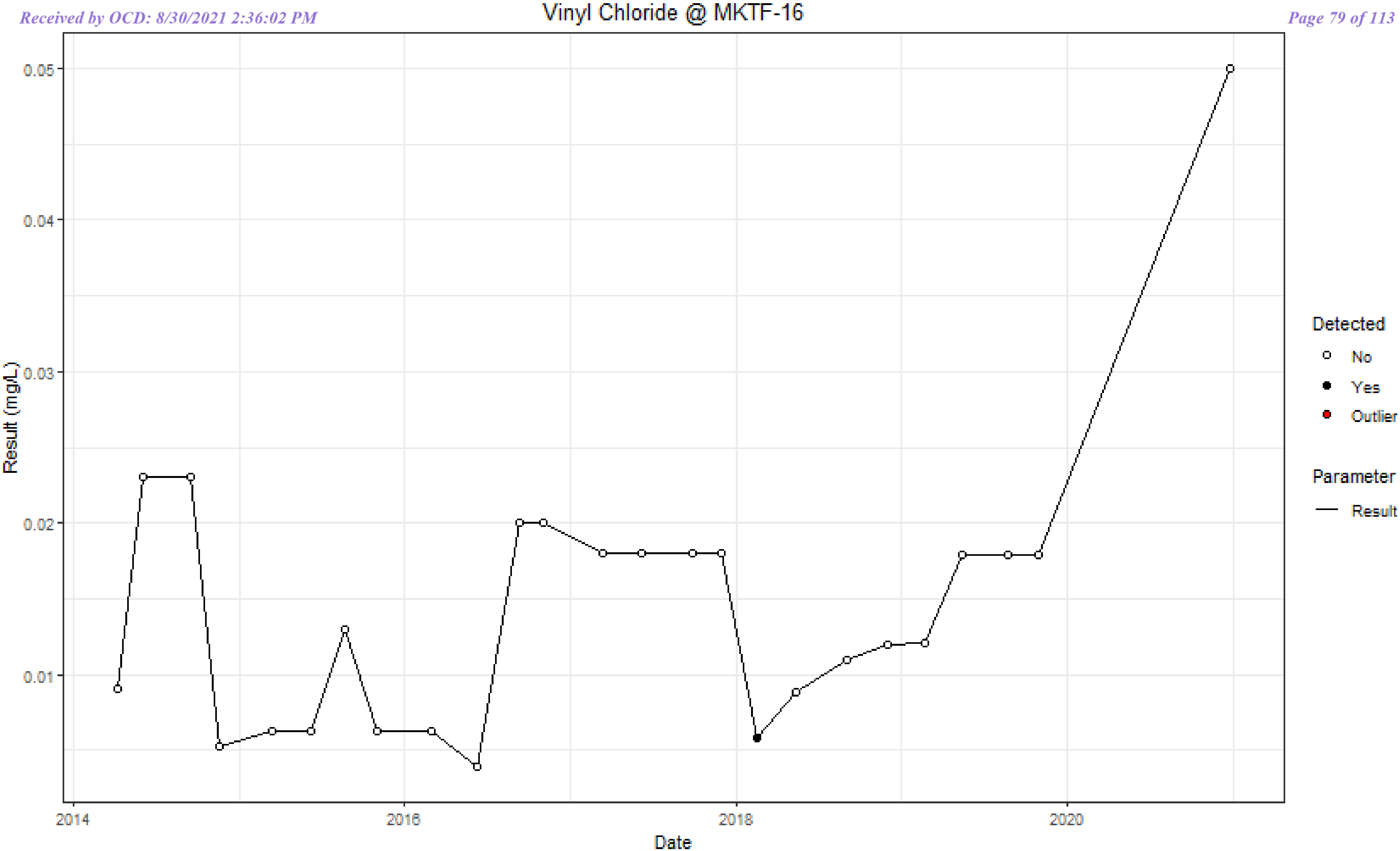


Method detection limit reported for ND results.

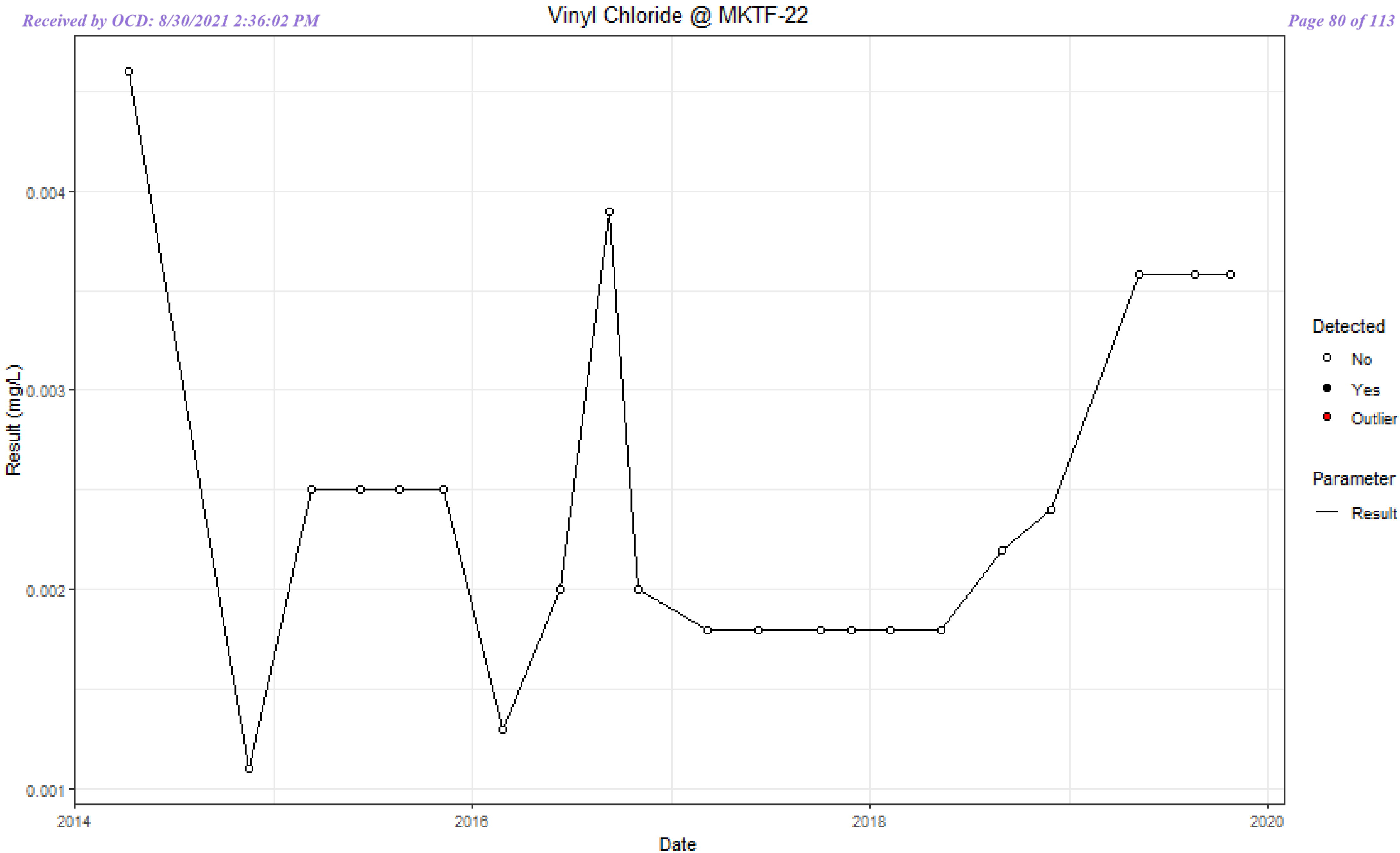

Vinyl Chloride @ MKTF-09
Result (mg/L)
0.000
0.001
0.002
0.003
0.004
Date
2014
2016
2018
2020
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.



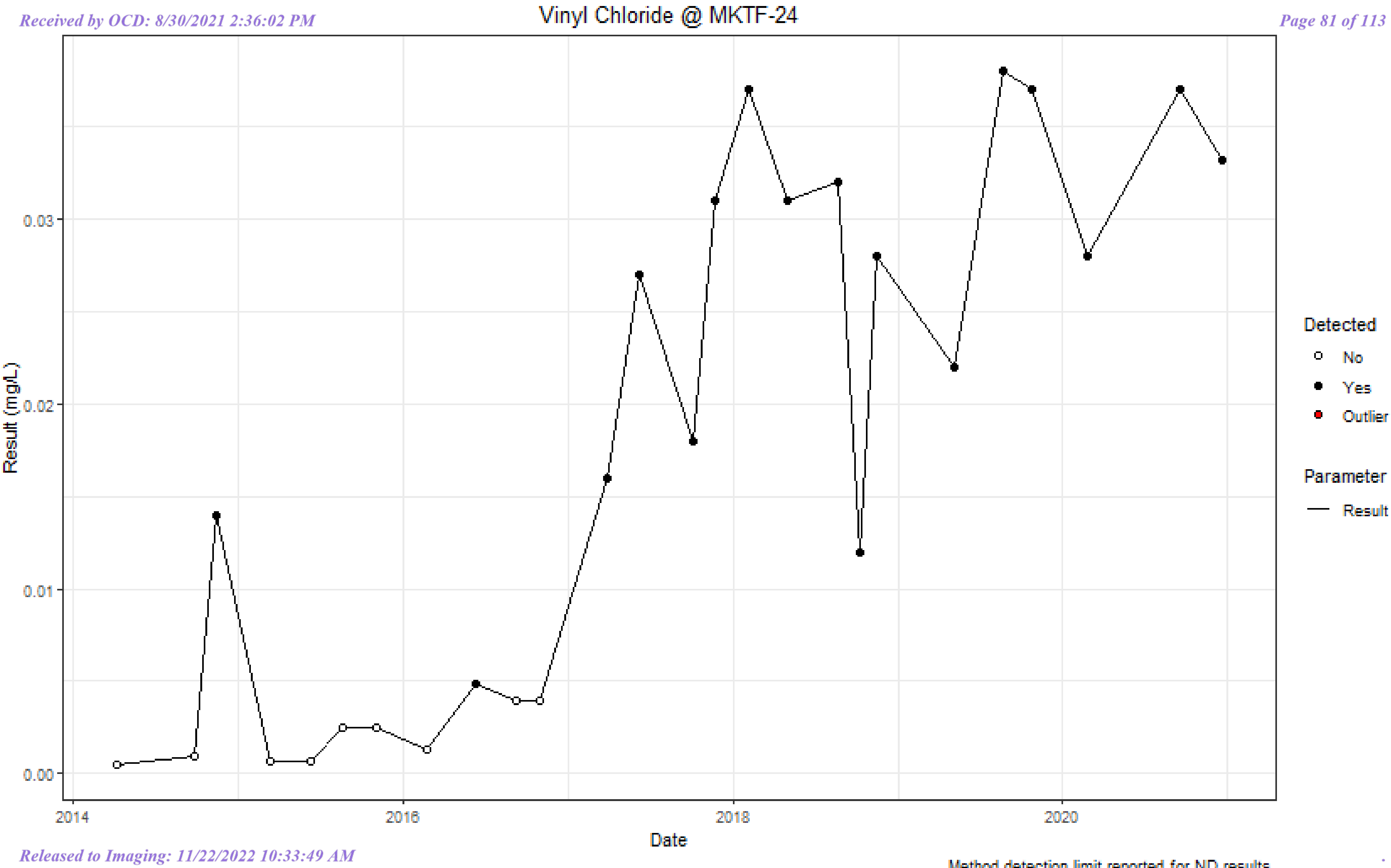
Method detection limit reported for ND results.

