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Prepared for
Colorado Springs Utilities

Submitted by
AECOM
1601 Prospect Parkway
Fort Collins, CO 80525

Coal Combustion Residuals (CCR) Landfill Groundwater Detection Monitoring Plan, Revision 1

Clear Spring Ranch
El Paso County, Colorado

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Clear Spring Ranch
El Paso County, Colorado

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List of Acronyms

Acronym	Definition
ASD	Alternative source demonstration
CCR	coal combustion residuals
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
COC	chain-of-custody
CSR	Clear Spring Ranch
DI	Deionized water
DO	Dissolved oxygen
DQR	Double quantification rule
EPA	U.S. Environmental Protection Agency
FGD	Flue gas desulfurization
GWMP	Groundwater monitoring plan
GWPS	Groundwater protection standards
HSU	Hydrostratigraphic units
LCB	Lower confidence band
LCL	Lower confidence limit
MCL	Maximum contaminant level
MS/MSD	matrix spike/matrix spike duplicate
mV	millivolts
ORP	Oxygen-reduction potential
PCA	Piney Creek Alluvium
pH	Potential of hydrogen
PVC	polyvinyl chloride
QA/QC	Quality assurance and quality control
RCRA	Resource Conservation and Recovery Act
Scrubber	Flue gas desulfurization
SOP	Standard operating procedure
SSI	Statistically significant increase
SSL	Statistically significant level
SWFPR	Site-wide false positive rate
Site	CCR Landfill
TDS	Total dissolved solids
UPLs	Upper prediction limits
USGS	U.S. Geological Survey
Utilities	Colorado Springs Utilities

Monitoring System Certification

Certification Statement 40 CFR § 257.91(f) – Design and Construction of a Groundwater Monitoring System for the existing Coal Combustion Residuals (CCR) Landfill, Clear Spring Ranch, El Paso County, CO, managed by the Colorado Springs Utilities.

I, Patrick Clem, being a Registered Professional Engineer in good standing in the State of Colorado, do hereby certify, to the best of my knowledge, information, and belief, and in accordance with good engineering practice, that the design and construction of the groundwater monitoring system as included in Section 2.0 of the Groundwater Detection Monitoring Plan Revision 1, dated January 27, 2026, meets the requirements of 40 CFR § 257.91.

Patrick M. Clem 01.27.2026

COLORADO LICENSED
PATRICK M. CLEM
0047622
1.27.2026
PROFESSIONAL ENGINEER

Statistical Method Certification

Certification Statement 40 CFR § 257.93(f)(6) – Statistical Method for the Evaluation of Groundwater Monitoring Data for the existing Coal Combustion Residuals (CCR) Landfill, Clear Spring Ranch, El Paso County, CO, managed by the Colorado Springs Utilities.

I, Patrick Clem, being a Registered Professional Engineer in good standing in the State of Colorado, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification is prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the statistical method selected for the groundwater monitoring system as included in Section 4.0 of the Groundwater Detection Monitoring Plan Revision 1, dated January 27, 2026, is appropriate for evaluating the groundwater monitoring data for the CCR management area. The statistical method selected to evaluate the groundwater monitoring data for the CCR Unit is identified and described in Section 4.0

Patrick M. Clem 01.27.2026

1 Introduction

The groundwater monitoring plan presented herein was developed as a guide for groundwater monitoring at the Clear Spring Ranch (CSR) Coal Combustion Residuals (CCR) Landfill conducted under the requirements of the U.S. Environmental Protection Agency Coal Combustion Residuals Rule (CCR Rule).

1.1 Background

CSR is a 4,759-acre property located at the intersection of Interstate 25 and Ray Nixon Road, approximately 17 miles south of Colorado Springs (**Figure 1**). It was acquired in 1972 by the City of Colorado Springs on behalf of its enterprise Colorado Springs Utilities (“Utilities”). The primary land uses on the CSR property are those related to utility services: electric generation and transmission; water and wastewater treatment and delivery; and waste management.

Power generation at Utilities’ Martin Drake power plant (located approximately 17 miles north of CSR) produced CCR until August 2021, which is when the plant ceased operation of its coal-burning units. Coal-fired power generation continues on site at Utilities’ Ray Nixon power plant, which produces CCR that is placed with other waste materials in the CCR Landfill (or “the Site”) located in the southern part of CSR. Materials authorized for placement in the CCR Landfill include the following:

- Fly ash and bottom ash from the Drake Power Plant and Nixon Power Plant,
- Flue gas desulfurization (“FGD” or “scrubber”) waste from the former Drake Power Plant and the Nixon Power Plant,
- Spent boiler cleaning sandblasting media from the former Drake Power Plant and the Nixon Power Plants,
- Evaporator salt from the Zero Discharge Wastewater Treatment Plant,
- Cooling tower solids from the Birdsall Power Plant,
- Process Water Pond sediment from the former Drake Power Plant,
- Stormwater Pond sediment from the former Drake Power Plant,
- Dry sorbent injection residuals from the former Drake Power Plant,
- EQ Basin sediment from the Nixon Power Plant
- Activated carbon injection residuals from the former Drake Power Plant and the Nixon Power Plants, and
- Ash derived from the co-combustion of clean cellulosic biomass and coal at the former Drake Power Plant.

The CCR Landfill is regulated by the Colorado Department of Public Health and Environment (CDPHE) – Hazardous Materials and Waste Management Division and the Local Governing Authority (i.e., El Paso County) under the Regulations Pertaining to Solid Waste Sites and Facilities (6 Code of Colorado Regulations 1007-2, Part 1) and El Paso County’s Land Development Code. It is also regulated under the CCR Rule promulgated by the U.S. Environmental Protection Agency (EPA) under 40 Code of Federal Regulations (CFR) Part 257, Subtitle D of the Resource Conservation and Recovery Act (RCRA).

A CCR Rule groundwater monitoring plan (GWMP) for the Site was developed in 2017 to direct conformance with 40 CFR 257, Subtitle D and 6 Code of Colorado Regulations 1007-2, Part 1. CCR Rule-required baseline (Detection) monitoring was initiated in 2017, but the CCR Landfill has been subject to Assessment Monitoring since 2018 because of downgradient detections of Appendix III indicator parameters boron and fluoride at concentrations representing statistically significant increases (SSIs) relative to upper prediction limits (UPLs) calculated from background/upgradient monitoring well concentrations. Assessment Monitoring requires monitoring of both 40 CFR 257 Appendix III and IV constituents. Appendix III constituents are boron, calcium, chloride, fluoride, potential of hydrogen (pH), sulfate, and total dissolved solids (TDS). Appendix IV constituents are antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, selenium, thallium, and the combined concentrations of radium 226 and radium 228. **Table 1** presents the analytical parameters and monitoring frequency for the CCR Landfill.

During the September 2022 sampling event, selenium was detected in groundwater sampled from monitoring well SC-10 at concentrations that represent a statistically significant level (SSL) above the applicable federal groundwater protection standard (GWPS) per 40 CFR 257.95(h). The SSL detection was reported in the Annual Update Statistical Analysis Report (MacStat 2022) dated January 13, 2022. As a result, Utilities requested AECOM Technical Services, Inc. (AECOM) conduct an Assessment-Mode Alternative Source Demonstration (ASD) for the elevated selenium levels as allowed under 40 CFR § 257.95(g)(3) to evaluate whether the SSL detection was due to a source other than the CCR Landfill.

In April of 2022, Utilities posted an ASD report, which demonstrated that a combination of site geology, topography, and upgradient groundwater geochemistry was responsible for the geochemical conditions that caused naturally occurring selenium to mobilize into the groundwater and to be detected at monitoring well SC-10 (AECOM 2022). Bedrock in the area of the CCR Landfill was found to have two main erosional channels partially filled with alluvial sediments. Groundwater is found in the lowest, most permeable sediments and uppermost weathered rock of the bedrock channels referred to as paleo-alluvial channels (e.g. the North Paleo-alluvial Channel and the South Paleo-alluvial Channel). Groundwater in these channels have unique geochemical signatures that do not mix until the channels converge downgradient of the CCR landfill. To provide support for these findings and to help document the upgradient conditions that resulted in the SC-10 SSL, additional groundwater monitoring wells were installed upgradient of SC-10 (within the North Paleo-alluvial Channel) in November 2022 and September 2023. An overview of the findings of the ASD is presented in Section 5.3.1 of this GWMP.

1.2 Purpose

The purpose of this monitoring plan is to outline a Detection Monitoring program and an Assessment Monitoring Program as required under 40 CFR Part 257. Monitoring results will be used to evaluate whether landfill operations are protective of groundwater. The monitoring program is intended to:

- Establish background and downgradient concentrations in groundwater for constituents that could reasonably be expected to leach from the material disposed of in the landfill. Baseline conditions to be established by collecting quarterly rounds of groundwater samples from the monitoring network for analysis of Detection Monitoring and Assessment Monitoring constituents. Typically, eight quarters of baseline sampling are conducted prior to reducing the sampling frequency to semiannual. Where available at existing monitoring wells, historic data may be utilized to establish baseline conditions instead of conducting quarterly sampling.
- Analyze groundwater samples collected on a routine basis from background monitoring wells and monitoring wells installed along the downgradient edge of the landfill.
- Measure groundwater elevations to evaluate seasonal variability in water levels and direction of groundwater flow. (Seasonal variability has not been observed to date, and evaluation will continue.)
- Establish the methodology used to evaluate whether a SSI in CCR indicator parameters above background levels has occurred.
- Reduce the potential for CCR disposal activities to degrade water quality in the Fountain Creek Alluvial aquifer.

2 Detection Monitoring Program

2.1 Site Hydrogeology

The CCR Landfill is located between tributary branches of Sand Canyon, a small, west-east trending topographic depression that is bounded to the north and south by outcrops of the Pierre Shale. Approximately 50 feet of Quaternary sediments have been deposited in the canyon and its tributaries. These sediments, referred to as the Piney Creek Alluvium, consist of horizontal layers of clay, silty clay, sand, and gravel. Most of the alluvium is poorly sorted and fine-grained, with silt-sized materials predominating. Bedding is poorly defined except for a thin layer of gravel near the base of the deposit. The Piney Creek Alluvium is saturated in the vicinity of the CCR Landfill and forms the uppermost water-bearing zone in Sand Canyon.

The Piney Creek Alluvium is underlain by approximately 3,500 to 4,000 feet of Pierre Shale, which forms a hydraulic barrier between the alluvium and deeper water-bearing formations, if present. Groundwater within the Piney Creek Alluvium flows to the east-southeast along the top of the alluvium-Pierre Shale contact. Water level measurements indicate that the saturated thickness of the alluvial water-bearing zone ranges from approximately zero to 25 feet. Investigations for the ASD conducted in 2022 have further refined the local geology of the Piney Creek Alluvium and Pierre Shale. A summary of this information can be viewed in Section 5.3.1.1 of this report.

Approximately one mile east of the CCR Landfill, Sand Canyon intersects the north-south alluvial channel of Fountain Creek. The Fountain Creek Alluvium represents a productive aquifer that is primarily used for agricultural and industrial purposes near CSR. On a regional geologic map of the area (Scott et al., 1978), the Fountain Creek Alluvium is mapped as the same geologic unit as the Piney Creek Alluvium in Sand Canyon. However, groundwater quality is markedly different in the Piney Creek Alluvium than that of the Fountain Creek Aquifer, with much lower groundwater TDS concentrations occurring in the Fountain Creek Aquifer. Other noted differences in general groundwater quality indicators include dissolved oxygen (DO) and conductivity.

The upgradient portion of Sand Canyon occupied by the CCR Landfill is isolated from the Fountain Creek Aquifer by a retention dam installed by Utilities in 1978. The retention dam, located approximately 3,000 feet downgradient (east) of the landfill (**Figure 1**), has a bentonite core and is designed to be keyed into the Pierre Shale bedrock. It captures surface water runoff from the CCR Landfill and also restricts the groundwater flow in the Piney Creek Alluvium within Sand Canyon. The dam is not completely impermeable, as some seepage has historically been measured. An engineering study was conducted in 1994 to evaluate seepage through the dam and to recommend alternatives for improving its effectiveness (Haley and Aldrich, 1994). The recommended alternative was to install a bentonite barrier wall through the upgradient toe of the dam. Utilities installed the bentonite barrier in October 1994 and later added a French drain along the southern downgradient side of the dam to collect residual seepage water. The seepage intercepted by the french drain is pumped back to the upgradient side of the dam.

Collectively, the monitoring program and the retention dam system (two bentonite slurry walls and groundwater collection and pumping) are the measures that Utilities have implemented to protect groundwater downgradient of the CCR Landfill. The monitoring program serves to identify potential releases from the landfill, while the retention dam system is intended to prevent releases that may occur from migrating in groundwater downgradient to the Fountain Creek Aquifer.

2.2 Monitoring Well Network

The monitoring network for the CCR Landfill is depicted in **Figure 2.** As described below, it includes eight background wells (CC-1, FC-1, FC-2, FC-3A, FC-3B, SC-15, SC-18 and SC-19) and four downgradient wells (SC-10, SC-11, SC-12 and SC-13).

The pre-2015 upgradient monitoring wells CC-1, FC-1, and FC-2 have been in service since 1993 and provide a long-term historical record of background constituent concentrations and variability in an area south and west of the Landfill.

The four CCR Rule downgradient compliance wells are SC-10, SC-11, SC-12, and SC-13. These wells are located as close as feasible to the limit of waste on the downgradient (east) side of the Landfill as required by the

CCR Rule. These wells were drilled using hollow-stem augers advanced into the Piney Creek Alluvium and underlying weathered and fractured Pierre Shale claystone, to the contact with the unweathered Pierre Shale. The wells were subsequently screened across the lower 10 feet of the alluvium using a 2-inch diameter, 0.010-inch factory-slotted polyvinyl chloride (PVC) screen and blank well casing.

As previously noted, an ASD for selenium detections in SC-10 was prepared that involved the installation of three new monitoring wells located north of the CCR Landfill (SC-15, SC-16, and SC-17) in November 2022. These wells helped identify the location of two additional background upgradient wells, SC-18 and SC-19, which were installed in September 2023. As discussed above, monitoring wells SC-15, SC-18 and SC-19 will be used as background monitoring wells in the groundwater monitoring program. Monitoring wells SC-16 and SC-17 are not incorporated into the Groundwater Monitoring Well network, as they were not considered ideal for background characterization.

Based on the ASD hydrogeology findings, the groundwater monitoring system is split into two subsystems: one to characterize conditions in the North Paleo-alluvial Channel and one for the South Paleo-alluvial Channel. The CCR Landfill is located on a topographic high in the bedrock surface, such that groundwater is concentrated in paleo-alluvial channels on the north and south sides of the landfill. The two channels have different background/upgradient areas, but they converge into a single channel downgradient from the landfill. Because of their separate background/upgradient areas, the two channels have differing geochemical conditions that result in different downgradient constituent concentrations. Accordingly, the North Paleo-alluvial Channel background represented by wells SC-15, SC-18 and SC-19, will be used to test the statistical significance of data from downgradient wells SC-10 and SC-11. Eight rounds of monitoring data were collected from the North Paleo-alluvial well network from November 2023 through November 2024 and were evaluated using the statistical methods outlined below. The results of the statistical analysis are presented in **Attachment 1**. The South Paleo-alluvial Channel is currently being characterized by the original background/upgradient wells (CC-1, FC-1, FC-2, FC-3A, and FC-3B), which are being used to test the statistical significance of data from downgradient wells SC-12 and SC-13.

The locations, as well as the ground surface and the top of casing elevations of the new wells, were surveyed by a Colorado-licensed professional land surveyor. **Table 2** summarizes the details of the construction of the CCR landfill monitoring wells. The boring logs and construction diagrams for the wells included in the monitoring network are included in **Attachment 2**.

2.3 Sampling Frequency

Wells in the CCR Landfill monitoring network were initially sampled approximately monthly to establish background concentrations for the Piney Creek Alluvium. The eight baseline sampling rounds began on June 22, 2016, and were completed on March 1, 2017, prior to the October 17, 2017 deadline established in the CCR Rule (40 CFR §257.94). Subsequently, Detection Monitoring will continue to be performed semiannually and Assessment Monitoring will be performed at least annually (**Table 1**).

2.4 Analytical Parameters

During the initial eight rounds of baseline Detection Monitoring, samples were collected from the CCR landfill wells, not including SC-15, SC-18, or SC-19 as these wells had not yet been installed at the site, and analyzed for the constituents listed in 40 CFR §257, Appendices III and IV. The Appendix III and IV analyte list includes the general chemistry parameters of pH and TDS; anions of chloride, fluoride, and sulfate; combined radium-226 and -228, and several metals, as shown in **Table 1**. Groundwater samples are not field filtered, so the reported metals concentrations represent “total recoverable metals” as required by the CCR Rule.

After the initial baseline Detection Monitoring was completed, the analyte list would reduce to the indicator parameters listed in Appendix III of 40 CFR §257 if the Site were to remain in Detection Monitoring. This shorter Detection Monitoring list, which includes boron, calcium, chloride, fluoride, sulfate, pH, and TDS (**Table 1**), would continue until the CCR Landfill is closed or Assessment Monitoring is triggered. Subsequently, Appendix III and IV parameters outlined in **Table 1** are currently being analyzed as the site was triggered into Assessment Monitoring as detailed in Section 5.

2.5 Reporting

To comply with the CCR Rule, an Annual Groundwater Monitoring and Corrective Action Report was prepared for the CCR Landfill after the eight rounds of baseline monitoring were completed. This initial report was completed before January 31, 2018, with subsequent reports completed annually thereafter. The annual reports document the status of the Detection Monitoring program for the CCR Landfill, summarize key actions completed, describe problems encountered, discuss actions to resolve the problems, and identify key activities for the upcoming calendar year. The annual report will be considered complete when it is placed in the facility's operating record by January 31st of each year. Other information required to be included in the annual report is listed in 40 CFR §257.90.

