

Guidance for 1200-C Construction Stormwater Discharge Permit pH and Turbidity Monitoring Conditions

DEQ Quality Assurance Guidance

February 2021

Laboratory and Environmental Assessment Division

7202 NE Evergreen Pkwy
Suite 150
Hillsboro, OR 97124
Phone: 503-693-5700
Fax: 503-693-4999
www.oregon.gov/DEQ

DEQ is a leader in restoring,
maintaining and enhancing
the quality of Oregon's air,
land and water.



State of Oregon
Department of
Environmental
Quality

Last Updated: 02/12/21
DEQ21-LAB-0007-QAG
Version 1.0

Construction Stormwater Discharge Permit Monitoring

This guidance document was prepared by:

Oregon Department of Environmental Quality
7202 NE Evergreen Pkwy, Suite 150
Hillsboro, OR 97124
1-503-693-5700
www.oregon.gov/deq

Contact:
Chris Moore
(503) 693-5700

Documents can be provided upon request in an alternate format for individuals with disabilities or in a language other than English for people with limited English skills. To request a document in another format or language, call DEQ in Portland at 503-229-5696, or toll-free in Oregon at 1-800-452-4011, ext. 5696; or email deqinfo@deq.state.or.us.

Table of Contents

1.0	Scope and Application	1
2.0	Useful Resources	1
3.0	Documentation Requirements.....	1
3.1	Procedures	1
4.0	pH.....	3
4.1	Monitoring of sedimentation Ponds and Discharge Points	3
4.2	Approved Methods	3
4.3	Meter Specifications	3
4.4	Electrodes	4
4.5	Analytical Checks.....	4
4.6	Monitoring the pH of stormwater captured in sediment basins/impoundments when engineered soils are used	4
5.0	Turbidity.....	5
5.1	Sample Collection, Preservation, and Holding Time.....	5
5.2	Approved Methods	5
5.3	Equipment Requirements.....	5
5.4	Analytical Checks and Measurement.....	6
5.5	General Effluent Limitations to Meet Applicable Instream Water Quality Standards.....	6
6.0	Reporting of Results.....	7
7.0	Statistical Measures	7

List of Figures

Figure 1	Precision Control Chart as a function of range or RPD	12
----------	---	----

List of Appendices

Appendix A	Procedure for Calculating Method Precision	8
Appendix B	Control Charting	12
Appendix C	Example Continuing Calibration Verification (CCV) Field Sheet.....	13
Appendix D	Example Data Field Sheet.....	15

1.0 Scope and Application

This guidance document is intended to provide assistance to self monitoring performed by permit registrants applicable to 1200-C Construction Stormwater Discharge Permit requirements in *Standard Methods for the Analysis of Water and Wastewater* and EPA requirements in 40 CFR Part 136. **This document does not supersede DEQ stormwater discharge permit conditions. The information is provided for information purposes only.**

This guidance is not intended to be used as guidance for compliance under national safe drinking water regulations (e.g. 40 CFR Part 141) nor as guidance for routine groundwater or surface water monitoring.

This guidance document is provided by DEQ as a summary of some of the basic method requirements and should not be considered a complete list of requirements. Registrants required to monitor any pollutant parameter should be familiar with the requirements of the basic analytical methodologies. **DEQ used the analytical methods and federal regulations as reference while preparing this document. In case of a discrepancy, the actual content of regulations and analytical referenced methods will supersede this document.**

2.0 Useful Resources

- Code of Federal Regulations: <https://www.ecfr.gov>
 - Test Methods: 40 CFR [136.3](#)
 - Alternate Test Procedure: 40 CFR [136.5](#)
 - Method Modifications: 40 CFR [136.6](#)
 - Quality Assurance Quality Control: 40 CFR [136.7](#)
- USEPA Handbook for the Analytical Quality Control In Water and Wastewater Laboratories (1979): <https://www.epa.gov/sites/production/files/2015-06/documents/QCHandbook.pdf>
- USEPA NPDES Compliance Inspection Manual (2004): https://www.epa.gov/sites/production/files/2013-09/documents/npdesinspect_0.pdf
- USEPA – 2017 Method Update Rule: <https://www.epa.gov/cwa-methods/methods-update-rule-2017>

3.0 Documentation Requirements

3.1 Procedures

Registrants should create a procedure manual that includes all the Standard Operating Procedures (SOPs) used for their self-monitoring program. The facility's SOPs should cover sampling, equipment calibration and maintenance, analytical methods, quality control activities and laboratory data handling (if necessary), documentation and reporting. Facility SOPs should include enough detail to use this document as a training manual for new employees.