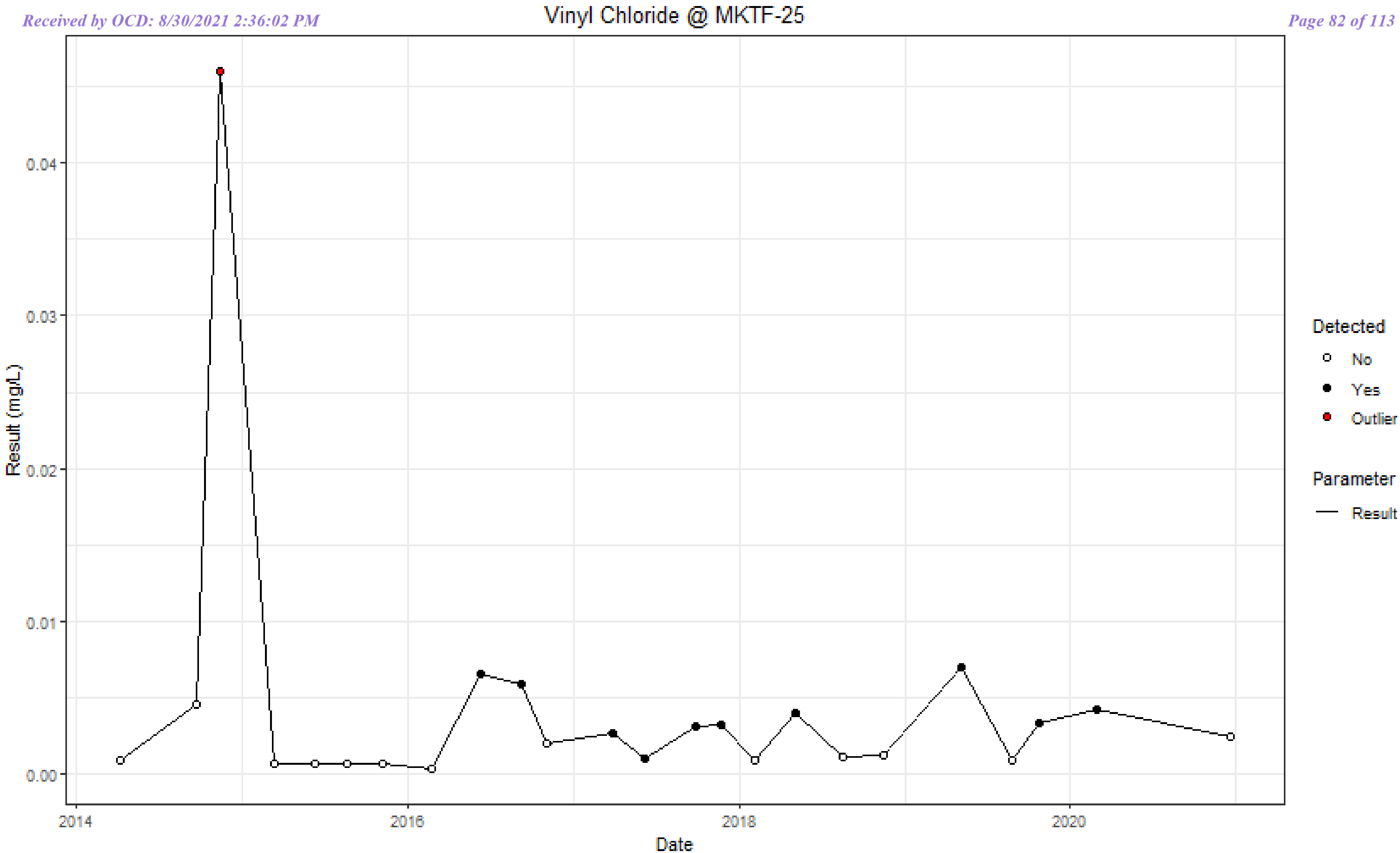


Method detection limit reported for ND results.



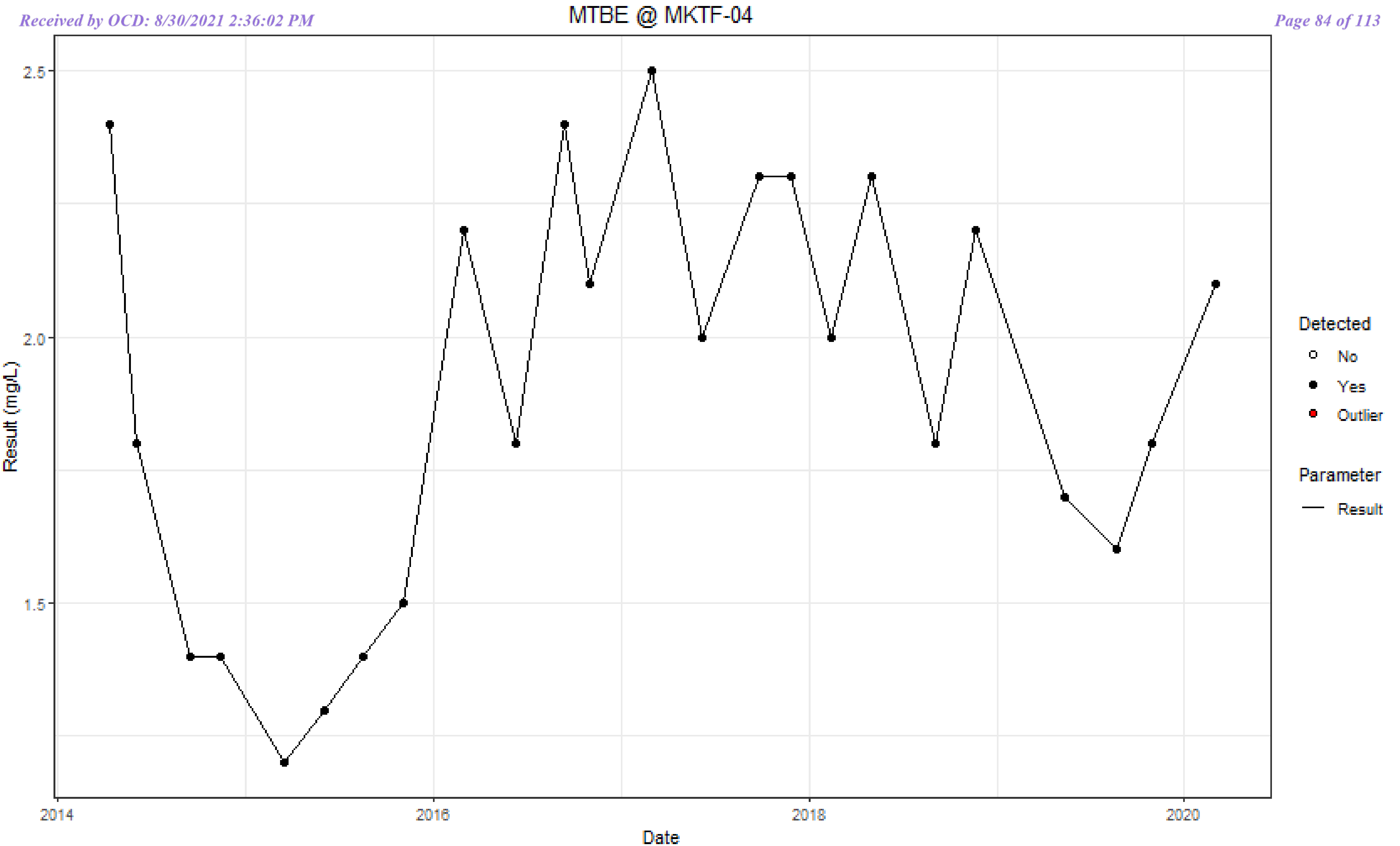
Method detection limit reported for ND results.


Vinyl Chloride @ MKTF-24
Result (mg/L)
0.00
0.01
0.02
0.03
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