3 Groundwater Sampling and Analysis

This section describes procedures that will be used at the Site for groundwater sampling and analysis. Groundwater sampling and analysis will be conducted in general accordance with the Utilities' standard operating procedure (SOP) sections listed below and included in **Attachment 3**. Field personnel must review these Utilities' SOP sections prior to conducting sampling activities.

- SOP Section 3.2 Chain-of-Custody Procedures
- SOP Section 5.3.1 Water Levels
- SOP Section 5.4 Purging Procedures
- SOP Section 5.5 Stabilization Criteria
- SOP Section 5.6 Sample Processing
- SOP Section 6.0 Quality Control and Quality Assurance
- SOP Section 6.2 Decontamination

Significant deviations from the SOP will be recorded in the field notes. Field notes will be kept by sampling personnel. The field notes will include sampler name(s), well identification numbers, the date and time, instrument calibration notes, water-level measurements, well purging volumes, deviations from the SOP, and other notable site observations.

3.1 Water Level Measurement

At the start of each monitoring event, field personnel will measure the depth-to-water in system monitoring wells prior to purging per SOP section 5.3.1 *Water Levels* **(Attachment 3)**. Water levels will be measured within a period of time short enough to avoid temporal variations in groundwater elevation, which could prevent an accurate determination of the groundwater flow rate and direction. The device used to measure water levels will be capable of achieving a measurement precision of ± 0.01 feet.

The procedure for measuring water levels in the monitoring wells is described below.

- Before any measurement is taken, the water level probe and cable should be properly decontaminated. Decontamination will take place prior to the start of sampling and between each well with a premixed Liquinox® spray solution of approximately 0.1-2%. Decontamination practices will be performed while wearing clean, disposable gloves. A final rinse of the tape/equipment will be completed with deionized (DI) water to remove detergent solution or tap water residuals. Decontamination will be conducted in accordance with SOP section 6.2 *Decontamination* (**Attachment 3**).

- The static water level depth within the well shall be measured using an electric water level indicator. The measuring point for monitoring wells should be the top of the well casing. The measuring point will be marked by a notch or other mark in the casing. If no mark is present, measurements will be collected from the top of the north side of the casing.
- The static water level depth shall be written down on the field data sheet or field notebook, and immediately rechecked before the indicator is removed from the well.
- If needed, water levels will be compared with past measurements to help verify the readings during each water level measurement period.
- The water level depth below the measuring point (in feet) will be subtracted from the measuring point elevation (in feet above mean sea level) to calculate the elevation of the static water level (in feet above mean sea level).
- If the well is dry, a total depth is collected with a note to indicate the well was dry.

3.2 Sample Collection

Before collecting samples, groundwater monitoring wells will be purged using low flow sampling techniques until field parameters have met stabilization criteria for three consecutive readings (i.e., temperature, pH, ORP, conductivity, DO, and turbidity) or until the well is pumped dry.

Well purging will begin by first removing the well cap and measuring the groundwater level as described in SOP Section 5.3. When total depth measurements are taken, they are collected after sampling to prevent disturbance to the water column by mobilizing sediments from the bottom of the well.

Well purging will be initiated using a bladder pump, peristaltic pump or similar low flow sampling pump, or a disposable bailer. Due to the low-flow/low-stress groundwater purge methods required on a well-by-well basis, well-purge volumes and the timing of field parameter collection will vary. Flow rates for low-flow purging target a range of (0.1-0.5 L/min) 100-500 mL/min or 0.026-0.132 gal/min, per SOP section 5.4.1 *Low-Flow Purging* (**Attachment 3**). When low-flow sampling is not performed and a bailer is used to purge the well, three standard well casing volumes will be purged as described in SOP section 5.4.2 *Bailer Purging* (**Attachment 3**).

The field sampler will measure the field parameters to confirm, to the extent possible, that the water chemistry is stabilizing. The sampler will also make note of the color, clarity, and odor of the produced groundwater, where indicated on Utilities' groundwater sampling field sheets. Generally, temperature ± 3 percent °Celsius, pH within ± 0.2 units, conductivity within ± 3 percent, DO within ± 10 percent or 0.2 mg/L, ORP within ± 10 millivolts (mV), and turbidity within ± 10 percent or < 10 NTU for consecutive readings indicate stable water chemistry, per SOP section 5.5 *Stabilization Criteria* (**Attachment 3**). Field meter calibration will be checked daily for measuring pH, DO, turbidity, ORP and conductivity, and operated in general accordance with manufacturers' instructions.

If a monitoring well purges dry and well recovery is slow, samples will be obtained when sufficient water (i.e., more than a foot of water column) is available to fill the required sample bottles. If sufficient water, more than one foot for sampling, is not available within 24 hours of well purging, the location will not be sampled during the specific monitoring event. Additionally, if a well has less than one foot of water column, it will not be sampled. Each well's recovery conditions will be included within the sampler's field notes per SOP section 5.4.3 *Purging to Dryness* (**Attachment 3**).

The field sampler will don new disposable nitrile gloves for sampling and will fill the laboratory-supplied sample containers directly from the bailer or pump discharge line. Sample containers should be filled with minimal turbulence and should not be overfilled to avoid spilling the sample preservative (where applicable). Groundwater samples will be collected in such a way as to minimize potential contamination to provide an accurate representation of groundwater constituent concentrations. Measures to help prevent contamination will include using dedicated sampling equipment, wearing a new pair of disposable gloves at each well, and decontaminating reusable equipment (such as the water level indicator) between wells per SOP section 6.2 *Decontamination* (**Attachment 3**).

Field notes will be kept by sampling personnel either in a field logbook or on groundwater sampling forms. The field notes will include sampler name(s), well identification numbers, the date and time, instrument calibration notes, water-level measurements, well purging volumes, and other notable site observations. These records will be maintained by Utilities.

3.3 Sample Preservation and Shipment

Each sample aliquot will be preserved as appropriate for the required analytical testing, and sample containers will be labeled and placed in appropriate shipping containers. **Table 1** lists the preservatives, if required, for each analytical constituent per SW-846 (EPA 2014). Sample containers will be placed on ice / cold packs following sample collection and during transport to the laboratory per SOP section 5.6.2 *Sample Preservation* (**Attachment 3**). Other sample preservatives include nitric acid for metals and hydrochloric acid for mercury analysis. Prior to sample collection, the Laboratory will place the preservatives into the bottles used to contain the samples for metals and mercury analysis. Following collection, samples will be transported under chain-of-custody (COC) control to Colorado Springs Utilities Laboratory, a Colorado State Certified Laboratory or shipped to an alternate appropriately certified laboratory.

3.4 Analytical Procedures

Groundwater samples collected will be analyzed for the analytes listed in **Table 1**. Analyses will be performed by a certified analytical laboratory using U.S. EPA SW 846 Test Methods for Evaluating Solid Wastes, Standard Methods for the Examination of Water and Wastewater (APHA et al. 2017), or an industry-standard or field method (e,g., multiparameter water quality meter and probe) listed in **Table 1**. Analytical laboratory practical quantitation limits will be less than or equal to the groundwater quality standards where possible. Metal parameters will be reported as total recoverable metals (i.e., will not be field or laboratory-filtered prior to analysis). Appendix III and IV analytes will be monitored for the eight baseline Detection Monitoring events after which the Appendix III analytes will be monitored if the site remains in Detection Monitoring as outlined in Section 2.4. Appendix III and IV parameters will be monitored once Assessment Monitoring is triggered.

Table 1 also lists the analytical method and sample preservative for each constituent. In general, Utilities will use EPA Methods 200.7 and 6010 or 6020 for metals analysis, EPA Method 1631 for mercury, EPA Method 4500 for fluoride, EPA Method 300.0 for anions (i.e., chloride and sulfate), EPA Method 903.0 for radium-226, 904.0 for radium-228 (EPA 2014), and Standard Methods 4500-HB for pH and 2540-C for TDS (APHA et al 1998).

3.5 Chain-of-Custody Control

Utilities standard COC procedures will be followed on all samples collected as detailed in SOP section 3.2 *Chain-of-Custody Procedures* (**Attachment 3**). Custody is recorded through a series of signatures on the COC form as sample possession changes from one person or organization to another. For each sample location, the sample name, date and time of collection, and requested analyses will be recorded on the COC form. The field sampler will provide the original COC form to the laboratory at the time of sample delivery. COC records will be maintained by Utilities.

Once samples are received at Colorado Springs Utilities Laboratory, each sample will be assigned a unique identifying number to facilitate accurate sample tracking. From there, sample information will be logged into the laboratory's computer information management system. Any samples being analyzed by a contract laboratory will be shipped under COC control in appropriate containers according to applicable requirements of the analytical methods listed in **Table 1**.

3.6 Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures will be implemented in an effort to collect reliable and valid field and analytical data per Utilities' SOP section 6.0 *Quality Control and Quality Assurance* (**Attachment 3**). The QA/QC program will include collecting field duplicate samples to assess error associated with sample methodology and analytical procedures. At a minimum, one field duplicate will be collected per sampling event or per 20 samples, whichever is greater. To assess the efficacy of equipment decontamination techniques, one equipment blank per sampling event will be collected when sampling equipment is re-used at multiple wells. In addition, matrix spike/matrix spike duplicate (MS/MSD) samples will be used to monitor lab performance and the degree to which matrix interferences affect the reported concentration of an analyte. At least one MS/MSD will be collected for every 20 samples. A laboratory quality control report for each groundwater monitoring event will be provided by the lab and maintained by Utilities.

4 Statistical Methodology

4.1 Regulatory Guidance

Regulatory guidance provided in 40 CFR 257.90 specifies that CCR groundwater monitoring programs include selection of the statistical procedures to be used for evaluating groundwater quality data as required by 40 CFR 257.93. Groundwater quality monitoring data will be collected under the detection monitoring program outlined in this plan and includes collection and analysis of a minimum of eight independent samples for the background and downgradient compliance wells as required by 40 CFR 257.94(b). The initial eight rounds of detection monitoring samples were analyzed for the constituents listed in 40 CFR 257 Appendices III and IV. Sampling and analysis were completed on May 9, 2017, which satisfies the October 17, 2017 deadline established by the EPA in the CCR Rule (40 CFR §257.94). Future detection monitoring samples will only be analyzed for 40 CFR 257 Appendix III constituents if the site were to enter into Detection Monitoring. The site is currently in Assessment Monitoring and samples are being analyzed for 40 CFR 257 Appendix III and IV constituents.

Per 40 CFR 257.93(h)(2), the initial eight sets of groundwater samples were statistically evaluated within 90 days after completing sampling and analysis on May 9, 2017, to determine if there were any SSIs over background concentrations for the Appendix III constituents. These data were analyzed using one or more of the statistical methods outlined in 40 CFR 257.93(f) and 40 CFR 257.93(g). In determining whether a statistically significant increase has occurred, Utilities compared the constituent concentrations at the downgradient and the background wells from the initial eight rounds of detection monitoring data using the statistical approach described in Sections 4.2 and 4.3 below. Future detection or assessment monitoring data will also be compared using the statistical approach presented in Sections 4.2 and 4.3.

40 CFR 257.93(f) outlines the statistical methods available to evaluate groundwater monitoring data. The statistical test(s) chosen will be conducted separately for each constituent in each monitoring well and will be appropriate for the constituent data and their distribution. 40 CFR 257.93(g) provides performance standards, as appropriate, for the statistical test method selected.

Per 40 CFR 257.93(f)(6), Utilities must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. The certification must include a narrative description of the statistical method(s) selected to evaluate the groundwater monitoring data.

Utilities must determine whether there has been a statistically significant increase over background for any of the Appendix III constituents at the downgradient wells within 90 days after completing the initial eight rounds of groundwater sampling and analysis (40 CFR 257.93(h)(2)). The results of this analysis will be used to determine whether the site will continue detection monitoring or whether assessment monitoring is required as discussed below.

Assessment monitoring is required per 40 CFR 257.95(a) whenever a SSI over background has been detected for one or more of the constituents listed in 40 CFR 257 Appendix III. An assessment monitoring program also includes annual groundwater sampling and analysis (40 CFR 257.95(b)) for the constituents listed in 40 CFR 257 Appendix IV. The purpose of assessment monitoring is to determine if releases of CCR constituents have occurred.

The facility can return to Detection Monitoring once Assessment Monitoring results are all at or below background for two consecutive assessment monitoring periods (40 CFR 257.95(e)). If the Assessment Monitoring demonstrates an exceedance of a groundwater protection standard defined under 40 CFR 257.95(h) at downgradient compliance wells (SC-10 through SC-13, for any of the CCR constituents specified in 40 CFR 257 Appendix IV, an assessment of corrective measures must be initiated within 90 days (40 CFR 257.96(a)) unless it can be demonstrated that a source other than the landfill caused the contamination or that the statically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in ground water quality.

4.2 Statistical Analysis Approach

There is no single method of statistical analysis appropriate for each chemical dataset. It is most prudent to use a suite of statistical methods that are dependent on the data and their distributions. The statistical analyses can be based on an interwell and/or an intrawell approach. The statistical algorithms used for the interwell and intrawell approaches are chosen based on the constituent data and their distributions as well as consideration of natural seasonally- or spatially-varying constituent concentrations.

The initial eight rounds of groundwater monitoring data were concurrently collected and analyzed for the 40 CFR 257 Appendices III and IV constituents. These data were used to represent background groundwater quality for the CCR Landfill and to determine if the CCR Landfill had impacted downgradient groundwater quality. The initial eight rounds of groundwater sampling and analysis were completed on May 9, 2017, prior to the October 17, 2017 deadline established in the CCR Rule (40 CFR §257.94).

A preliminary, exploratory statistical analysis was conducted after the initial eight rounds of baseline data were obtained to assess the constituent data and determine the most appropriate statistical approach(es) for the data. The data were examined for outliers and the percentage of non-detect values to verify that the data collected are suitable for statistical analysis. The data were also examined using goodness-of-fit tests to determine the most appropriate statistical distribution, and time series plots and areal maps were used to determine if seasonal or spatial variations in constituent concentrations were present. Based on this preliminary evaluation of the data, an interwell statistical method was selected as appropriate for evaluating groundwater at the Site, as described in Section 4.3.

Per 40 CFR 257.93(h)(2), statistical analysis of all eight rounds of the initial groundwater monitoring data was completed within 90 days after completing groundwater sampling and analysis on May 9, 2017, to determine whether there has been a statistically significant increase over background for any Appendix III constituent.

4.2.1 Interwell versus Intrawell Approaches

As described in Section 2.2 of this report, groundwater monitoring is being performed for two well networks with different wells establishing background conditions. Background conditions for the North Paleo-alluvial Channel will be represented by upgradient wells SC-15, SC-18 and SC-19. Data from these wells will be used to test the statistical significance of data from downgradient compliance wells SC-10 and SC-11. Background conditions from the South Paleo-alluvial Channel will be characterized by the original background/upgradient wells (CC-1, FC-1, FC-2, FC-3A, and FC-3B), which will be used to test the statistical significance of data from downgradient compliance wells SC-12 and SC-13. Since background conditions will be represented by upgradient wells, an interwell statistical approach will be used.

As an alternative to this statistical evaluation approach, for constituents that occur naturally and vary substantially in concentration across CSR due to natural hydrogeologic or geochemical factors, thus exhibiting significant spatial variability, an interwell testing scheme may not always be helpful. In aquifers where aqueous concentrations vary spatially, constituent concentrations greater than background could be attributed to anthropogenic contamination using an interwell approach when the differences are actually natural and due to locally varying distributions of groundwater constituents. In such cases, an intrawell approach may be warranted.

The overarching goals in selecting either interwell or intrawell testing will be to:

- Ensure that statistical comparisons will be adequately sensitive to detecting a facility release;
- Ensure that data used in testing reflect current background conditions; and
- Avoid confusing an impact caused by a release from the facility with a difference between wells caused by heterogeneous subsurface conditions.

4.2.2 Background Screening

Calculation of standard parametric limits for groundwater assumes that the background data (1) are representative of current background conditions; (2) are statistically stable over time (i.e., not trending); (3) do not include (extreme) outliers; (4) include a sufficient number of samples to accurately estimate the variability in the underlying groundwater population, and thus be sensitive to any persistent change in groundwater concentrations; and (5) can be normalized, possibly via transformation. Non-parametric prediction limits, including rank-based and bootstrap methods, also rely on assumptions 1-4, but do not require that the data can be normalized (assumption 5).

To test these assumptions, any proposed background data will be screened prior to constructing statistical limits. Time series plots and formal trend tests will be used to check stability. The statistical pattern of the data along with the history and hydrogeology of the site will be used to gauge how closely the data mimic current background conditions.

To handle potential outliers, a statistically robust method (Cameron, 2024) may be employed to both identify and down-weight potential outliers. This strategy also uses repeated Monte Carlo imputation for non-detects, since groundwater datasets are frequently a mixture of detected observations, non-detects and possible outliers. Once outliers are identified, weighted, robust versions of standard statistical estimates (e.g., robust prediction limits) will be constructed to curtail the influence of outlying values even when not formally excluded from the analysis. Robust methods have the advantage of bypassing sometimes uncertain judgments about whether specific observations are indeed outliers and can be adapted to cases where formal outlier testing is difficult, for instance, when the detection rate is low.

If average background concentration levels are changing over time (i.e., trending), the prospective background data may need to be truncated, removing older data to ensure that the resulting limits continue to represent current natural conditions. Confirmed outliers may be down-weighted using the approach noted above. Any values flagged as outliers will be summarized in periodic reporting.