3.1.1. Sampling Procedures

- a) Monitoring schedules for parameters specified in permit and/or other tests not covered in permit, but are used to determine site performance.
- b) Monitoring locations.
- c) Sample types:

- a. Samples must be used for the parameters pH and turbidity.

3.1.2. Facilities and Equipment

- a) Operating instructions for equipment, which outline proper calibration procedures to be followed whenever equipment is used.
- b) Maintenance schedules for equipment, which indicate what type of maintenance is to be performed should be followed whenever equipment is used.
- c) Cleaning procedures to be followed for each type of equipment used by the permit holder.
- d) Instructions for ordering chemicals and reagents used by the registrant, dating of all chemicals when received and opened, and preparation of laboratory reagents. Reagents or standards should be labeled for identity, concentration, date prepared, expiration date and preparers initials.
- e) An adequate supply of reagent water is required. Water must be free of the analyte tested and of interferences. Water may come from distilled/deionized, distilled, or Reverse-Osmosis systems.

3.1.3. Acceptable Methods

All methods that are referenced in 40 CFR part 136.3 are acceptable for reporting to Oregon DEQ unless otherwise specified. The references to *Standard Methods*¹ in 40 CFR 136.3 have changed to simply reference the year the method was adopted rather than referencing the multiple editions that contain a given method. The change was made so EPA would not have to continue adding all of the *Standard Method* Editions in the CFR.

Where a registrant wants to utilize a new method or technology that is not listed in 40 CFR part 136.3, they may apply directly to EPA Region 10 for an Alternate Testing Procedure (ATP) approval. The Approval must be submitted to the permit inspector once obtained.

EPA published the final 2017 Method Update Rule in the Federal Register on 8/28/2017 with an effective date of 9/27/2017. All references to Standard Methods will be from the 22nd or 23rd editions or Standard Methods on-line (almost all approved inorganic chemistry methods were updated in 2011).

3.1.4. Analytical Procedures

- a) Standard Operating Procedures (SOPs) should be written outlining the monitoring procedures to be followed by all personnel. The SOPs should conform to EPA approved methods contained in Standard Methods, ASTM, EPA Methods, or other methods listed in 40 CFR part 136.3. The SOP contains all specific instructions from monitoring of sedimentation ponds and discharge points to calibration and Quality Control (QC) procedures. SOPs should reference the approved method from which they were developed and describe the monitoring procedure as it is performed.
 - a. **Note:** as an Option to a formal written procedure, if the registrant follows the referenced method to the letter, another written document is not necessary or the

¹ Refers to the compendium method book *Standard Methods for the Examination of Water and Wastewater*, published by the American Water Works Association (AWWA) and Water Environment Federation (WEF). For more information see <https://www.standardmethods.org/>

laboratory may list their specific variances from the method and attach this to a copy of the referenced method as their written procedure.

- b) Methods which deviate from the approved method must be demonstrated to be applicable by documenting that results obtained are comparable to those obtained using the approved method.
- c) The Department of Environmental Quality and EPA must approve all nonstandard methods in writing.

Method Reference	Description
ASTM	American Society for Testing and Materials (ASTM), Consensus Standard Organization – www.astm.org
AOAC	Association of Analytical Communities, International (AOAC) “ <i>Official Methods of Analysis of the Association of Analytical Chemists, Methods Manual</i> , Sixteenth Edition, 4 th Revision 1998 www.aoac.org
USGS	Unites States Geologic Survey (USGS) <i>Methods for Analysis of Inorganic Substances is Water and Fluvial Sediments</i> , Book 5 1989 www.usgs.gov
Standard Methods	American Waterworks Association, Water Environment Federation – <i>Standard Methods for the Analysis of Water and Wastewater</i> . www.standardmethods.org

4.0 pH

4.1 Monitoring of sedimentation Ponds and Discharge Points

Monitoring is to be performed at locations specified in permits. Insert monitoring instrucment in the center of the channel at 40% - 60% of the channel depth where flow is turbulent and well mixed, and the settling of solids is minimal. If a grab sample is collected, it must be analyzed immediately in the field (within ~ 15 minute).