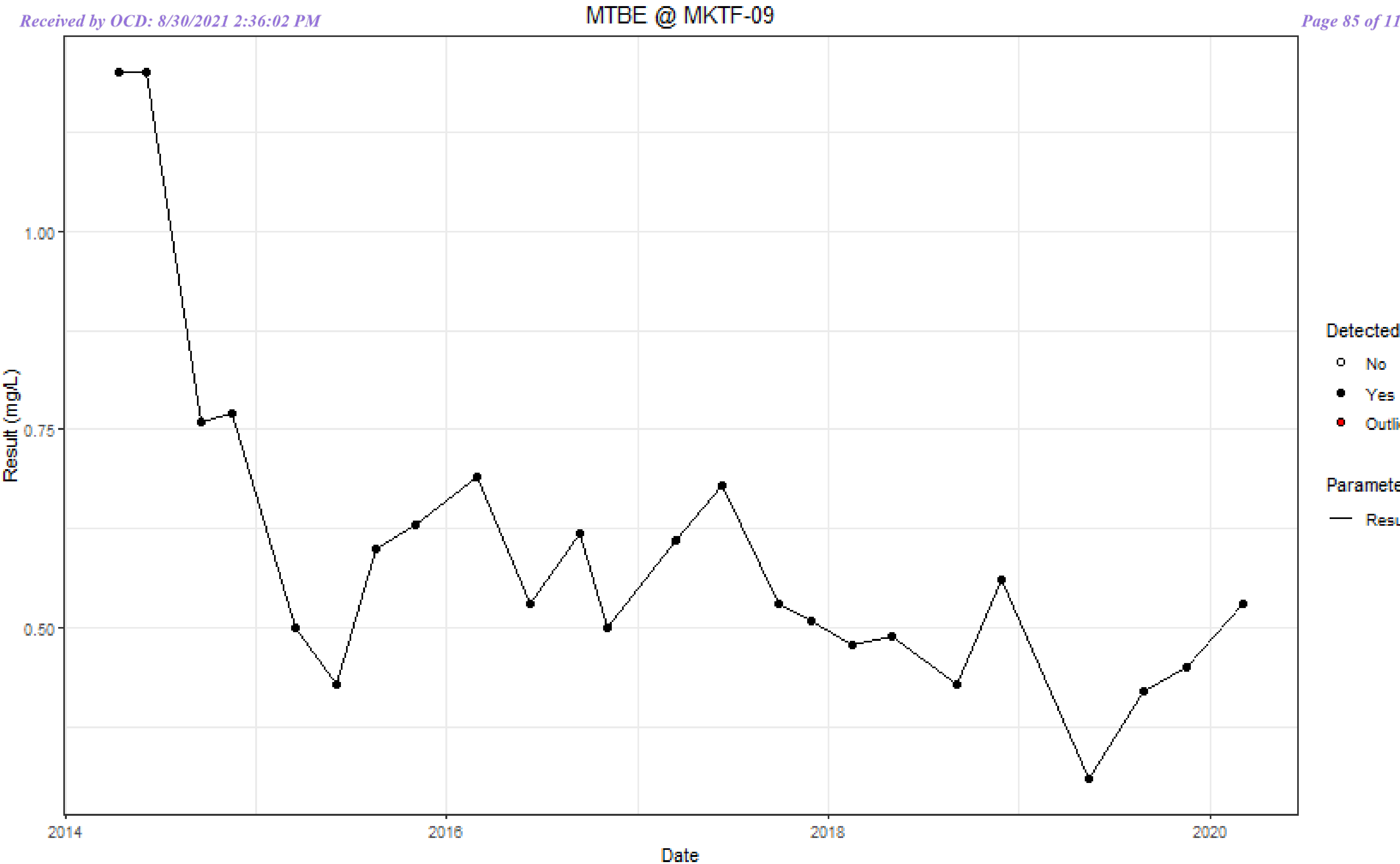


Method detection limit reported for ND results.