Probability plots and normality tests, adjusted for the presence of non-detects (Cameron, 2017), if any, will be used to identify and test best-fitting distributional models for the background data. If the data closely fit a normal distribution or can be ‘normalized’, possibly via mathematical transformation, a parametric prediction limit will be constructed. If the data cannot be normalized, a nonparametric rank-based or bootstrap prediction limit will be constructed instead. Non-parametric methods will also be considered when the skewness and pattern of the background data result in unrealistic and likely inaccurate parametric estimates.

The size of the background dataset impacts both the accuracy (false positive rate) and sensitivity (statistical power) associated with a prediction limit comparison. While some regulatory programs require or recommend at least 8 baseline samples prior to the start of statistical analysis and evaluations, often, more background data are needed to meet EPA performance requirements for groundwater tests, especially at larger well networks. These requirements are discussed below (Section 4.3.1).

4.2.3 Periodic Updating of Background

Background data will be updated for interwell statistical limits by consolidating more recent upgradient sampling observations with historical background data at least every four to eight new sampling events. Any new outliers in the combined background data will be down-weighted prior to construction of statistical limits. Updating in this fashion not only increases the background sample size but also reduces the incidence of false positives when using nonparametric prediction limits and increases the statistical power of parametric prediction limits.

For intrawell statistical limits, a similar consolidation of the site-specific intrawell background data will be done at each compliance well after every four new sampling events, with a similar inspection for new outliers. Since subtle trends or changes in the intrawell background observations can additionally impact the accuracy and potential bias of the updated statistical limits, two-sample tests and trend tests of the current background vs. the new candidate background observations will be run to ensure the older and newer data are comparable and can be combined prior to any statistical update. If the enlarged background data pool shows a significant trend or a significant difference in the newer measurements, the intrawell background will be re-examined and reconfigured as necessary to ensure it reflects current, but uncontaminated, conditions at the well.

4.3 Detection Monitoring Test

Prediction limits are recommended by EPA as a primary technique for Detection Monitoring. The Detection Monitoring methods described herein are in accordance with 40 CFR § 257.93(f)(3). Prediction limits are statistical thresholds estimated from background. If any new compliance observation exceeds the upper prediction limit, a potential statistical exceedance will be flagged. Retesting will then be conducted by collecting one or more independent resamples of the same well-constituent pair to confirm or disconfirm the initial exceedance. Any confirmed exceedance will be recorded as a statistically significant increase (SSI).

To conduct retesting, the pass one-of-m method, as described in Chapter 19 of the Unified Guidance, allows for an efficient plan to confirm or disconfirm a potential SSI over background identified during Detection Monitoring. Depending on the background sample size, the target site-wide false positive rate, and the available time period in which to collect independent resamples, either a 1-of-2 or 1-of-3 method will be used when retesting is needed.

Prediction limit tests will initially be implemented for all CCR program-required parameters. Note that if pH must be tested, it will require both upper and lower prediction limits. In that case, a potential SSI will be flagged whenever a new compliance measurement is either less than the lower statistical limit or higher than the upper statistical limit.

Parameters with all non-detects in background do not require formal testing but will be evaluated using EPA's Double Quantification Rule (DQR). The DQR assumes that a significant change in groundwater quality has occurred whenever two consecutive quantified detections (i.e., not 'J'-flagged or estimated values) of a parameter are observed after no previous detections. It is similar in nature to a nonparametric prediction limit with a single retest (1-of-2)

4.3.1 Statistical Performance Requirements

The Unified Guidance recommends two general criteria when designing a statistical Detection Monitoring program in order to meet RCRA statistical performance requirements: (1) an annual site-wide false positive rate (SWFPR) of no more than 10%, and (2) statistical power of a site's 'weakest' test greater than or equal to the minimum benchmark power represented by the EPA reference power curve.

The first criterion informs the accuracy of statistical testing, limiting the occurrence of spurious (false) SSIs. The second criterion guides the sensitivity of testing, ensuring an adequate probability of identifying real changes in groundwater quality. In practical terms, the annual SWFPR is distributed evenly among the total number of well-constituent pairs and among the total number of statistical evaluations per year. Statistical limits will be constructed with sufficient background size and retesting in order not to exceed the per-pair portion of the overall false positive risk. Similarly, site-specific power curves associated with each distinct type of test will be constructed and compared to the appropriate EPA reference power curve to ensure adequate statistical power.

Common regulatory program rules indicate that if an SSI over background is confirmed for one or more monitored constituents during Detection Monitoring (that is, after all necessary retesting has been conducted), then the owner or operator of the unit must, within a specified time frame: 1) establish an Assessment Monitoring program, 2) demonstrate that a source other than the unit caused the SSI over background, or 3) demonstrate that the SSI over background resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

4.4 Assessment Monitoring Tests

The methods described herein for Assessment Monitoring (i.e., confidence intervals and its variant confidence bands) are consistent with Unified Guidance recommendations.

To implement Assessment Monitoring, any detected monitoring parameters will be added to the list of parameters sampled semiannually. To statistically evaluate these parameters, concentration data will be compared to a GWPS through the use of confidence intervals or their variant, confidence bands. A confidence interval is recommended and appropriate when the monitoring data do not exhibit a statistically significant trend. A confidence band is more appropriate when a trend is present. The GWPS for each constituent will be established as either the Maximum Contaminant Level (MCL) or as a statistical limit based on background if either no MCL is available or background concentrations are higher in concentration than the established MCL.

4.4.1 Confidence Intervals

For each well-constituent pair, a trend test will be run to determine whether there is evidence of a significant trend. If not, a confidence interval around the population mean may be constructed at the 99% confidence level. Alternatively, a confidence band approach, as described in Section 4.2, below, may be applied.

If using a confidence interval approach, non-parametric bootstrap confidence intervals will be constructed as a robust statistical approach, due to possible non-normality, skewness or other reasons. The accuracy of non-parametric intervals, including the bootstrap, depends in part on the number of observations used to construct the interval. When a well-constituent pair does not have sufficient sample size to ensure high statistical accuracy, a confidence interval with potentially less accuracy will be constructed but updated after each new sampling event until the desired accuracy is reached. The pair will also continue to be reported and tracked using time series plots and/or trend tests until enough data are available.

In Assessment Monitoring, a compliance well (i.e. SC-10 through SC-13) is determined to be out of compliance and thereby has a statistically significant level (SSL), when the lower confidence limit (LCL) (and thus the entire interval), exceeds the GWPS, as discussed in EPA's Unified Guidance. Assessment of corrective measures is initiated within a specified regulatory time frame, with remediation efforts evaluated through the continuing use of confidence intervals and confidence bands to determine remedial effectiveness at compliance wells.

4.4.2 Confidence Bands

If the compliance data at a given well-constituent pair show evidence of a significant trend, a linear regression line will be fit to the data and a confidence band with 99% confidence will be constructed around the trend line. Confidence bands will only be constructed on pairs with at least four independent samples. This approach may also be applied in the absence of a significant trend for the sake of consistency.

To evaluate compliance with regulatory standards at compliance wells, the lower edge of the confidence band at the most recent sampling event will be compared to the GWPS. If the lower edge exceeds the GWPS at that point in time (thus guaranteeing the entire vertical cross-section of the band also exceeds the GWPS at that point), an SSL will be recorded. If the lower edge of the band does not exceed the GWPS, no SSL will have occurred. As new sampling events are collected, the trend estimate will be updated along with the confidence band.

4.5 Corrective Action Tests

If assessment of corrective measures is initiated due to exceedances at downgradient compliance monitoring wells (SC-10 through SC-13), this information will be placed in the operating record and, if possible, an ASD will be made. If there is evidence of an SSL above GWPS or if an ASD is not made regarding any SSL above GWPS, efforts will be made to characterize the nature and extent of the release. For statistical analysis, a minimum of eight quarterly rounds of baseline sampling will occur prior to considering corrective action.

Once corrective action activities begin, semiannual sampling will continue and confidence intervals and/or confidence bands will monitor the progress of corrective action efforts. Confidence intervals and bands are compared to GWPS or other risk-based criteria to determine when clean-up levels are achieved.

Though the same statistical techniques are used in Corrective Action and Assessment Monitoring, the manner of the comparison is different. In Corrective Action a well-constituent pair is declared 'clean' for the most recent sampling event when the entire confidence interval or cross-section of the confidence band falls below a specified clean-up limit or GWPS (i.e., the upper confidence limit or upper confidence band falls below the regulatory limit). Compliance is achieved when the lower confidence limit or lower confidence band for every required constituent does not exceed the GWPS for a period of three consecutive years.

4.6 Monitoring for Detection, Assessment, and Corrective Action

Figure 3 visually depicts the scheme for Detection and Assessment Monitoring and Corrective Action. Detection Monitoring data from each compliance monitoring well (SC-10 through SC-13) after each monitoring event will be compared to the upper prediction limits developed for each analyte to identify SSIs over background. Mann-Kendall trend analysis will also be used to identify statistically significant increasing trends for constituents with SSIs. If any constituent has a verified SSI, Assessment Monitoring will be implemented as discussed in 40 CFR 257.95**.** Assessment Monitoring compares the compliance well (SC-10 through SC-13) constituent concentrations to the GWPS (the higher of the MCL or a statistical limit based on background if either no MCL is available or background concentrations are higher in concentration than the established MCL) to determine if the constituent is present at a statistically significant level (SSL; i.e., exceeds the applicable groundwater standard).

5 Assessment Monitoring

5.1 Triggers and Timing

If, through the statistical analyses discussed in Section 4.0, it becomes evident that an SSI over background has occurred for one or more of the detection monitoring 40 CFR 257 Appendix III constituents, Utilities will place documentation in the facility operating record indicating which constituents have shown an increase and will notify CDPHE per CCR Rule requirements. The trigger for assessment monitoring occurs when an SSI has been identified in one or more of the downgradient compliance monitoring wells (SC-10 through SC-13). Utilities would then have three options for continued groundwater monitoring at the CCR Landfill.

- **Verification Sampling:** The first option would be to evaluate whether the increase resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality;
- **Alternate Source Demonstration:** The second option would be to evaluate whether a source other than the CCR Landfill caused a statistically significant increase; or
- **Assessment Monitoring:** The third option would be to establish an assessment monitoring program for the CCR Landfill in accordance with 40 CFR 257.95. An assessment monitoring program also includes annual groundwater sampling and analysis for the constituents listed in 40 CFR 257 Appendix IV. The purpose of assessment monitoring is to determine if releases of CCR Appendix III and IV constituents have occurred from the landfill. If this option proves to be necessary, Utilities will place a notification in the facility operating record stating that an assessment monitoring program has been established. Utilities would be required to implement the assessment monitoring program within 90 days of confirming the statistically significant concentration increase.

Protocols that would be followed for each of these options are described in Sections 5.2 through 5.4 below.

5.2 Verification Resampling

Verification resampling is an integral component of the statistical method outlined in Section 4.3. Verification sampling may consist of one or both of the following:

- A verification resample could only be collected from the well(s) where an outlier or statistically significant concentration increase was observed, and only for the relevant analyte(s). The same sampling procedures used for Detection Monitoring or Assessment Monitoring would also be used for verification resampling. Utilities would make reasonable efforts to complete verification resampling within two weeks of identifying the need to resample.

- Verification sampling may involve statistical testing of the downgradient monitoring wells (SC-10 through SC-13).

An SSI is only reported when verification sampling, as described above, confirms the initial result and when confirmed in the compliance monitoring wells (SC-10. SC-11, SC-12, and SC-13). A report documenting this action will be developed in accordance with the requirements of 40 CFR §257.94.

5.3 Alternate Source Demonstration

In addition to verification resampling, Utilities may also choose to evaluate whether the statistically significant concentration increase was derived from another source besides the CCR Landfill. Such an evaluation, if warranted, may require specialized sample analyses to identify concentration inputs from other potential sources. Any report prepared as a result of this evaluation or as a result of verification sampling will be entered into the facility operating record within 90 days of identifying the statistically significant concentration increase, and CDPHE will be notified per CCR Rule requirements. The report will also be certified by a professional engineer.

5.3.1 2022 Selenium Alternative Source Determination

An SSL of selenium was detected in groundwater sampled from monitoring well SC-10 during a semiannual sampling event in September 2022. The SSL detection was reported in the Annual Update Statistical Analysis Report (MacStat 2022) dated January 25, 2022. As a result, an assessment-mode ASD for the elevated selenium levels was completed in April 2022 that evaluated the potential for alternative sources causing the SSL detection.

The assessment-mode ASD findings indicated that the SSL for selenium resulted from a source other than the CCR unit; specifically, naturally occurring selenium released from alluvial sediments and underlying Pierre Shale (bedrock) in response to oxidizing conditions in the groundwater. The source of the selenium was found to have originated upgradient of the CCR Landfill. Multiple lines of evidence were presented in the assessment mode ASD and are summarized in the following sections (AECOM 2022).

5.3.1.1 Paleo-Alluvial Valleys

The Piney Creek Alluvium was deposited in drainages eroded down into the Pierre Shale bedrock. The original depositional and surface topography of the CSR area is obscured by the construction of the CCR Landfill, multiple sludge basins, lagoons, and designated land disposal units at the site since initial operations began in the early 1970s. An ArcMap structural contour map of the top of the Pierre Shale bedrock was constructed using information from around 80 boreholes across the CSR area (**Figure 4**). Additionally, U.S. Geologic Survey (USGS) geologic maps, flow lines and elevation contours from the USGS National Hydrography Dataset, and historical aerial imagery were consulted to inform the construction of the Pierre Shale structural contour map. An important observation from the structural contour map was the presence of a bedrock high beneath the northwest and central areas of the CCR Landfill. This area is currently covered with ash material, which extends down into the valleys to the north, east, and south of the bedrock high. The CCR Landfill is constructed over portions of two paleo-alluvial valleys, which are further separated by a bedrock high beneath a significant region of the landfill footprint.

5.3.1.2 Groundwater Conditions, Flow Directions, and Streamlines

Based on a review of boring logs in the CSR area, two hydrostratigraphic units (HSUs) were identified: the shallow Piney Creek Alluvium HSU (where it exists) and the uppermost weathered and unweathered zone of the underlying Pierre Shale (Kp) HSU. The Piney Creek Alluvium HSU is underlain by approximately 3,500 to 4,000 feet of Pierre Shale (Kp) that forms a hydraulic barrier between the alluvium and potential deeper water-bearing formations, if present. The saturated thickness of the Piney Creek Alluvium HSU ranges from approximately zero (dry) to 22 feet, with an average of 12 feet based on depth-to-water measurements in monitoring wells and depth-to-water or absence of water noted during drilling a borehole. This information was used to create an approximate boundary between the two HSUs and interpret groundwater flow and drainages (**Figure 4**). Groundwater present within the Piney Creek Alluvium HSU was determined to flow hydraulically downgradient to the east-southeast following the contour of the top of the alluvium-Pierre Shale contact. The extent of the Piney Creek Alluvium HSU is restricted to the paleo-alluvial valleys; (see “Paleo-alluvial Drainage Channels” on Figure 4), and therefore, groundwater flow in the uppermost saturated unit, both upgradient and downgradient of the CCR Landfill, is controlled by the locations of the paleo-alluvial valleys. The CCR Landfill is constructed over portions of two paleo-alluvial valleys separated by a bedrock high. These have been identified as the North Paleo-alluvial Channel and the South Paleo-alluvial Channel.

A potentiometric surface contour map of the Piney Creek Alluvium HSU was constructed using depth-to-water measurements from 20 wells measured on February 8 and 9, 2022 and combined with the Piney Creek Alluvium HSU boundaries (**Figure 5**). Flow lines were added to help visualize flow direction within the Piney Creek Alluvium HSU. The groundwater flow lines are shown in light blue and are drawn perpendicular to the darker blue potentiometric surface contours. Groundwater flow lines are subparallel streamlines that do not cross adjacent streamlines. As interpreted from the review of the bedrock structural contour map and the drainages present in the area before the development of the CCR Landfill facility, groundwater present beneath the south side of the CCR Landfill is hydraulically separated from and cannot flow to wells SC-10 and SC-11. This line of evidence is based on existing hydrogeologic conditions and is further supported by analysis of patterns in groundwater chemistry.

5.3.1.3 Chemical Signature Evaluation

Groundwater chemistry is significantly different in the North drainage as compared to the South drainage. Prior to this revision of the GWMP, groundwater samples were used to calculate background or upgradient concentrations of Appendix III and Appendix IV constituents (**Table 1**), which were obtained from monitoring wells completed only within the Piney Creek Alluvium HSU in the South drainage. Previously (prior to this GWMP), background concentrations for Appendix IV constituents were applied to downgradient monitoring wells located in both the South and North drainages; however, groundwater chemistry upgradient of the north side of the CCR Landfill is significantly different than the chemistry of groundwater flowing in the South drainage

Selenium is naturally occurring in the Pierre Shale and likely within clayey alluvial sediments derived from the Pierre Shale in the CSR region. Generally, selenium is immobile or stable under reducing or non-oxidizing groundwater conditions; however, laboratory column studies and field studies conducted in areas where Cretaceous marine shales (Pierre and Mancos) are present indicated that the presence of elevated concentrations of nitrate in groundwater can maintain oxidizing conditions sufficient to mobilize and transport selenium despite low DO concentrations. The nitrate concentrations in groundwater samples from monitoring wells located in the North drainage are significantly higher than samples obtained from wells located in the South drainage and concentrations of selenium are correspondingly significantly higher in wells located in the North drainage than wells located in the South drainage.