4.2 Approved Methods

Standard Methods 4500-H+ B-2011 (Current editions 22nd, 23rd, On-Line)

Or alterntively

- a) **ASTM** D1293-99
- b) **USGS** I-1586-85
- c) **AOAC** 973.41

Electrometric

4.3 Meter Specifications

- a) Desirable Performance Characteristics:
 - Accuracy: 0.05 SU
 - Scale Divisions: 0.1 SU
 - Temperature Compensation: either manual or automatic
 - Slope adjustment ability required.

4.4 Electrodes

A wide variety of pH electrodes are available. Generally a rugged full-range glass or plastic-bodied combination electrode is a good choice.

Calibrate the pH meter according to the manufacturer's specifications.

4.5 Analytical Checks

- a) Electrodes should be stored in distilled water or buffer between uses, as recommended by the manufacturer.
- b) Uncover fill hole in electrode before use.
- c) Meter should be calibrated before each use by performing a 2-point standardization with pH 7 and either pH 4 or 10 buffer. Calibrations must be documented in the meter logbook and the CCV form (Appendix C). The buffers used should bracket the pH of the samples. Test the third buffer using it as a QC check. Record the QC but do not adjust the calibration with the third buffer.
- d) The sample temperature should be recorded when pH is measured. pH readings should be normalized to 25°C. Most pH meters have built in temperature compensation, if not you will have to manually adjust the meter during calibration.
- e) The time required to obtain a stable reading is dependent on the electrode and whether the sample is being stirred during measurement. A rule of thumb would be at least 1 minute to obtain a stable reading.

4.6 Monitoring the pH of stormwater captured in sediment basins/impoundments when engineered soils are used

If construction activity involves the use of engineered soils (soil amendments including, but not limited to Portland cement-treated base, cement kiln dust, or fly ash), the registrant must conduct and document pH monitoring of stormwater captured in the sediment impoundment as described below:

- a) The registrant must begin the pH monitoring period when the engineered soils are first exposed to precipitation and must continue every 7 calendar days and within 24 hours of the occurrence of discharge from the site, or the occurrence of a storm event of 0.10 inches or greater until final stabilization of the area of engineered soils is established (see Section 2.2.21).
- b) Document the date when soil amendments were added and final stabilization achieved in the inspection Report per Section 6.5.
- c) The registrant must monitor the pH of stormwater in the sediment basins/impoundments and at discharge locations that receive stormwater runoff from the area where engineered soils were used before the stormwater discharges to surface waters.
- d) The benchmark value for pH is defined in Standard Units (su), and determined by the river basin containing the receiving waterbody according to OAR 340-041-0021. Anytime monitoring indicates that the pH of the site's stormwater is the maximum allowed su or greater, the registrant must either:
 - i. Prevent the high pH water from entering storm sewer systems or surface waters;
or

- ii. Adjust or neutralize the high pH water until it is in the range of pH su acceptable for discharge to the river basin containing the receiving waterbody by using an appropriate treatment BMP such as carbon dioxide (CO₂) sparging or dry ice. The registrant must obtain written permission from DEQ or Agent before using any form of chemical treatment other than CO₂ sparging or dry ice per Section 1.2.9.
- e) The registrant must perform pH monitoring on site within 15 minutes of sample collection with an accurately calibrated pH meter. The registrant must record the pH monitoring results and any pH adjustment treatments in the inspection report.

5.0 Turbidity

5.1 Sample Collection, Preservation, and Holding Time

Turbidity measurements should be made immediately after sample collection as light, temperature, and other processes can affect turbidity over time. If necessary samples may be held for 48 hours before analysis, however in such circumstances samples must be stored $\leq 6^{\circ}\text{C}$ and held in darkness.

5.2 Approved Methods

EPA Method 180.1 Determination of Turbidity by Nephelometry, Rev 2.0, 1993. The applicable range is 0-40 nephelometric turbidity units (NTU). Higher values may be obtained with dilution of the sample.