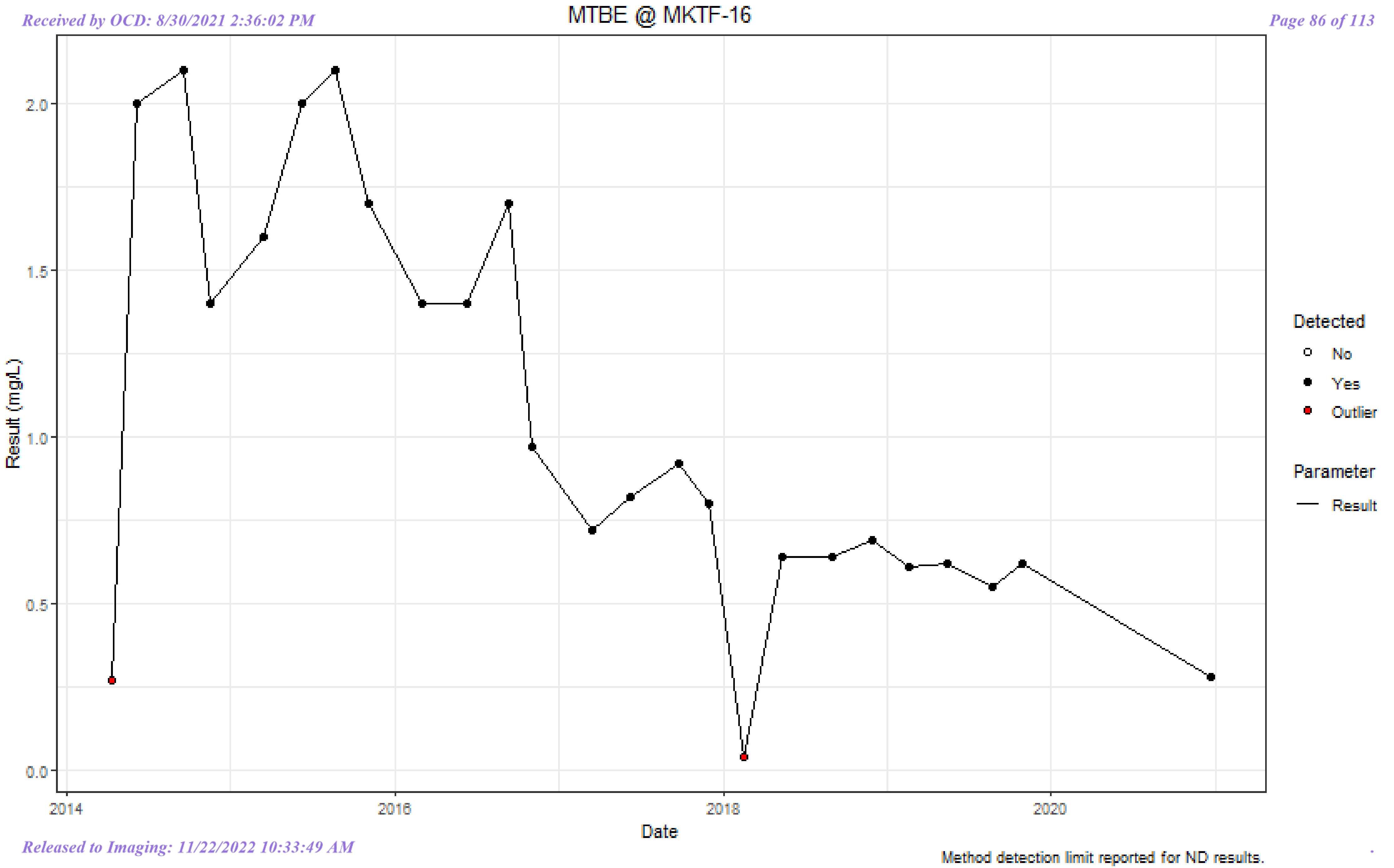
ATTACHMENT B – MTBE TIME SERIES PLOTS

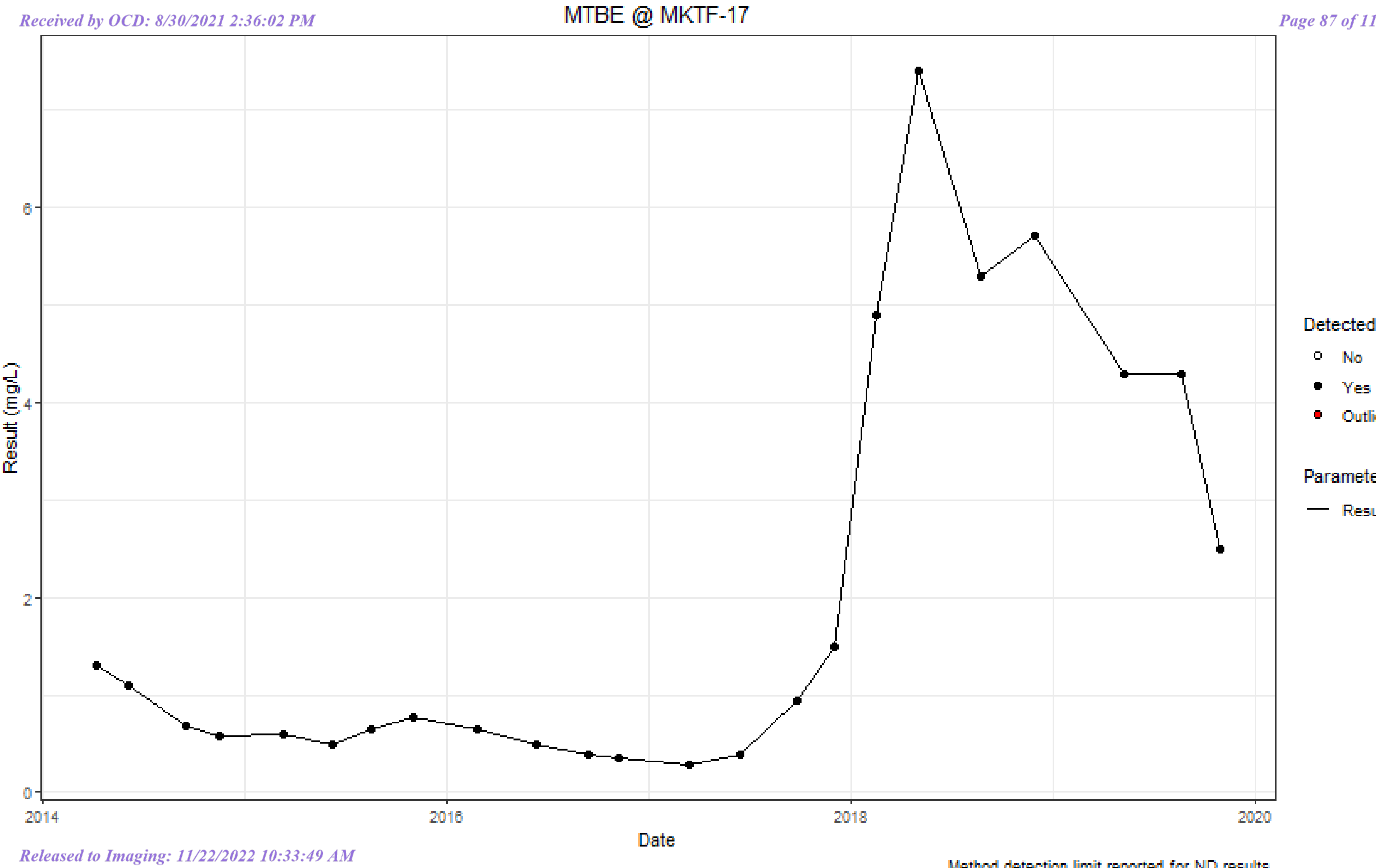


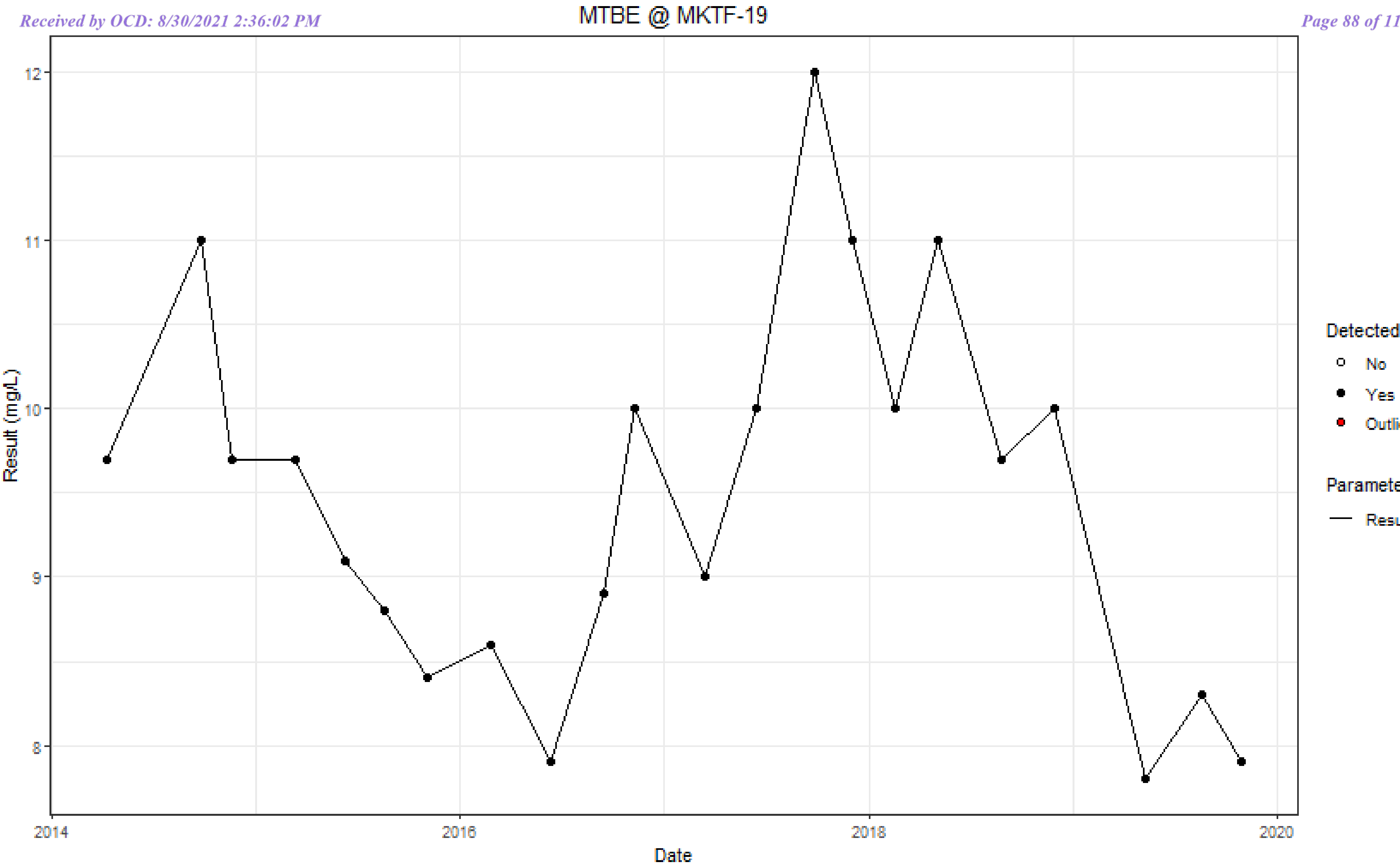
Method detection limit reported for ND results.



Method detection limit reported for ND results.


MTBE @ MKTF-16
Result (mg/L)
2.0
1.5
1.0
0.5
0.0
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.


MTBE @ MKTF-17
Result (mg/L)
0
2
4
6
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.



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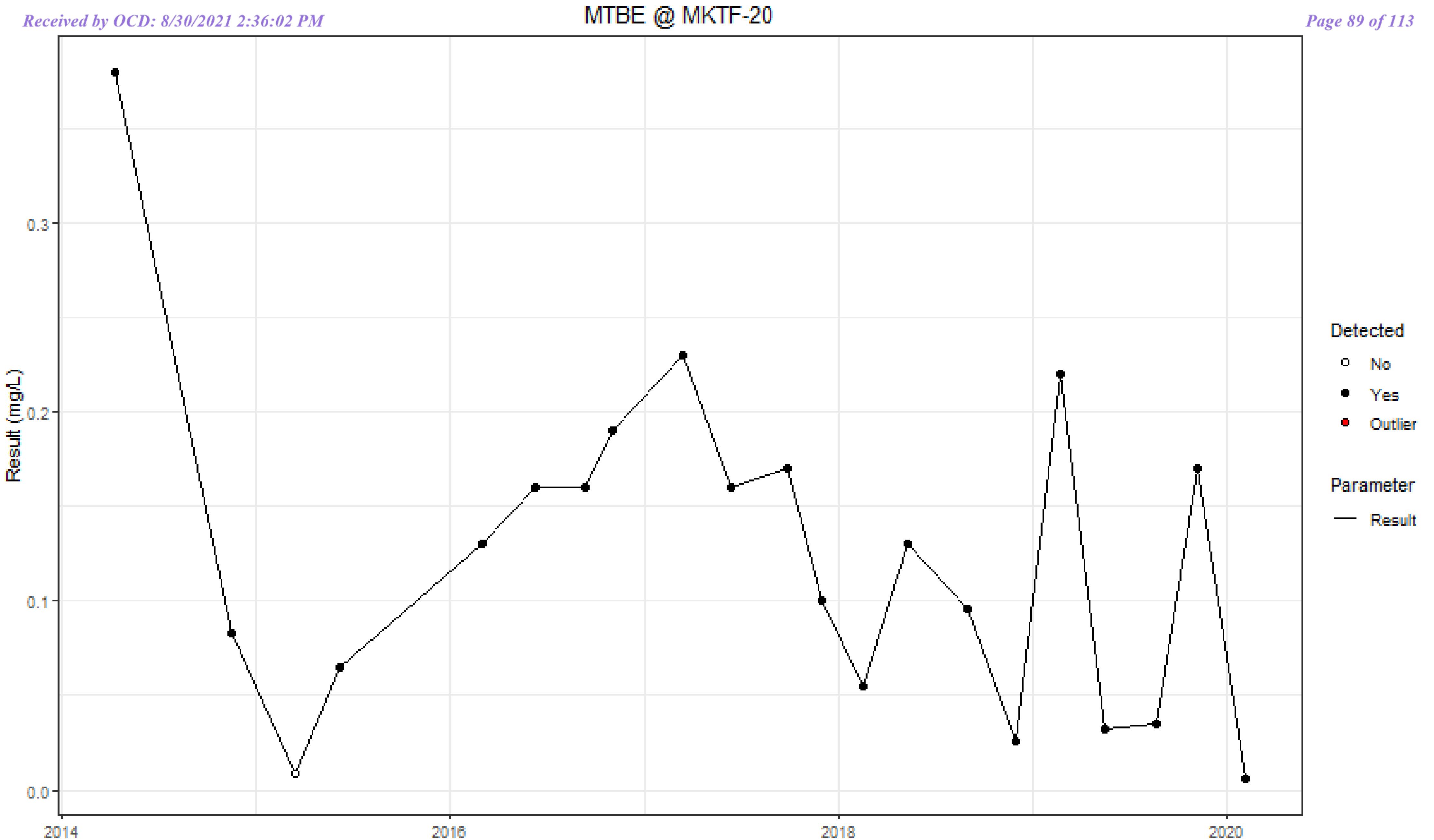

Method detection limit reported for ND results.