The association of elevated nitrate concentrations enhancing the dissolution of selenium from the Pierre Shale bedrock at the site is illustrated in wells WW-5A and WW-6A. Both monitoring wells are located in an additional “Northeast” drainage, and groundwater within this drainage does not flow beneath the CCR Landfill. Both wells encountered “hard black, green shale” at 22 to 23 feet below ground surface, noted groundwater at the contact between oxidized shale and underlying hard bedrock, and were screened in the lower 10 feet of oxidized shale and underlying 30 feet of hard shale. Analytical results from groundwater concentrations of selenium and nitrate in samples collected in February 2022 from wells WW-5A and WW-6A were elevated but are unrelated to the presence and operation of the CCR Landfill. Additional information on WW-5A and WW-6A is provided in the April 2022 ASD.

5.4 Assessment Monitoring Program

The purpose of Assessment Monitoring is to determine if constituent releases have occurred from the landfill to groundwater. Assessment Monitoring is required whenever a statistically significant increase over background has been detected for one or more of the constituents listed in 40 CFR §257 Appendix III. A routine monitoring sample result will only be considered valid if the verification sample result confirms a statistically significant increase over background values. If this situation occurs, the facility will implement an Assessment Monitoring program within 90 days of obtaining the verification resample result in accordance with 40 CFR 257.95.

If one or more of the Assessment Monitoring constituents are detected at an SSL above the background concentrations at the compliance wells (SC-10 through SC-13), the facility will:

- (a) Characterize the nature and extent of the release by installing additional monitoring wells, as necessary, and collecting data on the nature and estimated quantity of material released;

- (b) Install at least one additional monitoring well at the facility boundary in the direction of contaminant migration, and sample and analyze groundwater from this well for the Detection and Assessment Monitoring constituents. Existing monitoring wells located at the facility Certificate of Designation boundary may be sampled to meet this requirement;

- (c) Notify all persons who own the land or reside on the land that directly overlies any part of the contamination if contaminants have migrated off-site; and

- (d) Within 90 days, (i) initiate an assessment of corrective measures, (ii) demonstrate that a source other than the landfill caused the contamination, or (iii) show that the SSL resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. A report documenting this demonstration must be certified by a qualified groundwater scientist or professional engineer and placed in the operating record.

In Assessment Monitoring, the owner or operator of the CCR unit must sample and analyze the groundwater for all constituents listed in 40 CFR §257 Appendix IV (**Table 1**) within 90 days of a confirmed statistically significant increase over background, and annually thereafter. Within 90 days of obtaining the initial Assessment Monitoring results, and on at least a semiannual basis thereafter, all monitoring wells must be resampled. Analyses for all parameters in 40 CFR §257 Appendix III and for previously detected constituents in 40 CFR §257 Appendix IV must be conducted. All Assessment Monitoring results will be entered into the facility operating record as required by 40 CFR §257.95. The facility can return to detection monitoring once assessment monitoring results are at or below background values for two consecutive assessment monitoring events.

6 References

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Tables

Table 1
Analytical Parameters, Methods, and Sampling Frequency
CCR Landfill Detection Monitoring Program
Colorado Springs Utilities Clear Springs Ranch

Constituent	Analytical Method	Preservation	Sampling Frequency
Appendix III List - Constituents for Detection Monitoring			
Boron	EPA Method 200.7	Nitric Acid	Semi-Annual
Calcium	EPA Method 200.7	Nitric Acid	Semi-Annual
Chloride	EPA Method 300.0	≤ 6°C	Semi-Annual
Fluoride[1]	SM 4500FC	≤ 6°C	Semi-Annual
pH	SM 4500HB/Field Measurement	≤ 6°C	Semi-Annual
Sulfate	EPA Method 300.0	≤ 6°C	Semi-Annual
Total Dissolved Solids	SM 2540C	≤ 6°C	Semi-Annual
Appendix IV List - Constituents for Assessment Monitoring[2]			
Antimony	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual
Arsenic	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual
Barium	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual
Beryllium	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual
Cadmium	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual
Chromium	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual
Cobalt	EPA Method 200.7	Nitric Acid	Annual, Semi-Annual
Fluoride[1]	SM 4500FC	≤ 6°C	Annual, Semi-Annual
Lead	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual
Lithium	EPA Method 200.7	Nitric Acid	Annual, Semi-Annual
Mercury	EPA Method 1631	Hydrochloric Acid	Annual, Semi-Annual
Molybdenum	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual
Radium-226	EPA Method 903.0	Nitric Acid	Annual, Semi-Annual
Radium-228	EPA Method 904.0	Nitric Acid	Annual, Semi-Annual
Selenium	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual
Thallium	SW-846 6010/6020	Nitric Acid	Annual, Semi-Annual

Notes:

≤ 6°C = less than or equal to 6 degrees Celsius

CCR = Coal Combustion Residuals

EPA = United States Environmental Protection Agency

[1] SM 4500 FC with standard addition may be utilized for fluoride analysis.

[2] If assessment monitoring is triggered all Appendix IV constituents must be sampled annually. In addition, Appendix IV constituents that exceed background in the initial assessment monitoring sampling or the annual sampling, must be sampled semi-annually, along with the Appendix III constituents.

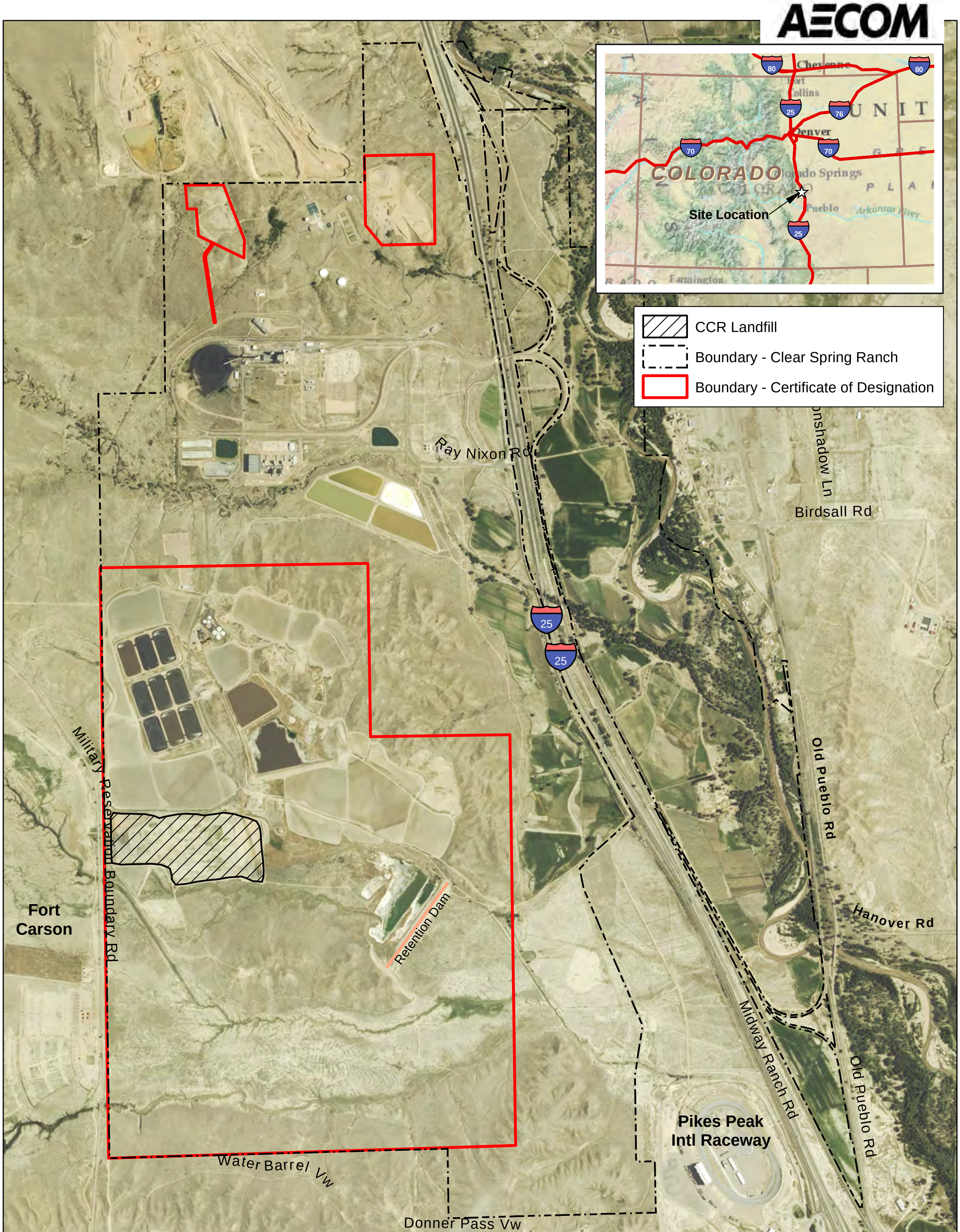
Table 2
Monitoring Well Construction Details
CCR Landfill Detection Monitoring Program
Colorado Springs Utilities Clear Spring Ranch

Well Name	Location Relative to Ash Landfill	Easting (feet)	Northing (feet)	Top of Casing Elevation (ft amsl)	Ground Surface Elevation (ft amsl)	Total Depth (ft bgs)	Well Screen Interval (ft bgs)	Well Screen Lithology
CC-1	Upgradient Well	3223490.00	1280702.88	5478.67	5476.72	38.0	33 - 38	Pierre Shale
FC-1	Upgradient Well	3223188.25	1283318.75	5486.87	5484.77	33.0	28 - 33	Silty Clay
FC-2	Upgradient Well	3223214.00	1282123.88	5483.00	5480.80	28.0	12.5 - 28	Silty Clay
FC-3A	Upgradient Well	3223409.73	1282807.37	5484.29	5481.78	34.8	14 - 34	Alluvium
FC-3B	Upgradient Well	3223416.43	1282806.09	5483.75	5481.29	55.1	45 - 55	Pierre Shale
SC-10	Downgradient Well	3226344.60	1283428.94	5447.65	5445.51	35.3	15 - 35	Alluvium
SC-11	Downgradient Well	3226374.64	1283151.69	5444.54	5442.18	30.7	10 - 30	Alluvium
SC-12	Downgradient Well	3226399.78	1282807.25	5444.32	5442.11	25.8	5 - 25	Alluvium
SC-13	Downgradient Well	3226375.83	1282422.79	5445.98	5443.61	23.2	5 - 22.5	Alluvium
SC-15	Upgradient Well	3225042.11	1284890.11	5483.13	5480.75	35.3	20 - 35	Alluvium
SC-18	Upgradient Well	3224403.70	1284057.50	5468.19	5465.86	30.0	10 - 30	Alluvium
SC-19	Upgradient Well	3224353.14	1284195.79	5469.68	5467.36	25.0	10 - 25	Alluvium

Notes:
CCR = Coal Combustion Residuals
ft amsl = feet above mean sea level
ft bgs = feet below ground surface

Easting and northing are survey coordinates in Colorado State Plane, Central, NAD 83/86, US survey foot

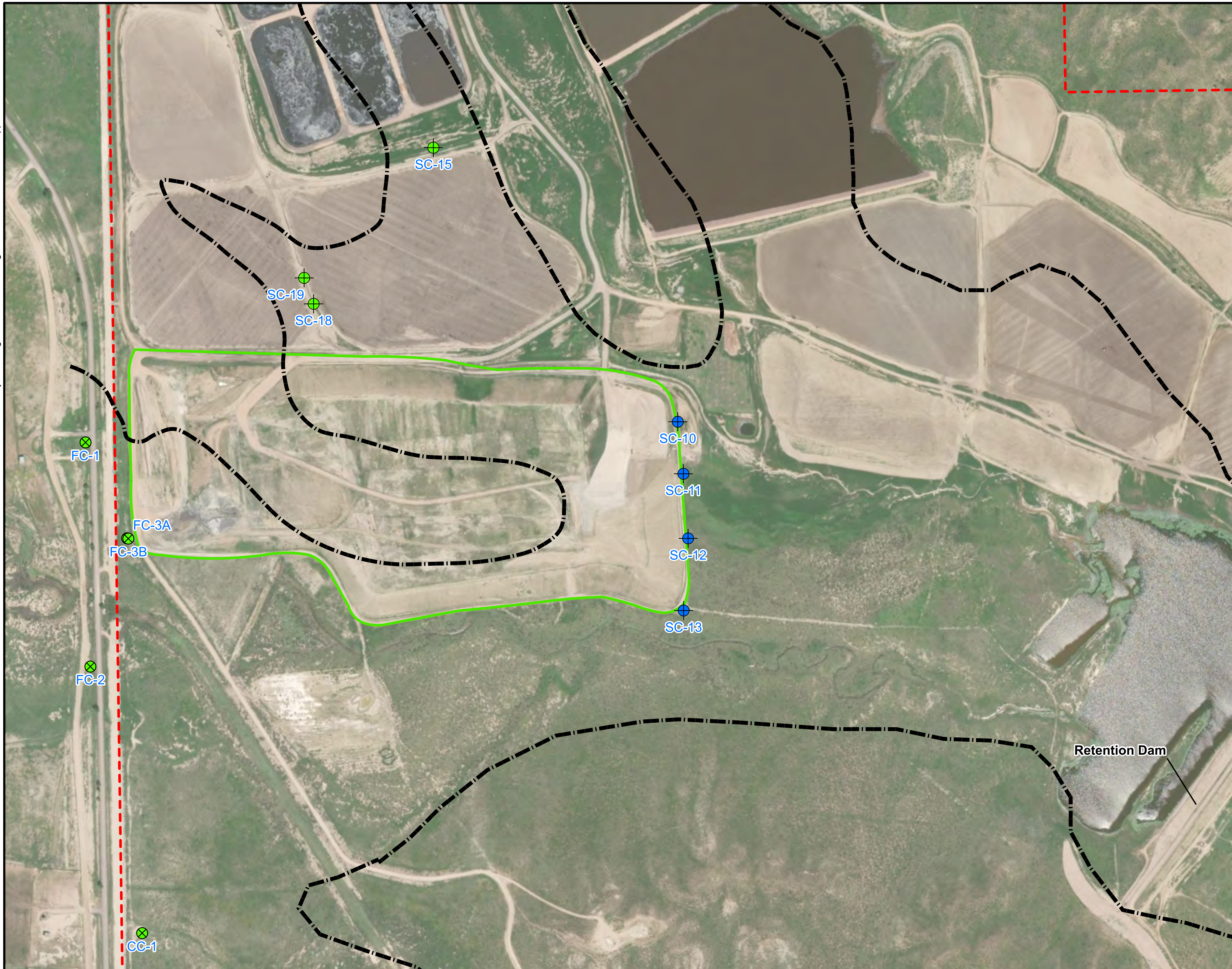
Figures



Job No.	60712294
Prepared By:	AMS
Date:	1/15/2026

Figure 1
Site Location Map
CCR Landfill Groundwater Monitoring Plan
Colorado Springs Utilities Clear Spring Ranch
El Paso County, Colorado

\\na.aecomnet.com\lfs\AMER\Denver-USDEN06\DCS\Projects\ENV\60442000_CSU_Clear_Sprg_Rch\7.0_CAD_GIS\7.01_GIS_Maps\Fig01 Site Location.mxd



Legend

CCR Status

- Background - North Paleo-Alluvial Valley
- Background - South Paleo-Alluvial Valley
- Downgradient
- Boundary Certificate of Designation
- Boundary CCR Landfill
- Boundary - Piney Creek Alluvium HSU Approximate

Note:
1. HSU = Hydrostratigraphic Unit

N

1 inch = 500 feet

0 250 500 1,000

Feet

AECOM

Title:

Groundwater Monitoring Well Network with Outline of PCA HSU

Project: Revisions to the Groundwater Monitoring Plan CCR Landfill

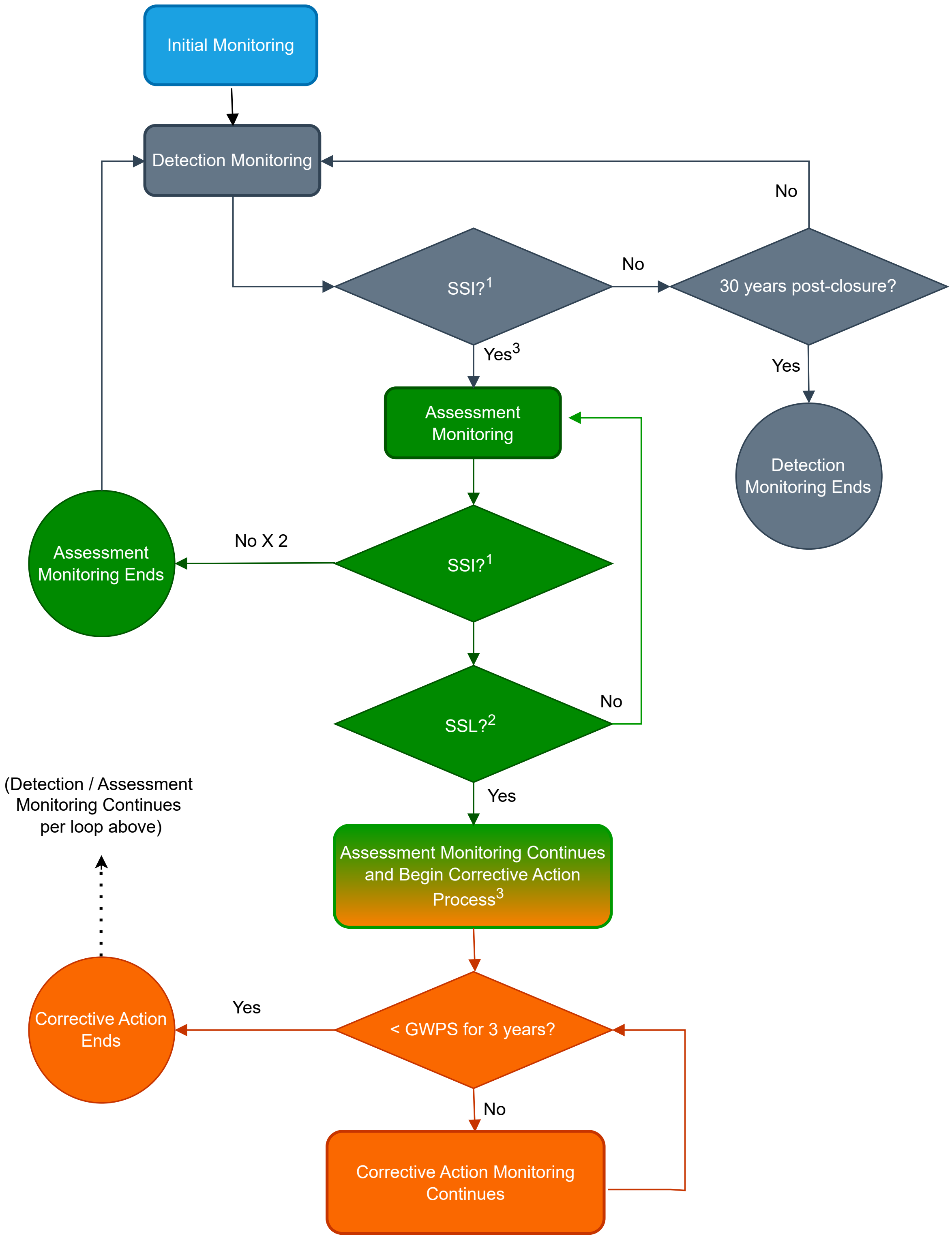
Location: Clear Spring Ranch El Paso County, CO