Or, alternatively:

- a) **Standard Methods** 2130 B-2011 Turbidity Nephelometric
- b) **ASTM D1889-00** Standard Test Method for Turbidity of Water. October 2000
- c) **USGS I-3860-85**

5.3 Equipment Requirements

The turbidimeter shall consist of a nephelometer, with light source for illuminating the sample, and one or more photo-electric detectors with a readout device to indicate the intensity of light scattered at right angles to the path of the incident light. The turbidimeter should be designed so that little stray light reaches the detector in the absence of turbidity and should be free from significant drift after a short warm-up period.

Differences in physical design of turbidimeters will cause differences in measured values for turbidity, even though the same suspension is used for calibration. To minimize such differences, the following design criteria should be observed:

- Light source: Tungsten lamp operated at a color temperature between 2200-3000°K.
- Distance traversed by incident light and scattered light within the sample tube: Total not to exceed 10 cm.
- Detector: Centered at 90° to the incident light path and not to exceed $\pm 30^{\circ}$ from 90°. The detector, and filter system if used, shall have a spectral peak response between 400 nm and 600 nm.

- The sensitivity of the instrument should permit detection of a turbidity difference of 0.02 NTU or less in waters having turbidities less than 1 unit. The instrument should measure from 0-40 units turbidity. Several ranges may be necessary to obtain both adequate coverage and sufficient sensitivity for low turbidities.

The sample tubes to be used with the available instrument must be of clear, colorless glass or plastic. They should be kept scrupulously clean, both inside and out, and discarded when they become scratched or etched. A light coating of silicon oil may be used to mask minor imperfections in glass tubes. They must not be handled at all where the light strikes them, but should be provided with sufficient extra length, or with a protective case, so that they may be handled. Tubes should be checked, indexed and read at the orientation that produces the lowest background blank value

Calibrate the turbidimeter according to the manufacturer's specifications (formazin standards are recommended).

5.4 Analytical Checks and Measurement

- a) Inspect the turbidimeter logbook to ensure that the instrument has been calibrated to formazin standards within the last year. Check the turbidimeter to ensure it is operating properly before measuring the first turbidity sample. Measurements are made with the turbidimeter set in automatic range mode (AUTO RNG) with the signal averaging (SIG AVG) mode off.
- b) Compare the assigned values of the Gelex secondary standards with the observed values. Calibration of the turbidimeter with formazin standards is necessary if the reading of the Gelex secondary standard is not within 5% of the assigned value. Conduct a field check of the meter using the Gelex secondary standards each day before samples are analyzed.
- c) Clean and apply silicone oil to a sample cell as directed in the instrument manual
- d) Agitate the primary sample container (e.g. sample bucket or HDPE bottle) to re-suspend material that may have settled between the time of sample collection and analysis, but avoid causing bubbles to form. Degassing the sample is not necessary for most ambient water monitoring applications. Fill the glass sample cell with 15 mL of sample, cap and wipe dry and clean. Holding the sample cell by the cap, carefully align the diamond on the sample cell with the line on the turbidimeter and place the sample cell into the turbidimeter. Press "Read" to measure turbidity.
- e) A single sample cell should be used through the course of the day for the best precision and repeatability. Each sample cell will gradually become slightly scratched and abraded through use and these imperfections may affect the optical properties of the sample cell. Slight imperfections in the sample cell are masked by the application of silicone oil, but visibly scratched cells may result in erroneous results and should be discarded. Condensate, incorrect sample cell alignment, or use of the meter in direct sunlight may also produce inaccurate turbidity values.
- f) QC measures Collect duplicate samples. Equipment blank measurements are made using distilled water.

5.5 General Effluent Limitations to Meet Applicable Instream Water Quality Standards

Discharges must be controlled and may not cause or contribute to an exceedance of the applicable water quality standards as established in OAR 340-041; specifically OAR 340-041-0036: Turbidity

(Nephelometric Turbidity Units, NTU); No more than a 10% (ten percent) cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity.

6.0 Reporting of Results

See attached pollutant parameter monitoring logs. May be used as are, or modified if the necessary information is provided.

7.0 Statistical Measures

Statistical methods provide the basis for determining the precision and accuracy of data. Once precision (Appendix A) performance has been established, it can be used to verify self-monitoring data by establishing quality control limits. Data that does not meet set control limits for precision or accuracy indicate that some sort of error has occurred due to equipment failure, analyst error, or a calculation error. Identification and correction of errors improves the overall quality of the data generated by a laboratory.