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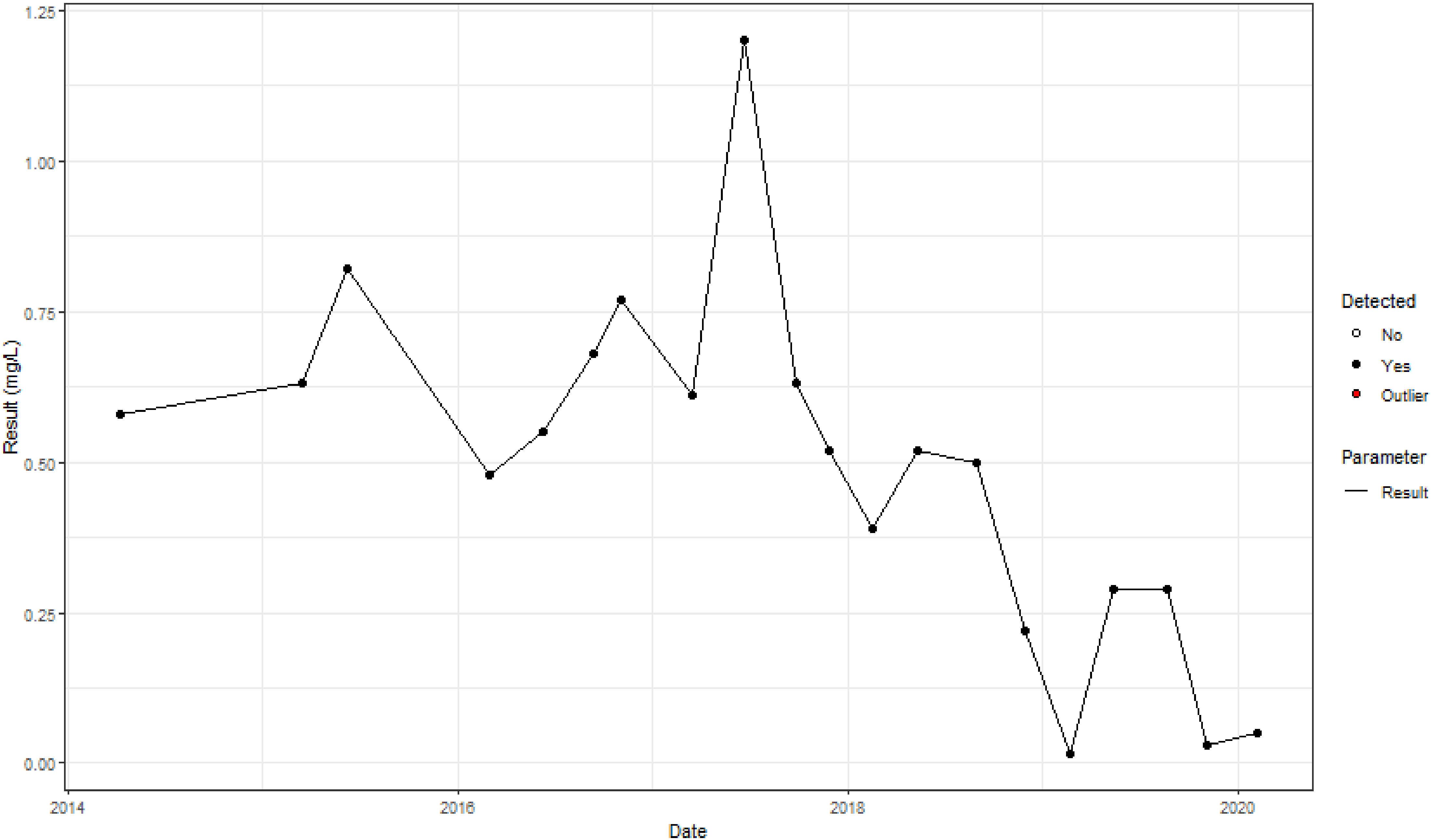
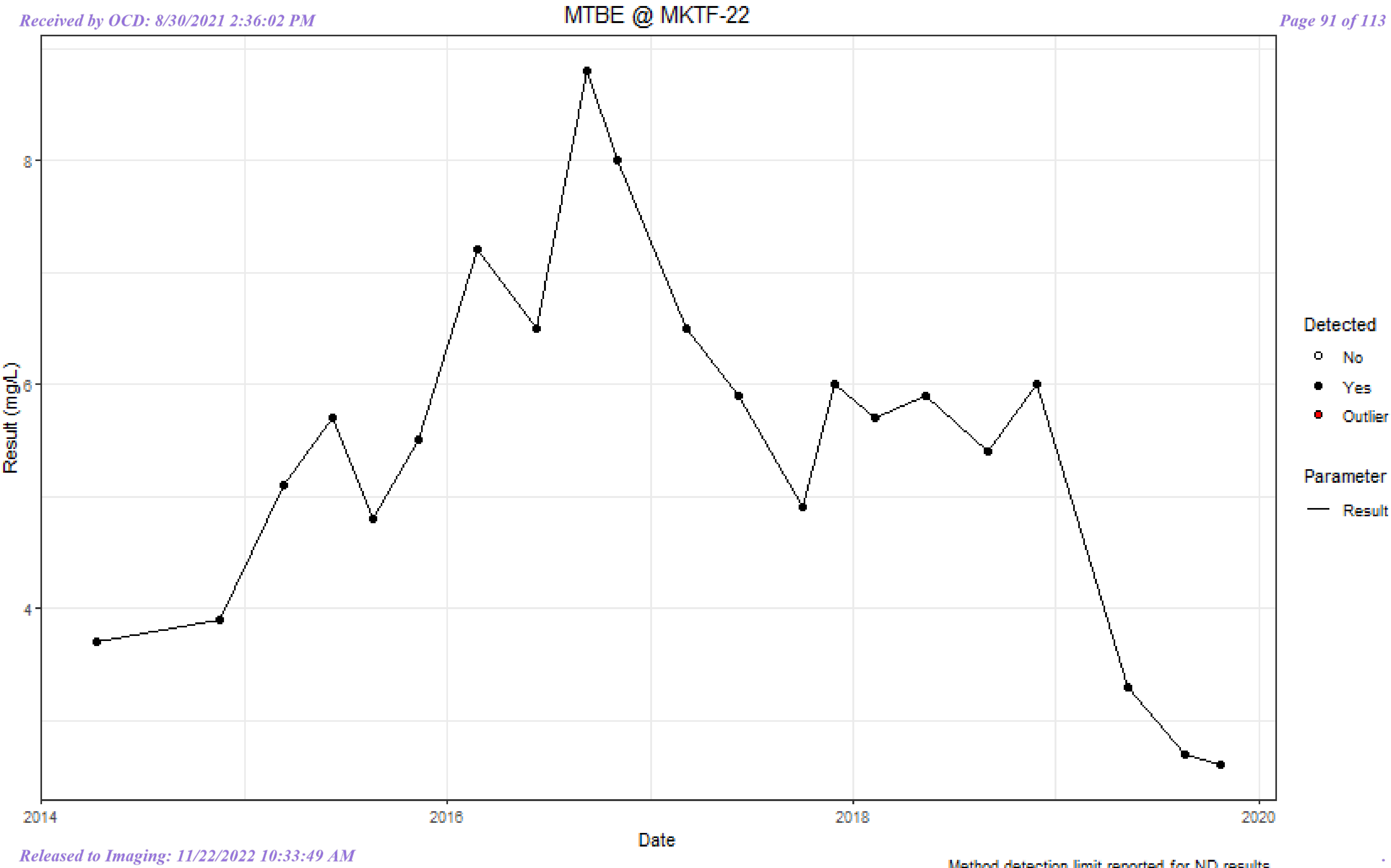
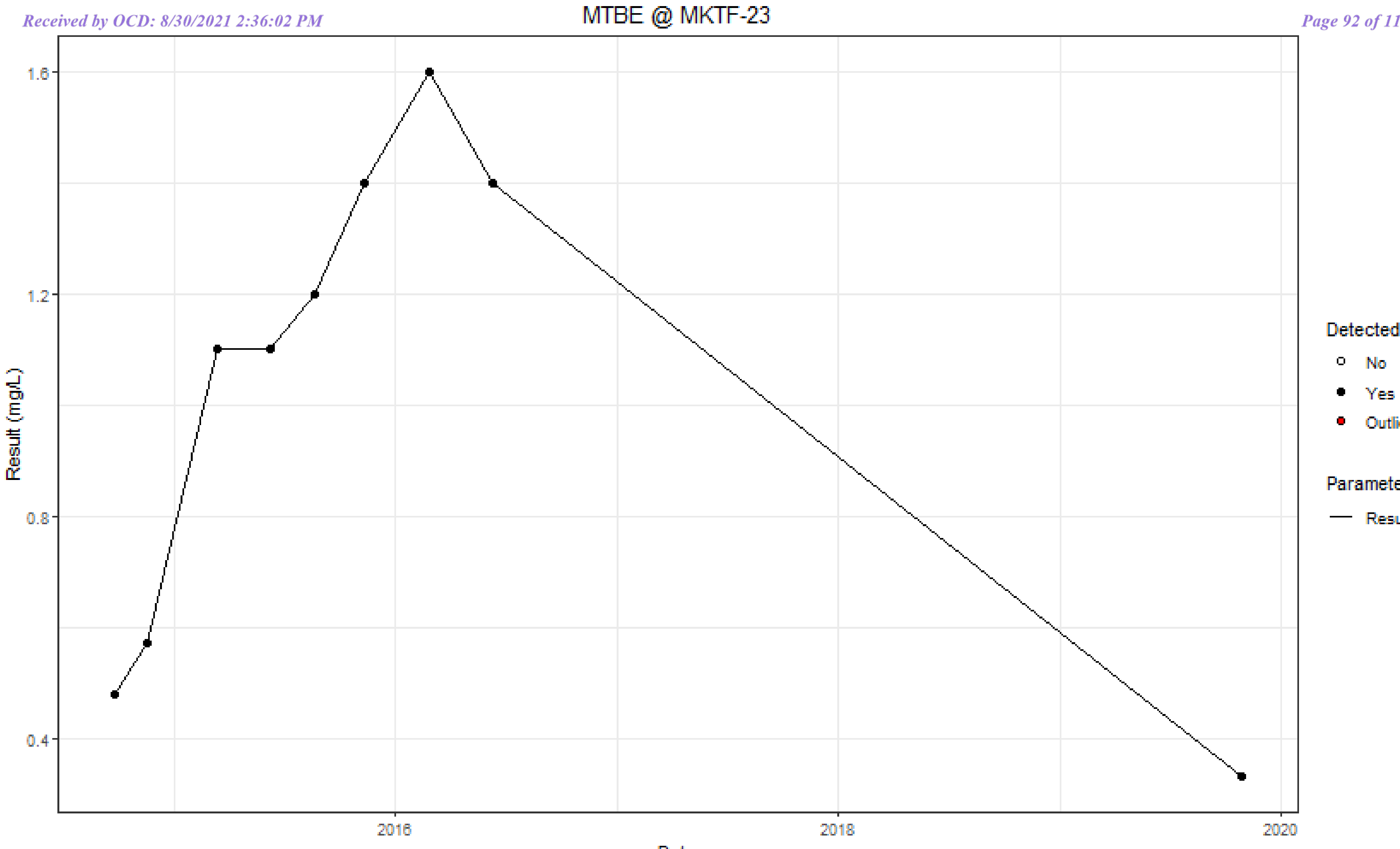
MTBE @ MKTF-21