Project No.:	Date:	Figure:
60712294	1/16/2026	2

ANSI 11" x 17" Approved:CRG Checked:CRG Designer:MKL Project Manager Initials:SW

\\na.aecomnet.com\lfs\AMER\Denver-USDEN06\DCS\Projects\ENV\60712294_2023_CSU_CCR_LFWells_GWMP\500_Deliverables\501_Federal GWMP\Rev1_01.09.2026\3_Figures\GIS\Colorado_Springs_Utilities.aprx

Figure 3. Scheme for Detection and Assessment Monitoring and Corrective Action



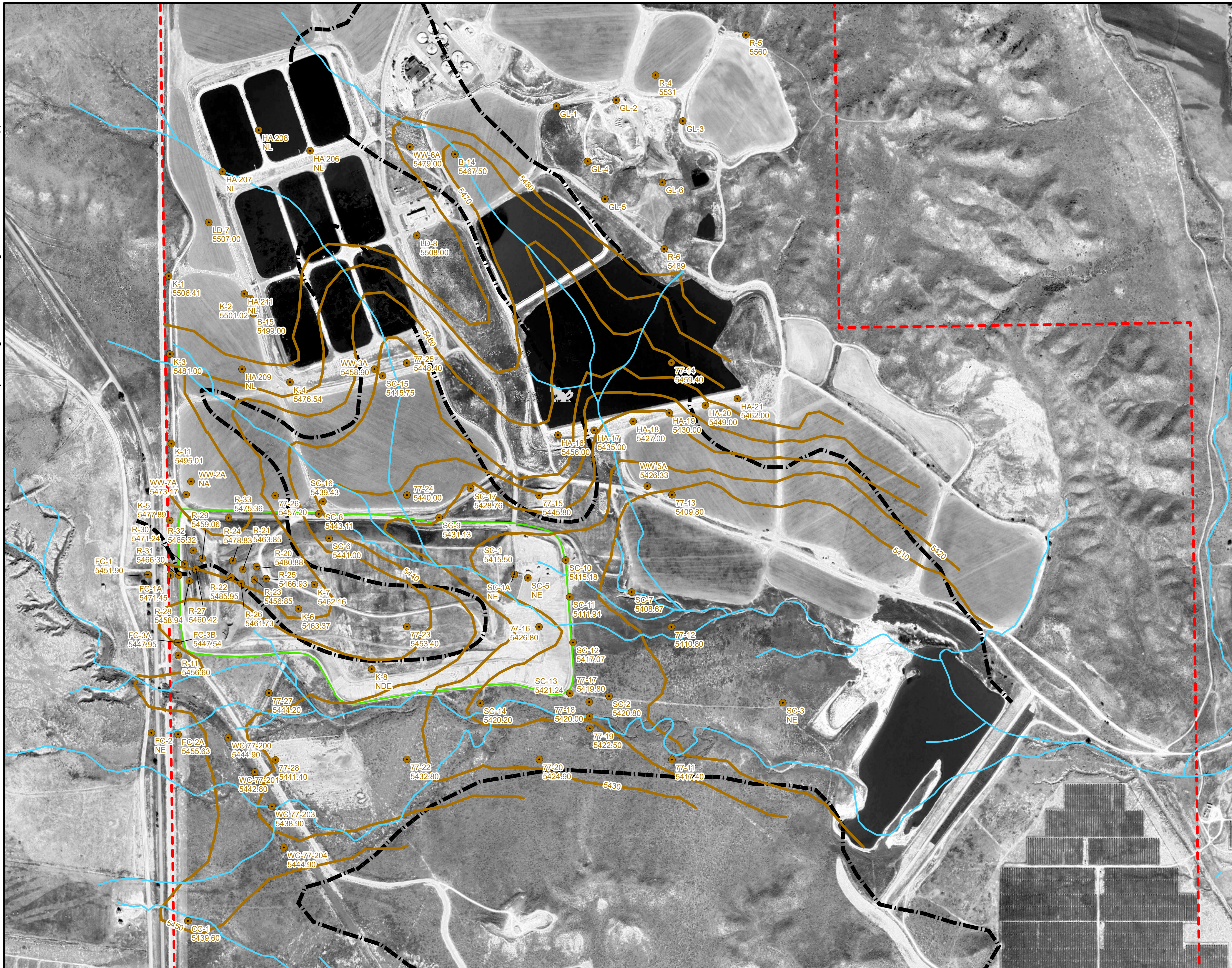
Notes:

[1] A Statistically Significant Increase (SSI) is present when detection monitoring concentrations exceed background for two consecutive monitoring events.

[2] A Statistically Significant Level (SSL) is present when the lower confidence limit (LCL) exceeds the Groundwater Protection Standards (GWPS).

[3] True unless a demonstration is made that the SSI or SSL is not due to a release.

ANSI 11" x 17"
Approved:CRG Checked:CRG Designer:MKL Project Manager Initials:SW



Legend

- Borehole Top of Bedrock Elevation
- Bedrock Elevation Contours (10-ft Interval)
- Paleo-alluvial Drainage Channels
- Boundary Certificate of Designation
- Boundary CCR Landfill
- Boundary - Piney Creek Alluvium HSU Approximate

Note:
1. HSU = Hydrostratigraphic Unit
2. Bedrock elevations derived from existing historical borehole logs. Supplemented with National Hydrology Dataset (NHD) contours from historic United States Geological Survey (USGS) topographic map of Butte Quadrangle.
3. Wells outside the monitoring well network were used to inform the bedrock contour map.

N

1 inch = 708 feet

0 250 500 1,000
Feet

AECOM

Title:
Top of Pierre Shale Bedrock Structure Contour Map

Project:
Revisions to the Groundwater Monitoring Plan
CCR Landfill

Location:
Clear Spring Ranch
El Paso County, CO

Project No.:	Date:	Figure:
60712294	1/16/2026	4

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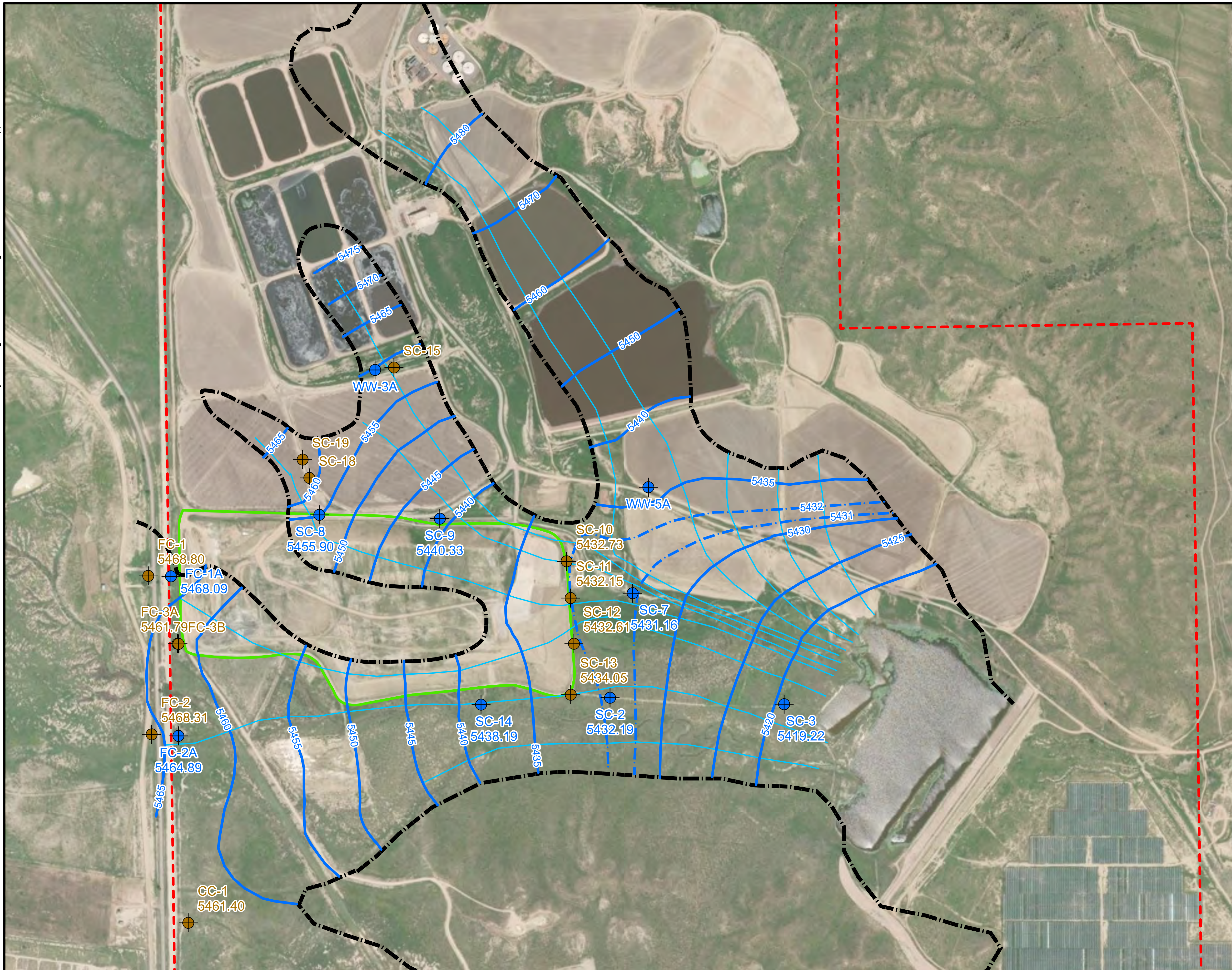
Project Manager Initials:SW Designer:MKL Checked:CRG Approved:CRG ANSI 11" x 17"



Legend

HSU

- Wells Within the Monitoring Well Network
- Wells Outside the Monitoring Well Network
- Potentiometric Surface Contour (5 ft interval)
- Potentiometric Surface Contour (1 ft interval)
- Groundwater Flow Line
- Boundary Certificate of Designation
- Boundary CCR Landfill
- Boundary - Piney Creek Alluvium HSU Approximate

Note:
1. Depth to water measurements obtained February 8 and 99, 2022.
2. HSU = Hydrostratigraphic Unit
3. Groundwater flow lines are drawn perpendicular to potentiometric surface contours.
4. Wells outside the monitoring well network were used to inform the potentiometric surface contour map.

N

1 inch = 708 feet

0 250 500 1,000
Feet

AECOM

Title: **Potentiometric Surface Map and Groundwater Flow Lines Piney Creek Alluvium HSU Wells**

Depth to Water Measured February 8 and 9, 2022

Project: Revisions to the Groundwater Monitoring Plan CCR Landfill

Location: Clear Spring Ranch El Paso County, CO

Project No.:	Date:	Figure:
60712294	1/16/2026	5

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Attachment 1 Statistical Analysis Report North Paleo Channel Groundwater Monitoring Well Network

Table of Contents

List of Attachments

List of Appendices

Statistical Analysis Report
North Paleo Channel Groundwater Monitoring Well Network

1 Introduction

Upgradient background wells and compliance wells for the North Paleo Channel monitoring network are summarized in Table 1. This analysis includes background data collected in the eight consecutive events from 9/27/2023 through 11/18/2024 and downgradient compliance well data from 06/22/2016 through 3/11/2025.

Table 1: North Paleo Channel Monitoring Network

Background	Downgradient
SC-15	SC-10
SC-18	SC-11
SC-19	

Table 2: Appendix III and IV Analytical Parameters

Constituent	Begin Date	End Date	Appendix
Antimony	6/22/2016	3/11/2025	IV
Arsenic	6/22/2016	3/11/2025	IV
Barium	6/22/2016	3/11/2025	IV
Beryllium	6/22/2016	3/11/2025	IV
Boron	6/22/2016	3/11/2025	III
Cadmium	6/22/2016	3/11/2025	IV
Calcium	6/22/2016	3/11/2025	III
Chloride	6/22/2016	3/11/2025	III
Chromium	6/22/2016	3/11/2025	IV
Cobalt	6/22/2016	3/11/2025	IV
Fluoride	6/22/2016	3/11/2025	IV, III
Lead	6/22/2016	3/11/2025	IV
Lithium	6/22/2016	3/11/2025	IV
Mercury	6/22/2016	3/11/2025	IV
Molybdenum	6/22/2016	3/11/2025	IV
pH	6/22/2016	3/11/2025	III
Radium 226 + 228	6/22/2016	3/11/2025	IV
Selenium	6/22/2016	3/11/2025	IV
Sulfate	6/22/2016	3/11/2025	III
Total Dissolved Solids (TDS)	6/22/2016	3/11/2025	III
Thallium	6/22/2016	3/11/2025	IV

2 Appendix III Statistical Analysis

The Appendix III statistical analysis for the North Paleo Channel under Coal Combustion Residue (CCR) detection monitoring involved the following steps:

1. The analytical result for each Appendix III parameter in each compliance well was compared to a background upper prediction limit (UPL) calculated using data from upgradient background wells (in the case of pH, a background prediction interval was used);
2. If the Appendix III parameter concentration in a compliance well exceeded the background UPL (or fell outside of the prediction interval, for pH), a potential statistically significant increase (SSI) was declared; and
3. If a potential SSI was declared in Step 2, the result of one resample was compared to the background UPL (or prediction interval, for pH). If the resample result exceeded the background UPL (or fell outside of the prediction interval, for pH), an SSI was declared.

2.1 Background Prediction Limits

Background UPLs (and prediction interval, for pH), were calculated using the combined data from the upgradient background wells in the most recent eight consecutive monitoring events (Section 1). The background data were evaluated first for potential outliers, then for underlying statistical distribution.

Potential outliers were identified visually and quantitatively using a method developed by Cameron (2024). Potential outliers identified using these methods were down-weighted. A weight of 1 was used for all non-outlier values.

No outliers were identified in the upgradient background data. Six outliers were identified in the downgradient compliance well data. Down-weighted outliers in downgradient wells are shown in Table 3.

Table 3: Down-Weighted Downgradient Outliers

COI	Well	Result	Units	ND Flag	Date	Outlier	Weight
Antimony	SC-10	15	µg/L	1	9/26/2023	OUT	4.03E-10
Antimony	SC-11	15	µg/L	1	9/26/2023	OUT	1.60E-11
Barium	SC-11	40.5	µg/L	0	9/26/2022	OUT	2.73E-03
Chloride	SC-10	790	mg/L	0	9/26/2023	OUT	3.10E-03
Mercury	SC-10	0.036	µg/L	0	6/22/2016	OUT	4.80E-04
Mercury	SC-11	0.067	µg/L	0	6/22/2016	OUT	1.15E-04

COI = compound of interest
mg/L = milligrams per liter
ND = Not Detected
µg/L = micrograms per liter

Background data were evaluated for underlying statistical distribution. Either a known statistical distribution was identified, or a mathematical transformation that best normalized the data. UPLs (or interval, for pH) were calculated using the raw data (if the raw data were approximately normal), or the transformed data, otherwise. If calculated using transformed data, the prediction limit/interval was back-transformed to the original units. Background UPLs (or interval, for pH) are summarized in Table 4.

Table 4: Background Interwell Prediction Limits

COI	N	ND%	Model	1-of-m	FPR	Units	LPL	UPL
Boron	24	0	TBOOT_Log	2	0.0149	µg/L	NA	1528
Calcium	24	0	NP	2	0.012	µg/L	NA	670000
Chloride	24	0	NP	2	0.0141	mg/L	NA	653
Fluoride	24	8.3	NP	2	0.0141	mg/L	NA	0.19
pH	24	0	TBOOT_^1/8	2	0.0149	SU	6.41	7.26
Sulfate	24	0	NP	2	0.0141	mg/L	NA	12539
TDS	24	0	TBOOT_Cube	2	0.0149	mg/L	NA	17960

µg/L = micrograms per liter
COI = compound of interest
FPR = false positive rate
LPL = lower prediction limit
m = Number of events needed to declare a statistically significant increase
mg/L = milligrams per liter
N = Number of samples
NA = Not Applicable
ND = Not Detected
NP = Nonparametric
SU = standard unit
TDS = total dissolved solids
UPL = upper prediction limit

2.2 Comparison to Prediction Limits

Appendix III parameter concentrations in each downgradient compliance well were compared individually to their respective background value(s). If the compliance well concentration exceeded the background UPL (or fell outside of the background interval, for pH), a potential SSI was declared and the resample (i.e., the analytical result from the next subsequent sampling event) was similarly evaluated. If the resample also exceeded the background UPL (or fell outside of the interval, for pH), an SSI was declared.