Appendix A Procedure for Calculating Method Precision

1 Definition:

Precision is a measure of the spread in the data, or the repeatability of obtaining a given result on a sample or standard. Precision is expressed either in standard deviation (multiple results), range (difference between duplicate analyses) or relative percent difference (RPD: range divided by the mean between duplicate analyses and multiplied by 100). Range is commonly used for samples that do not vary appreciably in concentration whereas RPD is used for samples, which may vary in concentration several orders of magnitude (i.e. 1 - 500 mg/L) and range is dependent on concentration.

2 Calculation:

$$RPD = \frac{|X_s - X_d|}{\frac{(X_s + X_d)}{2}} \times 100$$

Where

RPD = Relative Percent Difference

X_s = Sample measurement

X_d = Duplicate measurement

Example: Duplicate analysis for turbidity of samples obtained the following results: 15 and 20 NTU.

$$RPD = \frac{|15 - 20|}{\frac{(15 + 20)}{2}} \times 100$$

$$RPD = \frac{|-5|}{17.5} \times 100$$

$$RPD = 28.6\%$$

Note that calculation utilizes the absolute value in the numerator and therefore it doesn't matter which number is greater.

3 Establishing Control Limits:

Based range (difference) between duplicate analyses:

Establishing control limits in this fashion should only be used if the waste stream is consistent with little variability in analyte concentration. If concentrations of an analyte vary significantly precision control limits should be calculated based on variation in % RPD.

After approximately 20 separate measurements have been made, the average range is calculated and control limits set. To determine the average, sum all of the ranges (difference between duplicate analyses) and divide by the number of measurements. Multiply the average range by the student "t" factor of 3.27 for a 95% confidence interval to determine the control limit:

Equation

$$Rc = \left(\sum_{i=1}^n R \div n \right) \times t$$

Where

Rc = Range control limit
n = number of data points
i = individual data point
t = student-t factor for *n*

Example:

<u>Measurement</u>	<u>Range (difference)</u>	<u>Measurement</u>	<u>Range (difference)</u>
1	5	11	6
2	8	12	3
3	1	13	4
4	0	14	8
5	7	15	5
6	2	16	9
7	6	17	4
8	1	18	3
9	2	19	0
10	4	20	1

$$\sum_i^{20} R = 79$$

$$Rc = (79 \div 20) \times t$$

$$Rc = (3.95) \times 3.27$$

$$Rc = 12.9 \text{ (or 13)}$$

Duplicate analyses that have a difference of > 13 would be an exceedance of the control limit and an indication that an error may have occurred. The error may be due to sample matrix, a non-homogeneous sample, sampling error or a laboratory procedural error.

4 Establishing Control Limits:

Based on % RPD between duplicate analyses:

Establishing control limits in this fashion can be used anytime but must be used if the analyte concentration in the waste stream is variable. After approximately 20 separate measurements have been made, the average RPD is calculated and control limits set. To determine the average, sum all of the RPDs and divide by the number of measurements. Calculate the standard deviation (SD) of the data set. The control limit is determined by adding the average %RPD and 3xSD.

Equation 1: RPD Control Limit

$$RPD_c = \left(\sum_{i=1}^n RPD \div n \right) + (3 \times SD)$$

Where

- RPD_c* = RPD control limit
- n* = number of data points
- i* = individual RPDs
- t* = student-t factor for *n*
- SD* = standard deviation of data set

Equation 2: Standard Deviation

$$SD = \sqrt{\frac{\sum_{i=1}^n (RPD_i - RPD_a)^2}{n - 1}}$$

Where

- SD* = Standard Deviation
- n* = number of data points
- RPD_i* = individual RPDs
- RPD_a* = Average RPD

Scientific calculators have statistical functions for calculating averages and standard deviations. These calculations can also be performed easily with Microsoft Excel® or other commercially available spreadsheet software.