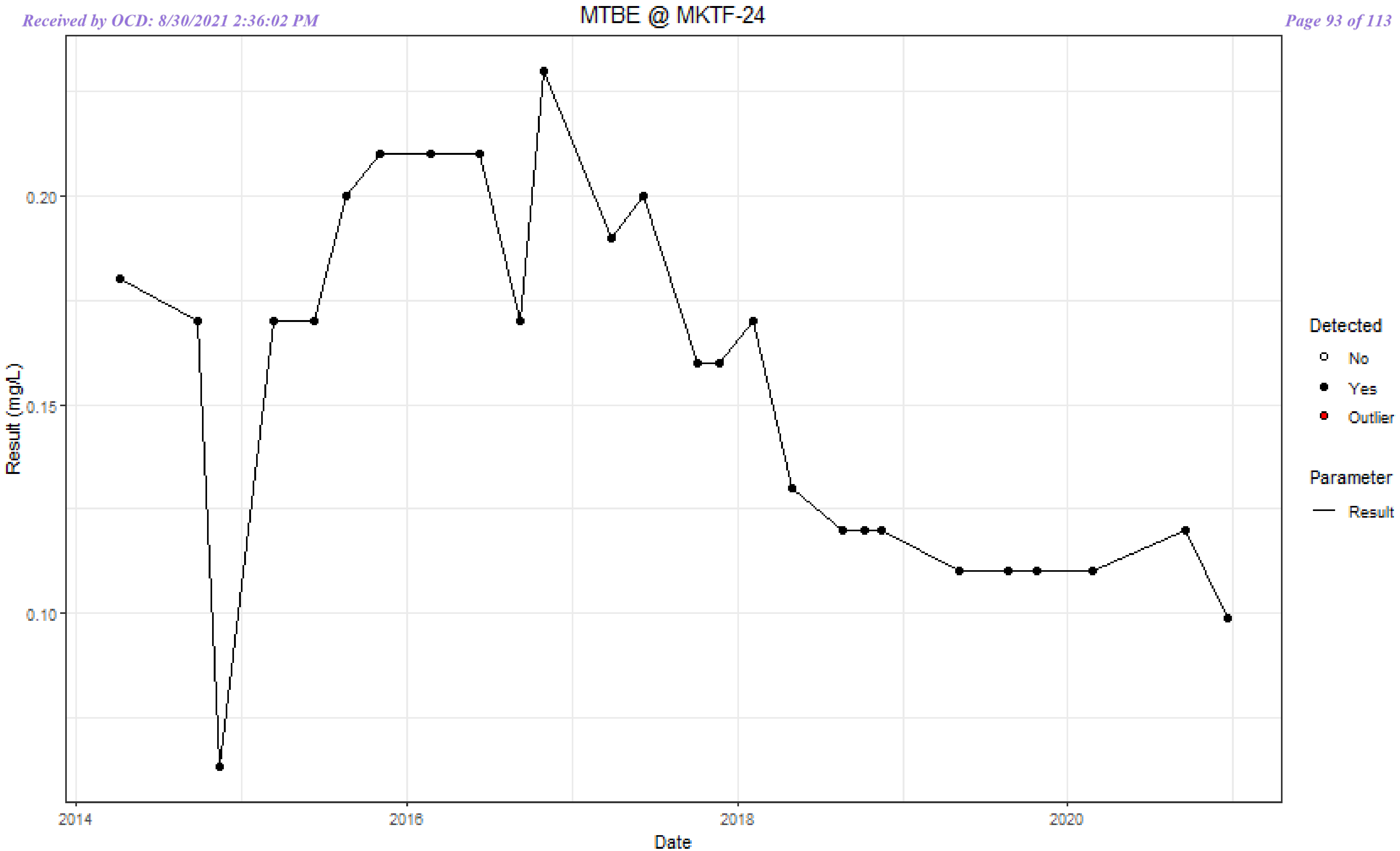


Method detection limit reported for ND results.

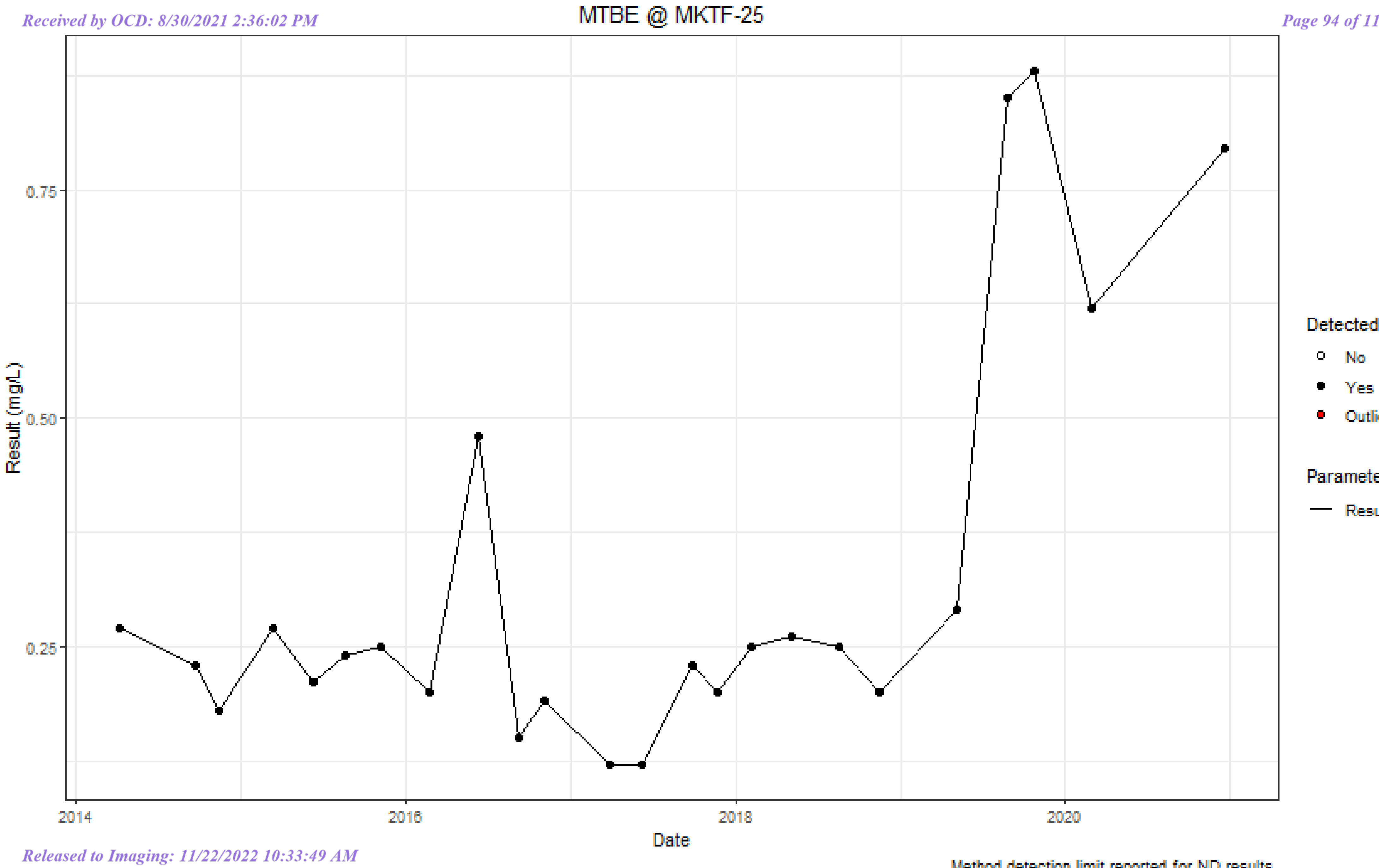

MTBE @ MKTF-22
Result (mg/L)
8
6
4
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.



Method detection limit reported for ND results.



Method detection limit reported for ND results.


MTBE @ MKTF-25
Result (mg/L)
0.75
0.50
0.25
2014
2016
2018
2020
Date
Detected
No
Yes
Outlier
Parameter
Result
Method detection limit reported for ND results.

ATTACHMENT 3

RED LINE/STRIKE OUT CHANGES

(PLEASE SEE ATTACHED CD)

Western Refining Southwest LLC
A subsidiary of Marathon Petroleum Corporation
I-40 Exit 39
Jamestown, NM 87347

~~December 15, 2020~~August 27, 2021

Mr. Kevin Pierard, Chief
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

RE: Revised Natural Attenuation Assessment and Proposed Workplan for the Hydrocarbon Seep Area
~~Marathon Petroleum Company, LP, Gallup Refinery~~Western Refining Southwest LLC, Gallup Refinery
(dba Western Refining Southwest, Inc.)
EPA ID# NMD000333211

Dear Mr. Pierard:

~~Marathon Petroleum Company LP, Gallup Refinery~~Western Refining Southwest LLC, Gallup Refinery (Refinery) ~~(MPC)~~ is submitting this letter in response to a request from the New Mexico Environment Department (NMED) Hazardous Waste Bureau for an assessment of natural attenuation in the hydrocarbon seep area at the Gallup refinery. This request was contained in a letter dated February 1, 2018, entitled *Disapproval, Interim Measures Report Hydrocarbon Seep Area, Western Refining Southwest Inc., Gallup Refinery, EPA ID# NMD000333211, HWB-WRG-15-002*~~.~~ and further defined in a letter dated January 26, 2021 entitled *Disapproval, Natural Attenuation Assessment and Proposed Work Plan for the Hydrocarbon Seep Area*. The area identified includes the Marketing Tank Farm area in the southwest portion of the refinery (Figure 1).

More specifically, the request is presented in NMED Comment 12, #2 ~~-~~through #5; relevant portions of which are excerpted as follows:

2. *The field analytical parameters such as dissolved oxygen concentration and oxidation-reduction potential (ORP) must be evaluated and presented to support the argument that reducing conditions and anaerobic degradation are occurring. Also, the ratio of total and dissolved iron concentrations must be examined to support the argument…*
3. *…Revise the Report to propose submittal of a work plan to investigate the occurrence of anaerobic dichlorination.*
4. *The accumulation of vinyl chloride may be occurring based on the site's groundwater conditions. In the plan referenced in Item 3 above, propose to monitor and evaluate the groundwater for analytical parameters pertinent to the accumulation of degradation of vinyl chloride (e.g., concentrations of daughter products, dissolved oxygen, chloride, redox potential and pH)…*

MARATHON

Western Refining Southwest LLC
A subsidiary of Marathon Petroleum Corporation
I-40 Exit 39
Jamestown, NM 87347

5. *The Permittee must evaluate for the occurrence of hydrocarbon and MTBE degradation (e.g~~.~~., concentrations of the electron acceptors, degradation byproducts, redox potential, and pH). Include all findings and interpretation of the existing data in the revised Report.*

Pursuant to the above request, this letter presents an evaluation of monitored natural attenuation (MNA) using existing monitoring well analytical data and proposes a workplan consisting of a similar evaluation of natural attenuation for future analyses~~, which~~. Findings would be included in ~~annual reports, pending NMED approval.~~an MNA evaluation report. Table 1 lists the monitoring wells within the area that were evaluated. The list consists of selected MKTF-designated wells within and hydraulically upgradient of the Hydrocarbon Seep Area. These wells contain chlorinated volatile organic compounds (CVOCs) above ~~standards~~ the NMED Groundwater Cleanup Levels (New Mexico Administrative Code 20.6.2.3103) and without separate phase hydrocarbon (SPH) observed in 2020.

Table 1 includes key analytical data collected between 2018 and 2020 for CVOCs, volatile organic compounds (VOC), methyl tert-butyl ether (MTBE), MNA indicator parameters, and relevant field parameters. These data are used to evaluate the potential for MNA in a procedure developed by the U.S. Environmental Protection Agency (USEPA) (1998). A more complete data set of laboratory analytical results from the period 2014 through 2020 is used for the statistical trend analysis (Attachments A and B). Figure 1 shows the location of these wells, and also the wells with SPH detected in the 3rd Quarter 2020 sampling event.