Table 5 summarizes potential and confirmed SSIs. Potential and confirmed SSIs are also visually identifiable on time-series plots with a horizontal line identifying the background value (Appendix B).

Table 5: Potential and Confirmed SSIs in the North Paleo Channel Well Network

COC	Well	Date	Result	Units	Stage	LPL	UPL	SSI
Boron	SC-11	3/11/2025	2780	µg/L	Resample/SSI	NA	1528	YES
Boron	SC-11	9/18/2024	2710	µg/L	Resample/SSI	NA	1528	YES
Boron	SC-11	3/19/2024	2570	µg/L	Sample	NA	1528	YES
Chloride	SC-10	3/11/2025	1030	mg/L	Resample/SSI	NA	652.7	YES
Chloride	SC-10	9/18/2024	998	mg/L	Resample/SSI	NA	652.7	YES
Chloride	SC-10	3/19/2024	1000	mg/L	Sample	NA	652.7	YES

Table 5: Potential and Confirmed SSIs in the North Paleo Channel Well Network

COC	Well	Date	Result	Units	Stage	LPL	UPL	SSI
Chloride	SC-11	3/11/2025	1320	mg/L	Resample/SSI	NA	652.7	YES
Chloride	SC-11	9/18/2024	1270	mg/L	Resample/SSI	NA	652.7	YES
Chloride	SC-11	3/19/2024	1290	mg/L	Sample	NA	652.7	YES
Fluoride	SC-10	3/11/2025	530	µg/L	Resample/SSI	NA	190	YES
Fluoride	SC-10	9/18/2024	500	µg/L	Resample/SSI	NA	190	YES
Fluoride	SC-10	3/19/2024	490	µg/L	Sample	NA	190	YES
Fluoride	SC-11	3/11/2025	630	µg/L	Resample/SSI	NA	190	YES
Fluoride	SC-11	9/18/2024	580	µg/L	Resample/SSI	NA	190	YES
Fluoride	SC-11	3/19/2024	560	µg/L	Sample	NA	190	YES
pH	SC-10	3/11/2025	7.3	µg/L	Resample/SSI	6.41	7.26	YES
pH	SC-10	9/18/2024	7.3	µg/L	Sample	6.41	7.26	YES
pH	SC-10	3/19/2024	7.2	µg/L	NA	6.41	7.26	NO

µg/L = micrograms per liter
COC = contaminant of concern
LPL = lower prediction limit
mg/L = milligrams per liter
NA = Not Applicable
SSI = statistically significant increase
UPL = upper prediction limit

2.3 Summary of Appendix III Results

The results of the above comparison are summarized in Table 6, a "traffic light" matrix. A green cell indicates no potential or confirmed SSIs after the most recent sampling event (incorporating comparisons throughout the eight sampling events). Potential SSIs are identified by a yellow cell, and confirmed SSIs are indicated by a red cell.

In summary, five confirmed SSIs were identified among the Appendix III parameters.

Table 6: Summary of Appendix III Statistical Comparison Results for the North Paleo Channel Well Network

	Well Locations	
COC	SC-10	SC-11
Boron	GRN	RED
Calcium	GRN	GRN
Chloride	RED	RED
Fluoride	RED	RED
pH	RED	GRN
Sulfate	GRN	GRN
TDS	GRN	GRN

COC = contaminant of concern
TDS = total dissolved solids

Color-Coding Key:

RED = Initial and resample results outside prediction limit bounds;

YLW = Initial results outside bounds (potential SSI);

GRN = Results within prediction limit bounds

3 Appendix IV Statistical Analysis

The Appendix IV statistical analysis conducted for Assessment Monitoring in this report involved:

1. Development of the Groundwater Protection Standards (GWPS) for each Appendix IV parameter as the maximum of the published maximum contaminant limit (MCL) (or 40 code of federal regulations [CFR] 257.95(h)(2) water quality limit) or a background value derived from upgradient background data;
2. Calculation of trends and associated confidence bands for each Appendix IV parameter in each compliance well; and
3. Comparison of trend line confidence bands to respective GWPS values to evaluate for statistically significant levels (SSLs).

3.1 Establishment of GWPS

Background values were computed 95% confidence, 95% coverage upper tolerance limits (UTLs) consistent with United States Environmental Protection Agency (USEPA) recommendations (USEPA, 2009). Prior to calculating UTLs, the upgradient background data were evaluated as described in Section 2.

A GWPS was established for each Appendix IV parameter as the maximum of the USEPA-published MCL (or the value provided in 40 CFR 257.95(h)(2) for parameters without published MCLs) and the respective background UTL. GWPS limits are summarized in Table 7.

Table 7: GWPS Limits for the North Paleo Channel Well Network

COI	Model	N	Coverage	Confidence	UTL	RegLimit	GWPS	Units
Antimony	NP	24	0.95	0.71	2	6	6	µg/L
Arsenic	NP	24	0.95	0.71	5	10	10	µg/L
Barium	TBOOT_Log	24	0.95	0.95	19	2000	2000	µg/L
Beryllium	NP	24	0.95	0.71	1	4	4	µg/L
Cadmium	NP	24	0.95	0.71	1	5	5	µg/L
Chromium	NP	24	0.95	0.69	3	100	100	µg/L
Cobalt	NP	24	0.95	0.71	5	6	6	µg/L
Fluoride	NP	24	0.95	0.68	0.19	4	4	mg/L
Lead	NP	24	0.95	0.69	1	15	15	µg/L
Lithium	TBOOT-^1/4	24	0.95	0.95	1110	40	1110	µg/L
Mercury	TBOOT-^1/2	24	0.95	0.95	0.02	2	2	µg/L
Molybdenum	TBOOT-^1/2	24	0.95	0.95	2.9	100	100	µg/L
Rad226+228	TBOOT-Norm	24	0.95	0.95	2.5	5	5	pCi/L
Selenium	NP	24	0.95	0.71	340	50	340	µg/L
Thallium	NP	24	0.95	0.71	1	2	2	µg/L

µg/L = micrograms per liter
COI = contaminant of interest
GWPS = groundwater protection standards
mg/L = milligrams per liter
N = Number of samples
NP = Nonparametric
pCi/L = picoCuries per liter
RegLimit = regulatory limit
UTL = upper tolerance limit

3.2 Comparison to GWPS

Confidence bands for modeled trends were used to compare compliance data to GWPSs for Appendix IV parameters.

3.2.1 Trend Lines and Confidence Bands

To account for any trends in Appendix IV concentrations in compliance wells, a confidence band around a trend line was developed in accordance with USEPA recommendations (2009). Trend lines and confidence bands were computed using the weighted sample data and linear regression analysis (Draper & Smith, 1998). At each Assessment Monitoring event, an interval was determined by the confidence band at the Assessment Monitoring date for each Appendix IV parameter in each compliance well.

3.2.2 Comparison of Lower Confidence Bands to GWPS

The interval described in Section 3.2.1 for each Appendix IV parameter in each compliance well, was compared to the GWPS for that parameter-well combination to evaluate for SSLs. If the entire interval determined by the confidence band at the compliance date being evaluated exceeded the GWPS, an SSL was declared.

3.3 Summary of Appendix IV Results

The results of the comparisons described in Section 3.2.2 are summarized in Table 8. Similar to the comparisons described in Section 2, a "traffic light" matrix was used to summarize results. A green cell indicates no SSL in the sampling event being evaluated. A red cell indicates identification of an SSL. Yellow cells suggest maintaining a closer watch of a parameter-well combination in cases where the lower limit of the interval exceeds two-thirds of the GWPS, or more. SSLs are also visually identifiable on time-series plots with fitted linear regression lines and confidence bands and a horizontal line identifying the GWPS (Appendix B).

In summary, no SSLs were identified among the Appendix IV parameters.

Table 8: Summary of Appendix IV Statistical Comparison Results for the North Paleo Channel Well Network

	Well Locations	
COC	**SC-10**	**SC-11**
Antimony	GRN	GRN
Arsenic	GRN	GRN
Barium	GRN	GRN
Beryllium	GRN	GRN
Cadmium	GRN	GRN
Chromium	GRN	GRN
Cobalt	GRN	GRN
Fluoride	GRN	GRN
Lead	GRN	GRN

Table 8: Summary of Appendix IV Statistical Comparison Results for the North Paleo Channel Well Network

	Well Locations	
COC	**SC-10**	**SC-11**
Lithium	GRN	GRN
Mercury	GRN	GRN
Molybdenum	GRN	GRN
Rad226+228	GRN	GRN
Selenium	GRN	GRN
Thallium	GRN	GRN

COC = contaminant of concern
GWPS = groundwater protection standards

Color-Coding Key

RED = Confidence Interval (CI) Band above GWPS;

YLW = CI Band straddles GWPS or Lower Bound at least 2/3 of GWPS;

GRN = CI Band below GWPS

4 References

Cameron, K. 2024 Cameron, K. (2024). Outlier accommodation in censored time series. 2024 JSM Proceedings. https://doi.org/https://doi.org/10.5281/zenodo.13994247

Draper, N. R., & Smith, H. (1998). Applied regression analysis, 3rd edition. Wiley: NY.

USEPA. (2009). Statistical analysis of groundwater monitoring data at RCRA facilities: Unified guidance. USEPA: Office of Resource Conservation & Recovery, EPA 530-R-09-007.

Attachment A

2025 Groundwater Monitoring Plan CCR North Paleo Alluvial Channel Ash Landfill Statistical Summary

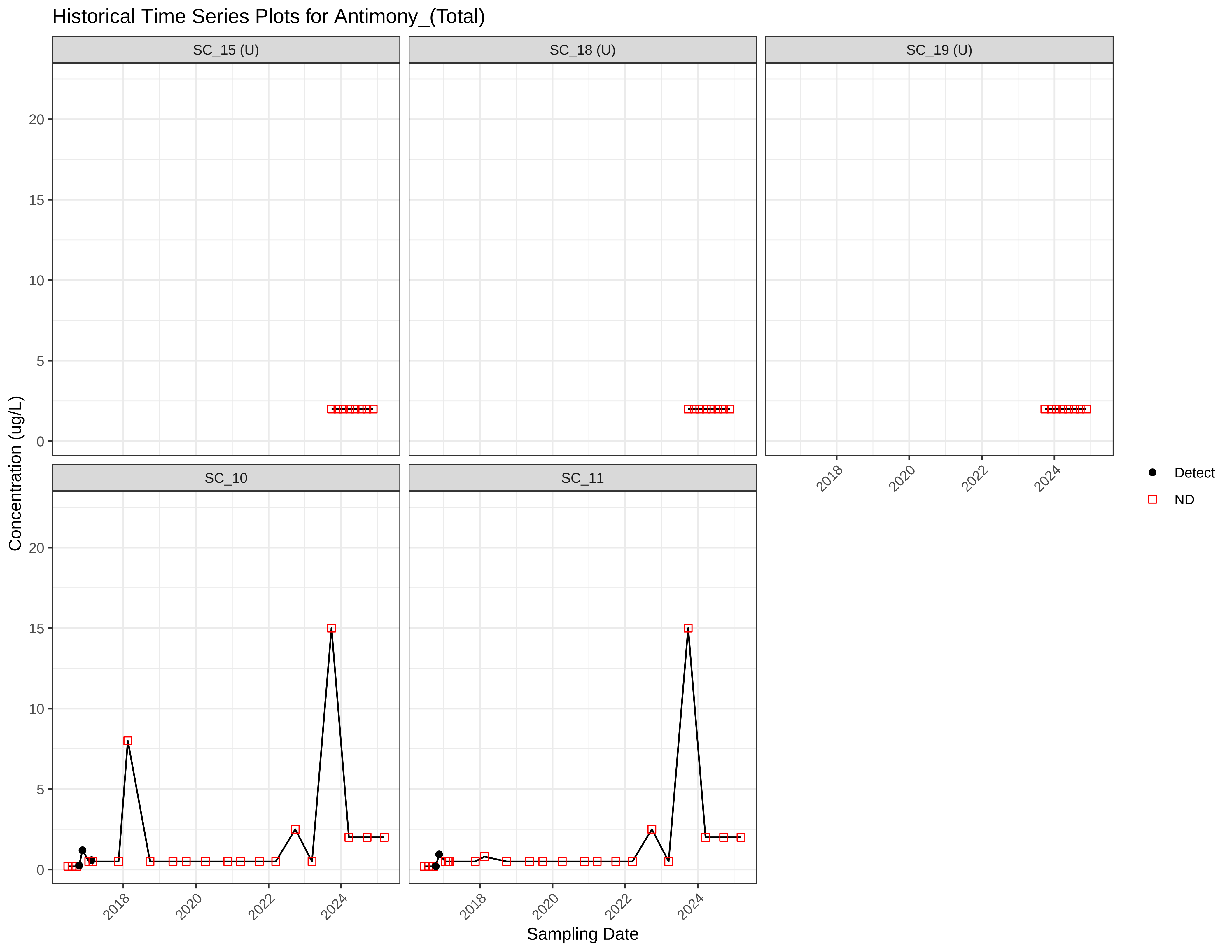
Attachment A – 2025 Groundwater Monitoring Plan CCR North Paleo Alluvial Channel Ash Landfill Statistical Summary

	Background Wells			Downgradient Wells	
Statistical Method/Test	**SC-15**	**SC-18**	**SC-19**	**SC_10**	**SC_11**
Down-weighted Extreme Outliers	0	0	0	3	3
Seasonality	None	None	None	None	None
Trends/Time Series – Appendix III	pH - D	Fluoride - D; pH - D	Chloride - U; TDS - D	Chloride - U; Sulfate - D; TDS - D	Boron - U; Chloride - U; Sulfate - U
Trends/Time Series – Appendix IV	Mercury - D	Barium - D; Fluoride - D; Radium 226 + 228 - D;	Barium - D	Lead - D; Molybdenum - D	Antimony - U Barium - D Chromium - D Lead - D Lithium - U Selenium - U
Prediction Limit Apx III SSIs	NA	NA	NA	2	3
Confidence Band Apx IV SSLs	NA	NA	NA	0	0

Notes:
CCR = coal combustion residual
D = decreasing
NA = Not Applicable
SSI = statistically significant increase
SSL = statistically significant levels
TDS = total dissolved solids
U = increasing