Example:

<u>Measurement</u>	<u>% RPD</u>	<u>Measurement</u>	<u>% RPD</u>
1	15.2	11	25.2
2	16.8	12	19
3	10.3	13	17.3
4	15.6	14	25
5	25.6	15	30
6	28.5	16	14.2
7	18.8	17	14.3
8	28.6	18	23.8
9	14	19	12.2
10	27.8	20	16.9

Note: Standard Deviation (SD) = 6.215

$$\left(\sum_{i=1}^{20} RPD = 399.1 \right)$$

$$RPDc = (399.1 \div 20) + (3 \times SD)$$

$$RPDc = (19.955) + (3 \times 6.215)$$

$$RPDc = (19.955) + (18.645)$$

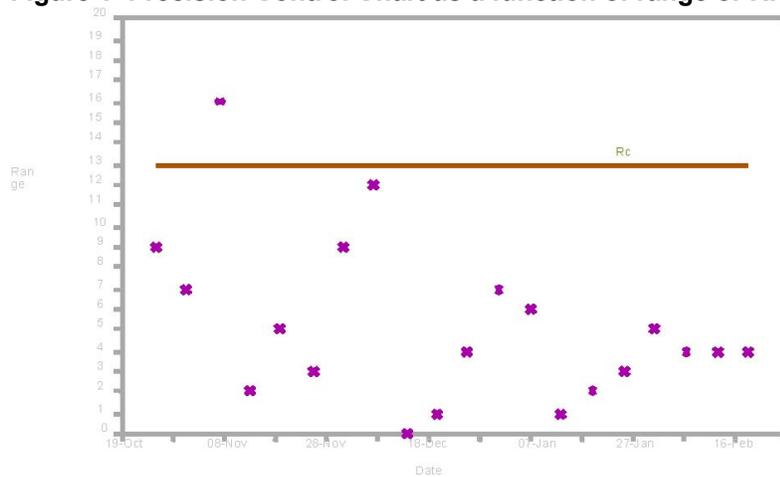
$$= \mathbf{38.6\% (39\%) RPD}$$

Duplicate analyses that have an RPD of $> 39\%$ would be an exceedance of the control limit and an indication that an error may have occurred. The error may be due to sample matrix, a non-homogeneous sample, sampling error or a laboratory procedural error.

Appendix B Control Charting

Control charts are an effect tool to monitor Precision on individual data points over time. The concept is to plot each percent recovery, RPD, Range, etc. on a chart showing the control limits to give a visual display of performance and trends.

Figure 1 Precision Control Chart as a function of range or RPD



The dark bar is the upper control limit.

Appendix C Example Continuing Calibration Verification (CCV) Field Sheet

Sampling
 Agency:

Date:

Sample
 Collector:

Permit
 Number:

pH	Meter S/N ID# ¹ :		Accuracy Criterion: +/- 0.2 SU								
	Meter Make:										
	Meter Model:										
Pre time ² :						Post time ³ :					
Std	Temp (°C)	Theo (SU)	Read (SU)	Diff (SU)	Pass ⁴ (Y/N)	Std	Temp (°C)	Theo (SU)	Read (SU)	Diff (SU)	Pass ⁴ (Y/N)

Turbidity	Meter S/N ID# ¹ :		Accuracy Criterion: +/- 10%			
	Meter Make:					
	Meter Model:					
Pre time ² :			Post time ³ :			
Std	Read (NTU)	Diff (%)	Pass ⁴ (Y/N)	Read (NTU)	Diff (%)	Pass ⁴ (Y/N)

Standards QA information ⁵			
	pH		
Std Value	7	10	4
Lot #			
Exp. Date			

Instructions for completing CCV:

1	Meter ID , please record the meter number used for each parameter
2	Pre-time , please record the time each meter was checked with standards prior to sample analysis
3	Post-time , please record the time each meter was checked with standards after sample analysis
4	Pass , please indicate whether the meter passed the pre-check according to the accuracy criteria for the meter by indicating Y or N
5	Standards QA Information , please record the lot numbers and expiration dates for pH standards being used in the field

Appendix D Example Data Field Sheet

Monitoring Agency:

Monitoring Observation Date¹:

Monitoring Personnel²:

Permit Number:

Monitoring Information			Field Data		Notes ⁵
Result #	Monitoring Site Description ³	Time ⁴	pH (SU)	Conductivity (NTU)	

Instructions for completing Data Field Sheet:

1	Observation Date , please record the date once at the top of the data field sheet
2	For Monitoring Personnel , please list all personnel that were present during sampling. Initials are not sufficient for this field
3	The Monitoring Site Description should describe the exact location from which the sample was collected
4	Please record the Time the field measurement was observed
5	For Notes , please identify any pertinent information, including but not limited to whether initial test failed acceptance criteria, any treatment performed, and whether result is a re-test after treatment