Background
The Hydrocarbon Seep area is located in the western portion of the refinery to the west-southwest of the refinery tank farm. Historically, the Hydrocarbon Seep Area has been impacted by releases of ~~petroleum hydrocarbons~~SPH associated with refinery operation. Hydrocarbon seeps were discovered in 2013~~; subsequent~~. Subsequent ~~Interim Measures activities identified the source, implemented source control measures, and characterized groundwater impacts.~~

~~Chlorinated hydrocarbons that have been~~CVOCs detected ~~above standards~~ as part of routine quarterly sampling in ~~the~~this area between 2014 and 2020 include trichloroethene (TCE), 1,1-dichloroethane (1,1-DCA), ~~and~~ 1,2-dichloroethane (1,2-DCA), 1,1-dichloroethene (1,1-DCE), tetrachloroethene (PCE), and vinyl chloride. ~~Methyl tert-butyl alcohol (~~ Monitoring wells with consistent detection of vinyl chloride are shown in Figure 1. VOCs detected above the NMED Groundwater Cleanup Level standards include benzene, toluene, ethylbenzene, and xylenes (BTEX), and MTBE. ~~MTBE) has also been detected above standards. The TCE and 1,1-DCA may be associated with past degreasing operations at the refinery machine shop; 1,2-DCA is a lead scavenger compound that historically have~~had ~~been used in hydrocarbon fuels. MTBE was used as a fuel oxygenator. Figure 2 presents the most recent quarterly groundwater sampling results (3rd quarter 2020) for these constituents and benzene from the Hydrocarbon Seep Area, including detections of separate-phase hydrocarbon (SPH), also referred to as light non-aqueous~~

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~~phase liquid (LNAPL).~~ Table 1 presents recent groundwater analytical data for monitoring wells in the Hydrocarbon Seep Area and nearby Marketing Tank Farm (MKTF) monitoring wells.

Hydrogeology
Surface Conditions
Site topographic features include high ground in the southeast gradually decreasing to a lowland fluvial plain to the northwest. Elevations on the refinery property range from 7,040 feet (ft) to 6,860 feet. Surface soils within most of the area of investigation are primarily Rehobeth silty clay loam. Rehobeth soil properties include alkaline pH (ranging from 8 to 9 standard units) and salinity (naturally occurring and typically measuring up to approximately 8 ~~mmhos/cm) (Marathon Petroleum Company~~millimhos per centimeter (MPC 2019).

Local surface water features include the refinery evaporation ponds and a number of small ponds (one cattle water pond and two small unnamed spring fed ponds). The site is located in the Puerco River Valley, north of the Zuni Uplift with overland flows directed northward to the tributaries of the Puerco River. The Puerco River continues to the west to the confluence with the Little Colorado River. The South Fork of the Puerco River is intermittent and retains flow only during and immediately following precipitation events (~~Marathon Petroleum Company~~MPC 2019).

Subsurface Conditions
The shallow subsurface soils consist of fluvial and alluvial deposits comprised of clay and silt with minor inter-bedded sand layers. Very low permeability bedrock (e.g., claystones and siltstones) underlie the surface soils and effectively form an aquitard. The Chinle Group, which is Upper Triassic, crops out over a large area on the southern margin of the San Juan Basin. The uppermost recognized local Formation is the Petrified Forest Formation and the Sonsela Sandstone Bed is the uppermost recognized regional aquifer (~~Marathon Petroleum Company~~MPC 2019). Aquifer test of the Sonsela Bed northeast of Prewitt indicated a transmissivity of greater than 100 ~~ft^2/~~ft squared per day (Stone and others, 1983). The Sonsela Sandstone's highest point occurs southeast of the site and slopes downward to the northwest as it passes under the refinery. The Sonsela Sandstone forms a water-bearing reservoir with artesian conditions throughout the central and western portions of the refinery property.

The diverse properties and complex, irregular stratigraphy of the surface soils across the site cause a wide range of hydraulic conductivity ranging from less than 10^{-2} centimeters per second (cm/sec) for gravel like sands immediately overlying the Petrified Forest Formation to 10^{-8} cm/sec in the clay soils located near the surface (Western~~,~~ 2009). Generally, shallow groundwater at the refinery follows the upper contact of the Petrified Forest Formation with prevailing flow from the southeast to the northwest.

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~~In the Hydrocarbon Seep Area, three~~Three-dimensional geological modeling using available boring log information strongly suggests that the swale in the area of the hydrocarbon seep area is underlain by a corresponding swale in the shallow alluvium that likely influences shallow groundwater flow in this area. This is shown in Figure ~~3~~2.

Monitored Natural Attenuation
MNA was assessed for this area following references published by the Interstate Technology Regulatory Council (ITRC) (1999), the USEPA (1998) and the New Jersey Department of Environmental Protection (NJDEP 2012).~~ as well as others.~~

Dissolved organic compounds can be degraded naturally in groundwater, with the rate dependent on the redox state of the groundwater and the presence of suitable electron receptors for microbial degradation (NJDEP 2012). Biodegradation under aerobic (oxidizing) conditions is generally faster than under anaerobic (reducing) conditions, but degradation occurs under both redox regimes.

In general, reducing conditions are present in the subsurface where ~~LNAPL~~SPH and dissolved ~~petroleum hydrocarbons~~organic compounds (e.g., CVOCs, BTEX) are present in groundwater. This has been established by numerous studies (ITRC 2009, Lawrence 2006, and NJDEP 2012~~),~~) and is generally recognized and accepted. This redox condition is caused by depletion of oxygen through aerobic biodegradation of the dissolved petroleum. A generalized diagram of typical hydrocarbon groundwater plume redox conditions is shown Figure ~~4~~3. When a release of hydrocarbons occurs into groundwater, existing microbes catalyze reactions between the electron-donating carbon and the electron acceptors, in a sequence that is most favorable to the microbes (ITRC 2010). In general, the sequence of electron acceptor use is as follows:

$$O_2 > NO_3^- > Mn(III) \text{ or } Mn(IV) > Fe(III) > SO_4^{-2} > CO_2$$

The presence of the oxidized inorganic compounds shown above indicates the potential for biodegradation. Moreover, the presence of the reduced forms of these species generally indicates active biodegradation.

The strongest reducing conditions are generally present in the source area of the hydrocarbon plume where ~~LNAPL~~SPH is present. More oxidizing (less reducing) conditions are generally present in the downgradient direction of the dissolved hydrocarbon plume, as shown in Figure 4. Figure 4 also shows the areas of the plume where redox conditions are sufficient to allow reduction of the indicated species.

~~Chlorinated organic compounds~~CVOCs generally require anaerobic conditions for biodegradation. Figure ~~5~~4 presents a list of ~~chlorinated organic compounds~~CVOCs and the likelihood of biodegradation through various degradation mechanisms/pathways. As shown in

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this figure, the primary mechanisms for biodegradation ~~is~~are reductive dechlorination and ~~dichlorination.~~ dichloroelimination.

~~More recent S~~Studies of MTBE aerobic biodegradation indicate that it is less recalcitrant than previously thought (Lawrence 2006). Anaerobic biodegradation proceeds more slowly under reducing conditions ranging from methanogenic to nitrate-reducing.

Evaluation of Current MNA Conditions

Table 1 presents recent (2018 to 2020) groundwater analytical data from ~~MKTF~~the hydrocarbon seep area wells, including ~~key~~ organic and inorganic analytes, dissolved oxygen (DO), temperature, and ~~pH. Table 2 presents~~ oxidation reduction potential (ORP~~) field data~~). This date range was selected to represent current conditions for the analysis of the key MNA parameters. A trend analysis was also conducted using data from ~~quarterly sampling from quarters 1, 3~~the period 2014 through 2020 and ~~4~~is presented in ~~2016 (Western 2017). The second quarter~~Attachments A and B (CVOCs and MTBE, respectively).

Table 1 includes laboratory analytical data ~~were not available.~~ and field data collected during well purging, including temperature, pH, DO, and ORP. Field ~~measurement~~measurements of DO and ORP can be an indicator of the redox regime of groundwater, with the method of field measurement important to the absolute value of the results. Field pH/ORP is measured using a silver/silver chloride reference electrode. In general, for more accurate measurements of DO/ORP, a groundwater sampling pump and a flow-through cell for well purging and measuring DO/ORP is preferred because this configuration eliminates contact with air. For the DO/ORP data presented in Table ~~2~~ 1, measurements were conducted using bailed water from a well, which was then placed into a container for ORP measurement. This procedure introduces oxygen, and actual in situ groundwater conditions would be expected to have a lower, more reducing DO/ORP. Nevertheless, the data in Table 1 can be evaluated in a relative sense for trends.

~~Current~~*Evaluation for CVOCs*

Qualitatively, current conditions and available geochemical data provide evidence that reducing conditions are present in the Hydrocarbon Seep Area. These reducing conditions create a geochemical environment for the anaerobic biodegradation of ~~petroleum hydrocarbons~~SPH and dissolved VOCs and may also be conducive to the anaerobic biodegradation of ~~chlorinated hydrocarbons~~ CVOCs (TCE, 1,1-DCA and 1,2-DCA~~.~~) (USEPA 1998).

Evidence for conditions favorable for anaerobic biodegradation of ~~chlorinated compounds~~CVOCs includes:

- Elevated benzene concentrations~~,~~ indicating that a high dissolved hydrocarbon load is present and anaerobic conditions are ~~likely~~occurring. ~~LNAPL~~SPH is also present in several areas (Figure 1~~)~~), which represents a continuing source for dissolved phase hydrocarbons.

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- Detection of vinyl chloride, 1,1-DCE and cis-1,2-DCE, which ~~is typically a byproduct~~are typical byproducts of TCE degradation. Vinyl chloride was detected consistently in monitoring wells MKTF-2, MKTF-10, MKTF-24, and MKTF-25, as shown in Figure 1.
- Presence of dissolved iron and total iron, indicating likely presence of ferrous iron in response to reducing conditions and anaerobic biodegradation
- Depleted sulfate in wells with elevated benzene (e.g., MKTF-10, MKTF-16, MKTF-17), indicating reducing condition and sulfate reduction to sulfite as part of anaerobic biodegradation.
- Presence of manganese, indicating availability as an electron receptor for anaerobic biodegradation.
- Occasional detection of nitrite above detection limits, indicating reducing conditions and probable use of nitrate as an electron receptor for anaerobic biodegradation.
- ~~Given the evidence for reducing conditions presented above, anaerobic degradation of MTBE is more likely than aerobic degradation~~
- Neutral to slightly basic pH conditions ~~appear~~, which are favorable for biodegradation.
- Low ORP measurements ~~indicate~~, indicating reducing conditions are present~~,~~ particularly for MKTF wells located in the paved areas where ~~LNAPL (separate phase hydrocarbon [~~SPH~~])~~ is present (~~see~~ Figure 1). Wells located to the west in unpaved areas without ~~LNAPL~~SPH and elevated dissolved hydrocarbon such as benzene are generally oxidizing.

Chloride concentrations are generally elevated in the MKTF wells, as shown in Table 1, but do not correlate with areas of elevated ~~chlorinated organic compounds.~~CVOCs. In the absence of high chloride from other sources, elevated chloride can be used as an indicator of the biodegradation of ~~chlorinated compounds~~CVOCs (NJDEP 2012).