Appendix A

Exploratory Plots


Historical Time Series Plots for Antimony_(Total)
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_10
SC_11
Concentration (ug/L)
Sampling Date
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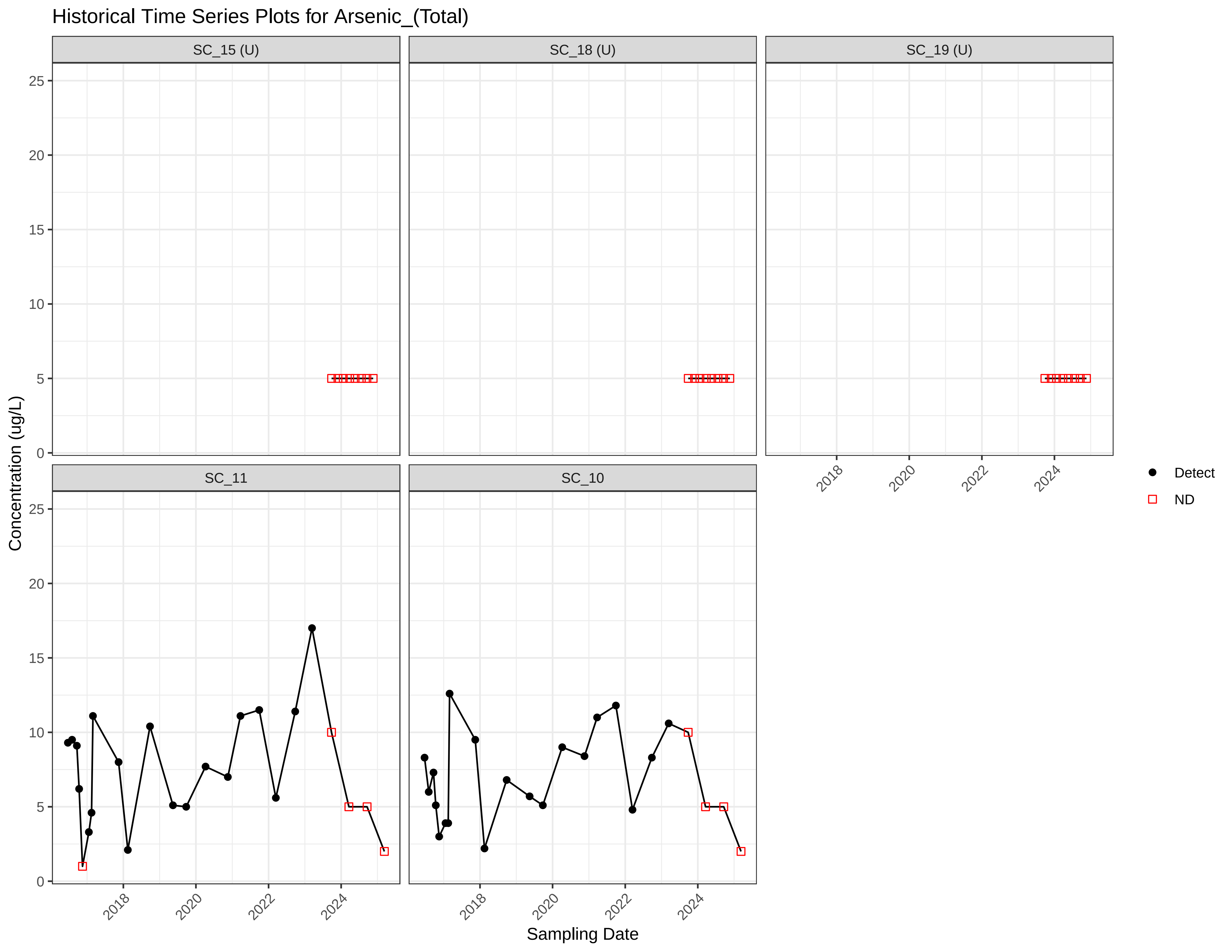
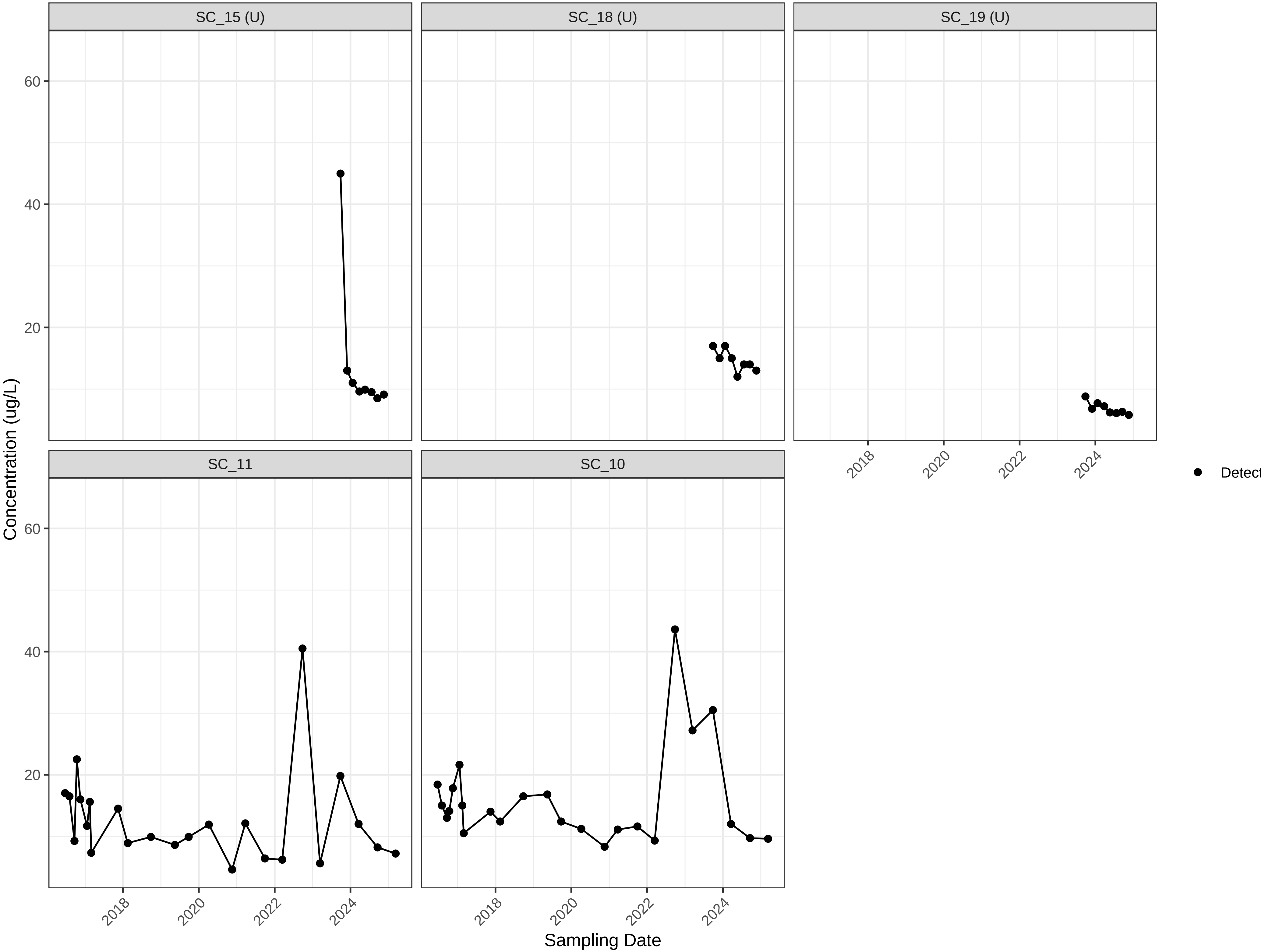
5
10
15
20
2018
2020
2022
2024
Detect
ND

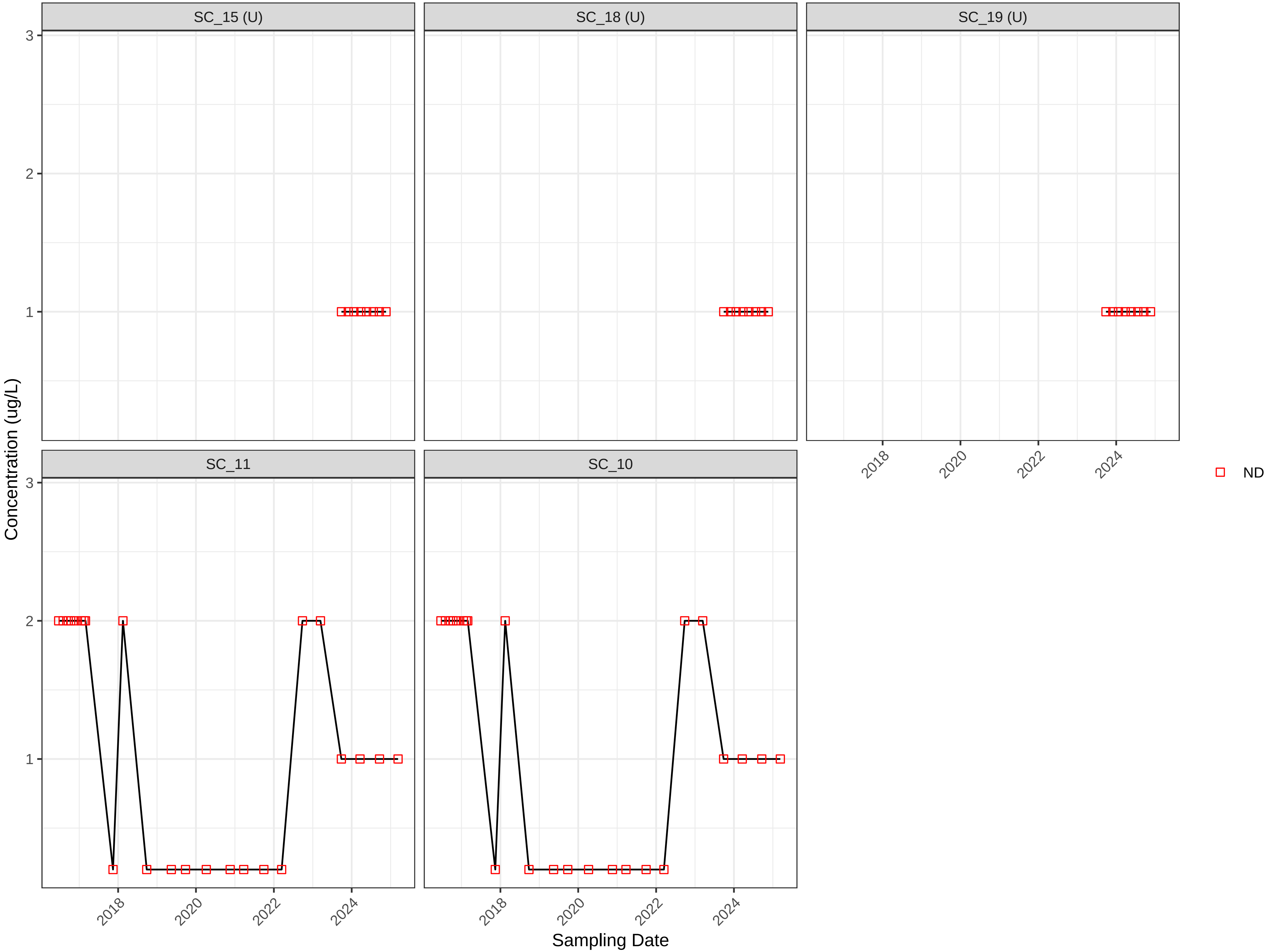


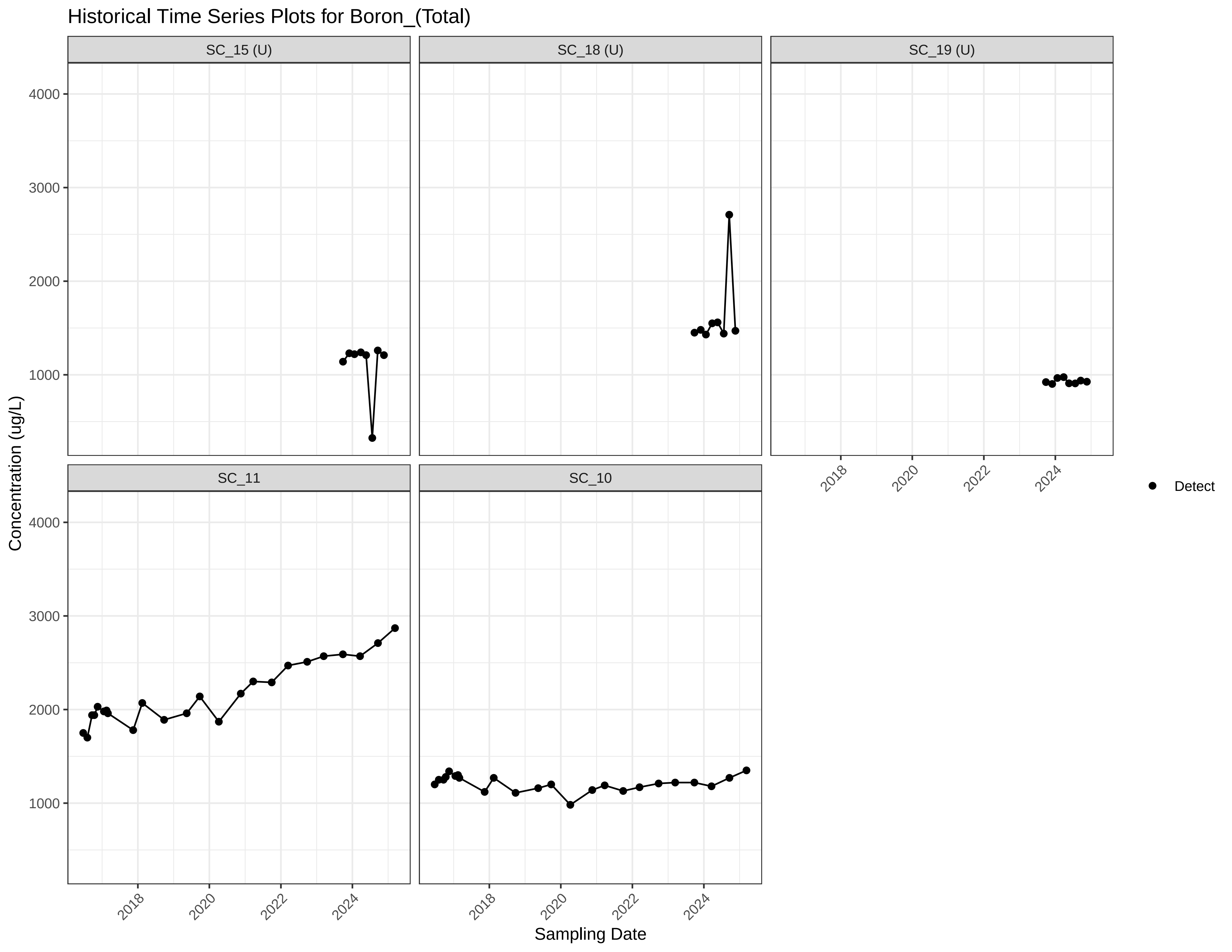
Historical Time Series Plots for Arsenic_(Total)
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
Concentration (ug/L)
0
5
10
15
20
25
2018
2020
2022
2024
Sampling Date
Detect
ND

Historical Time Series Plots for Barium_(Total)

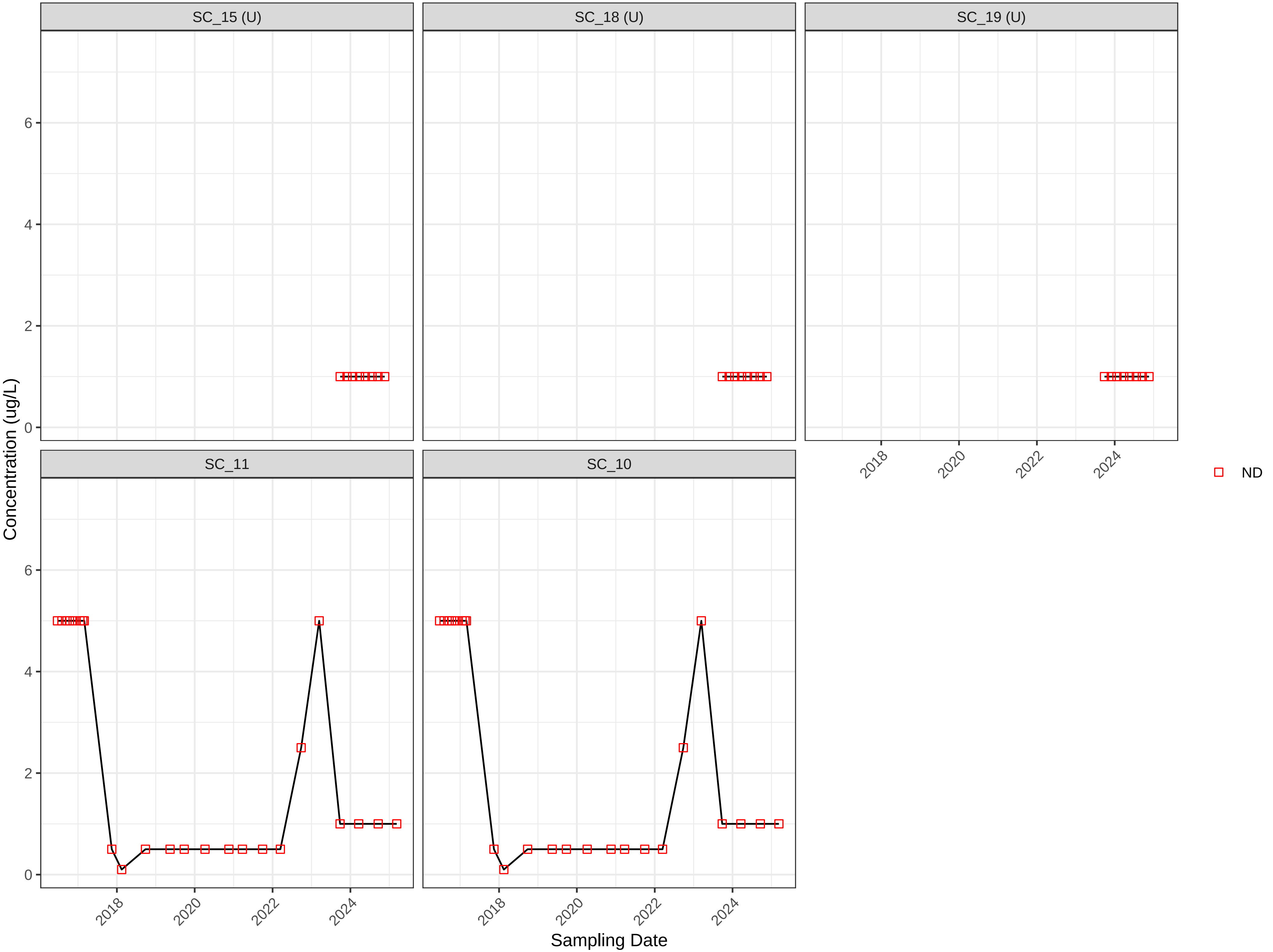


Historical Time Series Plots for Beryllium_(Total)