MNA Scoring Criteria

~~To date, insufficient monitoring well analytical data is available to perform a statistical analysis of concentration trends. As more date become available, contaminant trend plots can be developed and statistical analysis can be performed.~~

From a more quantitative standpoint, an evaluation was conducted on a well-by-well basis in accordance with USEPA guidance (USEPA 1998). Table 2 presents the scoring criteria from the USEPA and the applicability of the criteria to the Hydrocarbon Seep Area, given the analytical requirements of the existing approved Sampling Plan (MPC 2021) and current field sampling practices. Table 3 shows the implementation of the scoring for each well, and presents the final evaluation score for each well, which summarizes the potential for CVOC natural attenuation (reductive dichlorination). Four categories of scores assess the potential for anaerobic biodegradation of CVOCs, as follows:

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- > 20 Strong evidence
- 15 to 20 Adequate evidence
- 6 to 14 Limited evidence
- 0 to 5 Inadequate evidence.

As shown in Table 3, the evidentiary scores ranged from 7 to 16, with nine wells deemed "Limited" category and one well deemed "Adequate."

Statistical Analyses

Statistical analyses were performed to determine if the analytical data results from the current monitoring period represent statistical upward or downward trends in analyte concentrations in the groundwater samples collected from MKTF-designated wells.

Statistical Methods

QAQC and Data Handling

Trace concentrations (estimated results between the reporting limit [RL] and the method detection limit [MDL]) reported since 06/08/2016 were treated as true detected values. Therefore, being the upper bound of non-detect (ND) results, the MDL was used as substitute values for ND values in all statistical evaluations, unless stated otherwise (see Exploratory Data Analysis and General Statistics section). R® (R Core Team, 2020), a programing language and software environment for statistical analysis, was used for all statistical needs.

The statistical evaluation was performed for six chlorinated volatile organic compounds (CVOCs; 1,1-Dichloroethane, 1,1-Dichloroethene, 1,2-Dichloroethane, cis-1,2-Dichloroethene, Trichloroethene, and Vinyl Chloride) and methyl tert-butyl ether (MTBE). All constituents were reported in mg/L. Seven wells for CVOCs (i.e., MKTF-02, MKTF-09, MKTF-10, MKTF-16, MKTF-2, MKTF-24, MKTF-25) and 11 wells for MTBE (i.e. MKTF-04, MKTF-09, MKTF-16, MKTF-17, MKTF-19, MKTF-20, MKTF-21, MKTF-22, MKTF-23, MKTF-24, MKTF-25) were part of the 2020 evaluation.

Exploratory Data Analysis and General Statistics

Exploratory Data Analysis (EDA) was performed on all well-analyte combinations and are presented in Table 4 and Table 5, for the CVOCs and MTBE respectively. For each analyte-location pair, these statistics include the number of samples collected since April 8, 2014, the overall detection rate, the minimum and maximum detected concentrations, the minimum and maximum MDLs reported by laboratories, the overall sample mean, median, and sample standard deviation, and the dates of the range of the first and last sample.

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Time Series Plots and Outlier Analysis

Outlier analysis was performed at a 95% confidence level using the Dixon's and Grubbs' tests when the sample size for each analyte-location pair, *n*, was more than 4 but less than 30, with at least one detected result. If the sample size was greater than 25, then the Rosner's test was used instead of or in addition to the two tests mentioned above and up to 3 potential outliers were considered. Because outlier tests' assumptions are often difficult to attain with real data, and the presence of one outlier can mask the detection of another, any extreme and unusual values flagged as outliers by any of the outlier tests (e.g., concentration 3 times greater or 1/3 smaller than the overall concentration) were graphically confirmed using time series plots. The last results were never considered an outlier regardless of their value since they could be the results of a recent event. Results from the outlier analysis are also presented in Table 4 (CVOCs) and Table 5 (MTBE).

For each analyte-location pair, time series plots were constructed to show any potential trend in CVOCs and MTBE. In addition, any graphically confirmed outliers were also shown on the time series plots (Attachments A [CVOCs] and B [MTBE]).

Nonparametric Trend Analysis

Non-parametric trend analysis was conducted for all analyte-location pairs with a sample size equal to or greater than 8 (not including graphically confirmed outliers) and one detected result above the MDL to assess the temporal stationarity of the constituents' concentrations through time. To avoid trends in the MDLs driving the trend analysis results, the USEPA (2009) recommends ND values be assigned "a common value lower than any of the detected measurements" (USEPA 2009, Section 17.3.2 p. 17-31). ND values were assigned half of the minimum MDLs in each location for all analyses related to the trend analysis. Trend analyses were performed using the nonparametric approach, Mann-Kendall's monotonic trend analysis. Traditional Mann-Kendall trend analysis relies on several assumptions such as no serial correlation, no outliers, and no seasonality. The presence of serial correlation was tested for each location using the rank von Neumann ratio test at 95% confidence level and the results were graphically confirmed using Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). The presence of outliers in the data was addressed during the outlier analysis described above. Seasonal effects between the Summer-Fall (May to October) and Winter-Spring (November to April) sampling events were tested using Wilcoxon-Mann-Whitney tests at a 90% confidence level. The assumption of homogeneity of variance between the two seasons for the Wilcoxon tests for each COC-well combination was performed using the traditional Levene's test. In the absence of both serial autocorrelation and seasonal effect, the traditional Mann-Kendall trend analysis test was used. When serial correlation was identified, a modified

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Mann-Kendall test for serially correlated data using the Yue and Wang (Yue, 2004) variance correction approach was used. When seasonality was present in the data, a standard seasonal Mann-Kendall test, which performs a nonparametric test for a monotonic trend within each season based on Kendall's tau statistic, was used. Finally, if the presence of both serial correlation and seasonality in the data was confirmed the seasonal Mann-Kendall approach was adapted to handle serial correlation. Results from all trend analyses for the CVOC are presented in Table 4 and for MTBE in Table 5.

Results

COVCs

Nonparametric monotonic increasing trends were identified since 2014 for the following analyte-well pairs with 95% confidence (Table 4):

- 1,1-Dichloroethene in wells MKTF-10 and MKTF-22
- Vinyl Chloride in wells MKTF-02, MKTF-10, MKTF-24

In addition, evidence of decreasing monotonic trends since 2014 was found, with 95% confidence, for 1,1-Dichloroethane, 1,1-Dichloroethene, cis-1,2-Dichloroethene, and Trichloroethene in wells MKTF-02, MKTF-09, MKTF-24, and MKTF-25.

All other analyte-well pairs showed no evidence of an overall trend since 2014 at a 95% confidence level.

MTBE

The Mann-Kendall (MK) trend analysis test found no evidence of monotonic increasing trends since 2014 for MTBE in the 11 wells with 95% confidence (Table 5). Recent changes in MTBE in well MKTF-17 and MKTF-25 will be monitored moving forward (see time series plot in Attachment B).

In addition, evidence of decreasing monotonic trends since 2014 was found, with 95% confidence, for MTBE in wells MKTF-09, MKTF-16, MKTF-21, and MKTF-24.

All other analyte-well pairs showed no evidence of an overall trend since 2014 at a 95% confidence level.

Proposed Workplan for Natural Attenuation Evaluation for Future Annual Reports

The proposed workplan to evaluate natural attenuation is presented in this section for NMED review and approval. ~~MPC~~The Refinery proposes that a natural attenuation evaluation ~~section~~ be

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completed on an annual basis using the existing quarterly sampling analyte list ~~as shown in~~ (Table ~~3~~6) as lines of evidence. These lines of evidence will include:

- ~~Benzene~~BTEX, MTBE, tertiary butyl alcohol (TBA), PCE, TCE, cis-1,2- DCE, 1,1-DCE, 1,1-DCA, 1,2-DCA, ~~TCE,~~ and vinyl chloride ~~analytical results~~concentrations
- ~~Inorganic analyses including dissolved/total analyses for~~ Ethene analysis will be conducted in four monitoring wells with elevated vinyl chloride concentrations (MKTF-2, MKTF-10, MKTF-24, and MKTF-25)
- Dissolved/total iron and manganese, nitrate/~~nitrate, pH~~nitrite, and sulfate/sulfide to determine their availability as terminal electron receptors and the redox state~~. A table of the results will be prepared.~~
- Field ~~measurements conducted during quarterly sampling and well purging (pH, ORP and dissolved oxygen)~~parameters such as pH, temperature, ORP, and DO pH, temperature, ORP, and DO

~~As more~~

The ~~data become available, and trends become evident, a Mann-Kendall statistical analysis will be performed to quantify contaminant concentration trends.~~

~~Tables will be added to~~evaluation in future ~~annual~~MNA reports ~~with~~ will include data tables summarizing these analytes, updating the USEPA quantitative spreadsheet scoring the MNA potential, and ~~a new~~updating the MK statistical trend analysis for CVOCs and MTBE. A discussion section will be added ~~to present these key data and to summarize~~summarizing natural attenuation progress, including trends in contaminant concentrations and key MNA indicators. ~~MPC expects to initiate this the year following NMED approval~~The MNA evaluation will be submitted to NMED in a letter report. Reports will be submitted on March 31 of each year starting in 2022.

If you have any questions or comments regarding the information contained herein, please do not hesitate to contact Mr. John Moore at (505) 879-7643.

Certification

I certify under penalty of law that this document and all attachments were prepared under my direction of supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Western Refining Southwest LLC, Marathon Gallup Refinery

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Ruth Cade
Vice-President

Attachments

cc: D. Cobrain, NMED HWB
M. Suzuki, NMED HWB
T. McDill, NMOCD
L. King, EPA Region 6
G. McCartney, Marathon Petroleum Corporation
K. Luka, Marathon Petroleum Corporation
J. Moore, Marathon Gallup Refinery
H. Jones, Trihydro Corporation

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Tables

Figures

ATTACHMENT A – CVOC TIME SERIES PLOTS

ATTACHMENT B – MTBE TIME SERIES PLOTS

District I
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Phone:(575) 393-6161 Fax:(575) 393-0720
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Phone:(505) 476-3470 Fax:(505) 476-3462

State of New Mexico
Energy, Minerals and Natural Resources
Oil Conservation Division
1220 S. St Francis Dr.
Santa Fe, NM 87505

CONDITIONS

Action 45280

CONDITIONS

Operator:	
Western Refining Southwest LLC 539 South Main Street Findlay, OH 45840	OGRID: 267595
	Action Number: 45280
	Action Type: [UF-DP] Discharge Permit (DISCHARGE PERMIT)

CONDITIONS

Created By	Condition	Condition Date
jburdine	Accepted for Record Retention Purposes-Only	11/22/2022