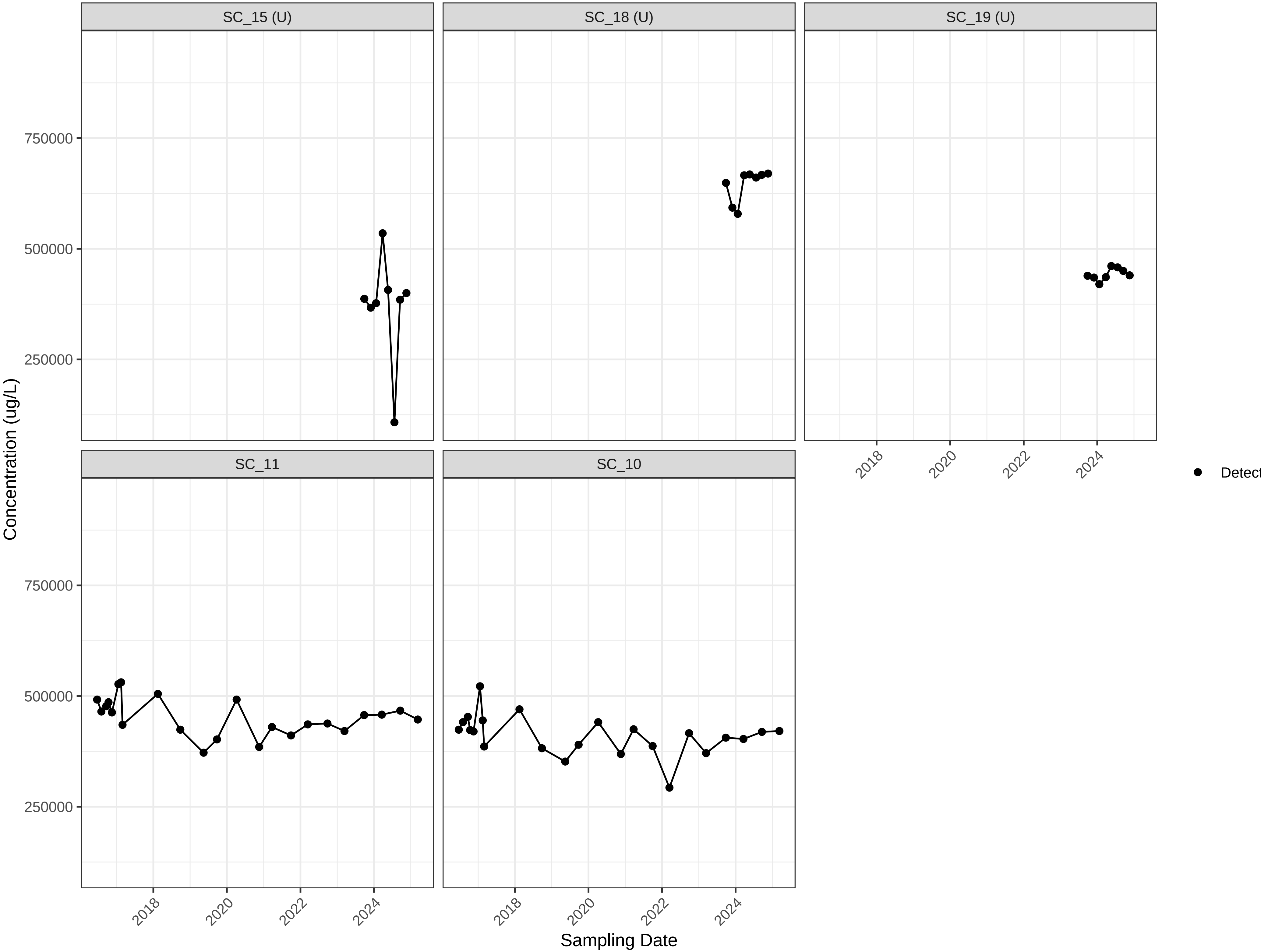


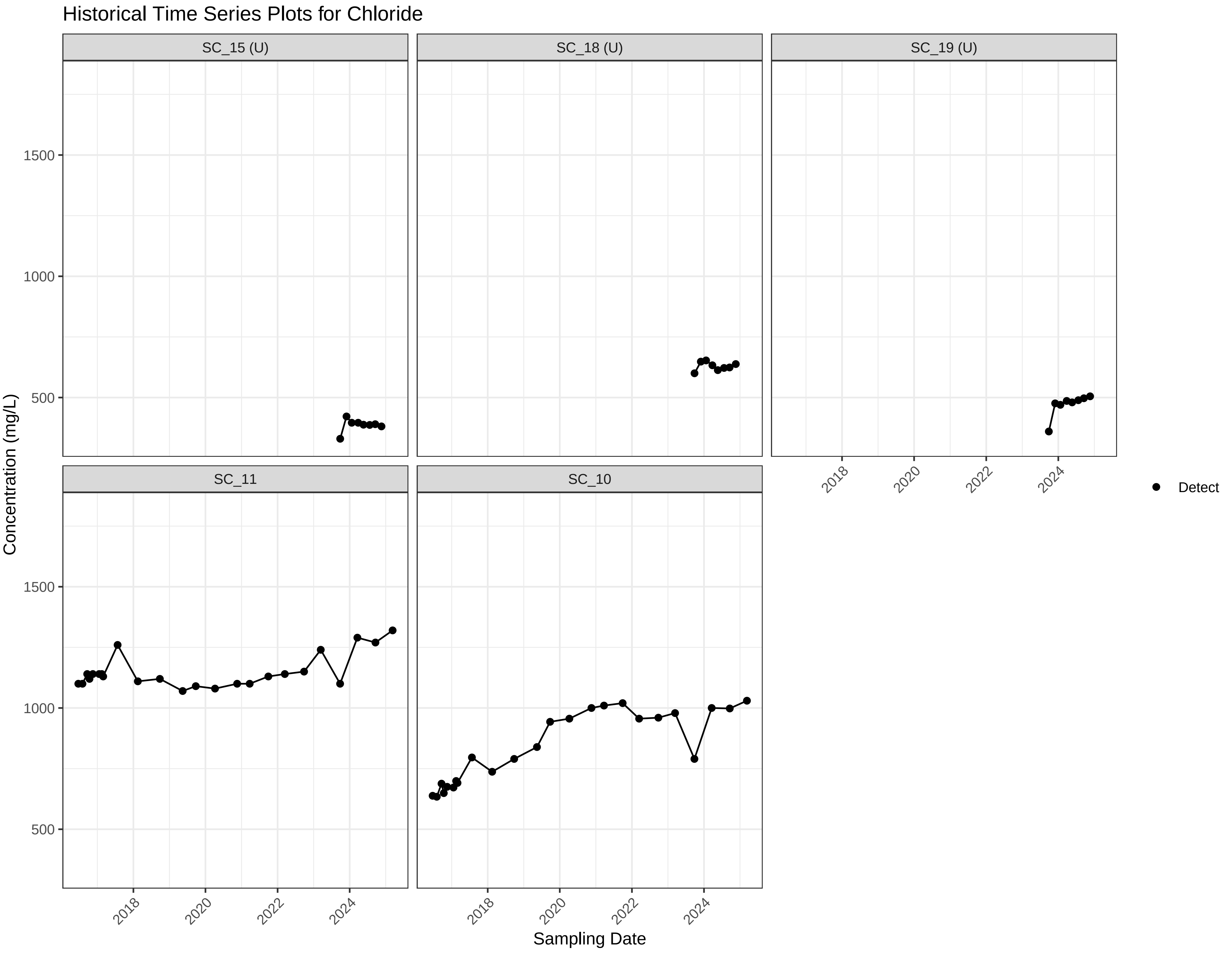

Historical Time Series Plots for Boron_(Total)
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
Concentration (ug/L)
Sampling Date
Detect
1000
2000
3000
4000
2018
2020
2022
2024

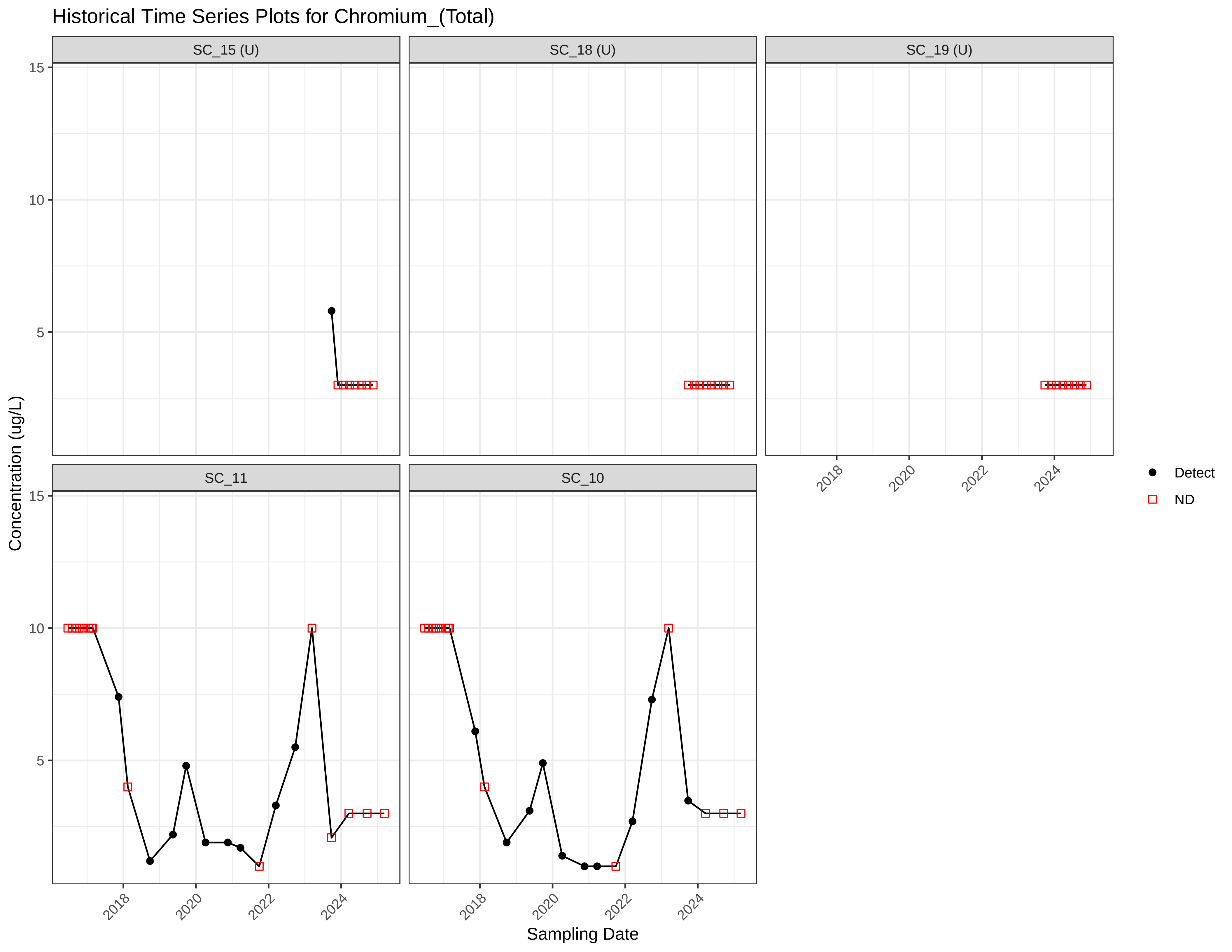
Historical Time Series Plots for Cadmium_(Total)



Historical Time Series Plots for Calcium_(Total)

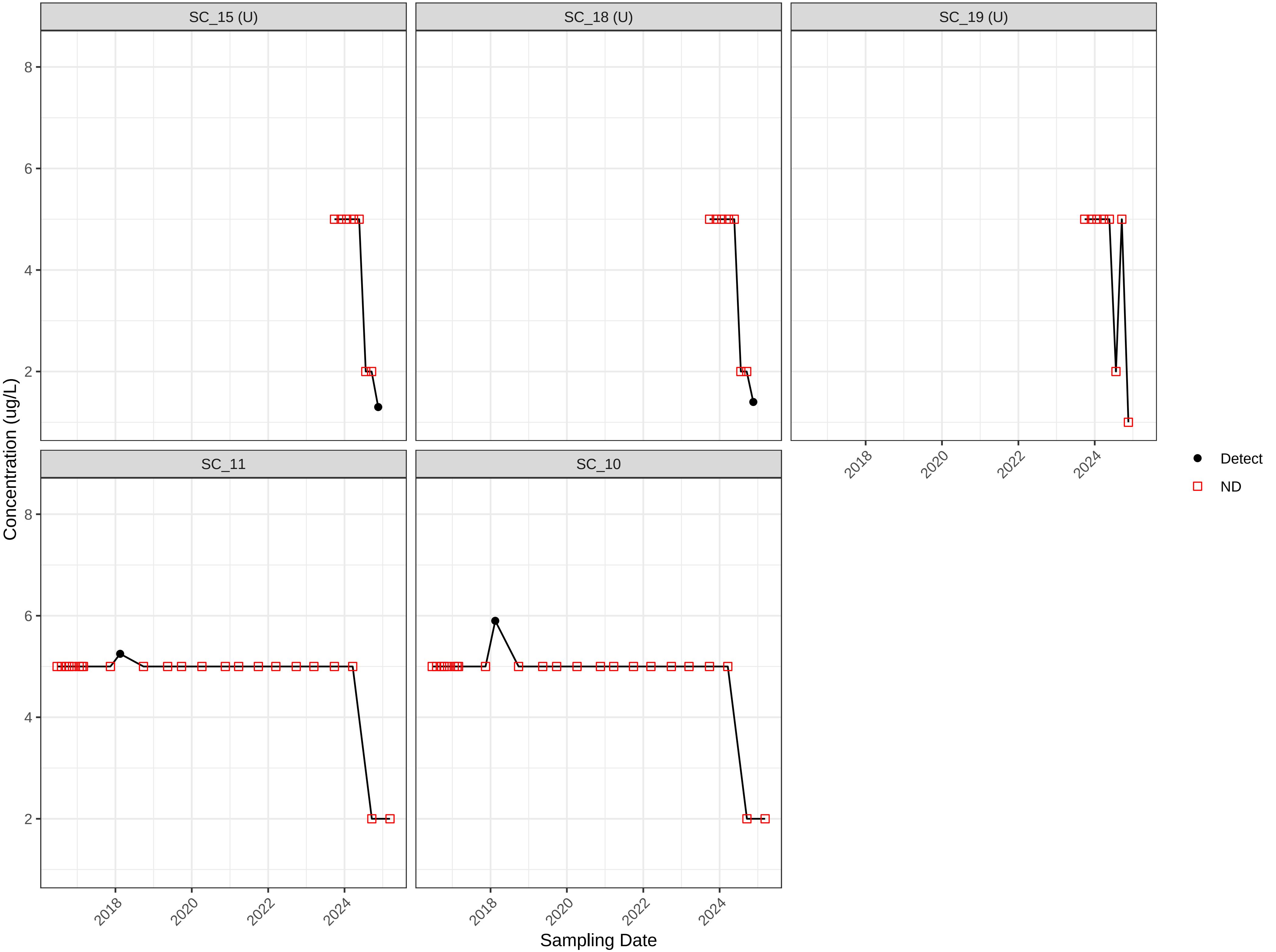


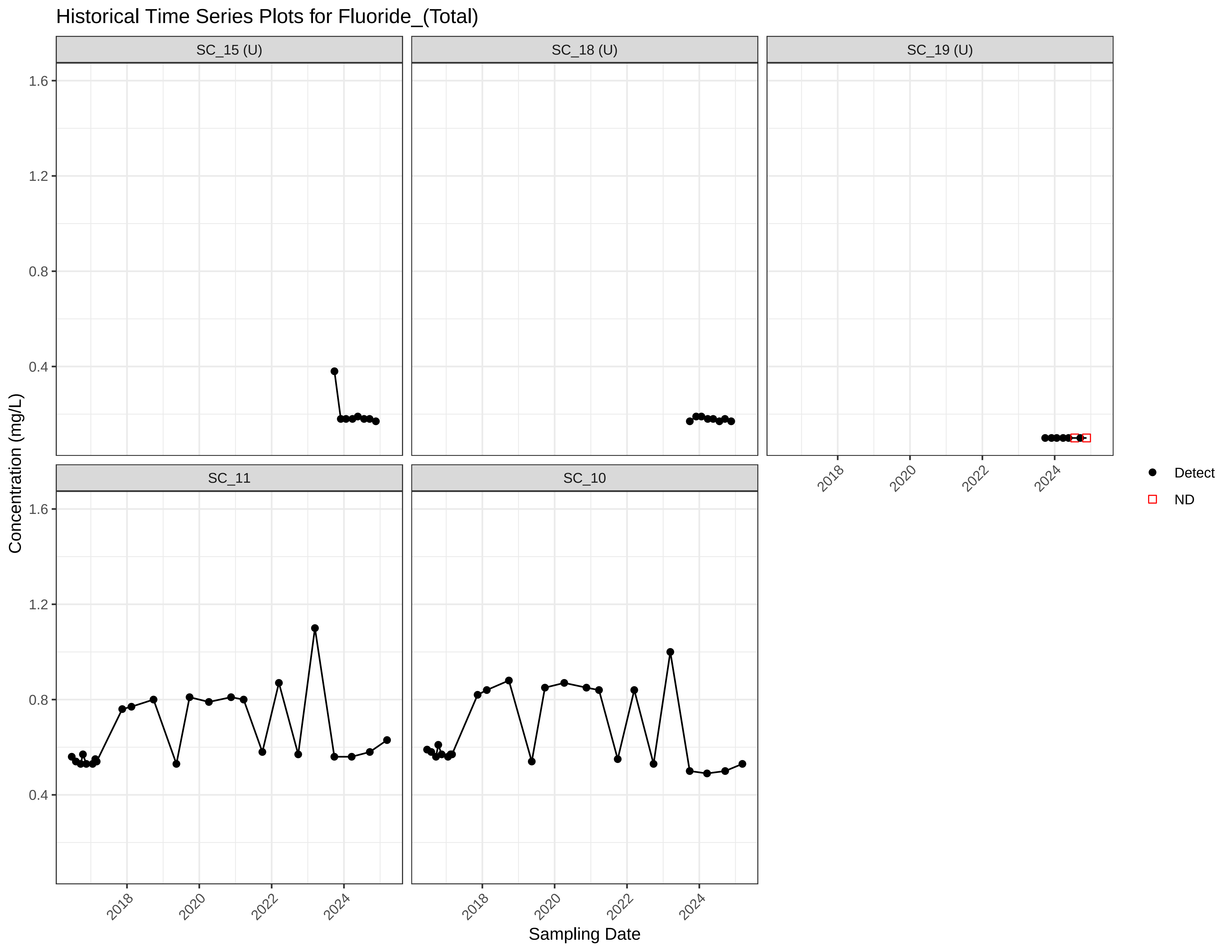

Historical Time Series Plots for Chloride
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
1500
1000
500
2018
2020
2022
2024
Concentration (mg/L)
Sampling Date
Detect



Historical Time Series Plots for Chromium_(Total)
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
Concentration (ug/L)
Sampling Date
15
10
5
2018
2020
2022
2024
Detect
ND

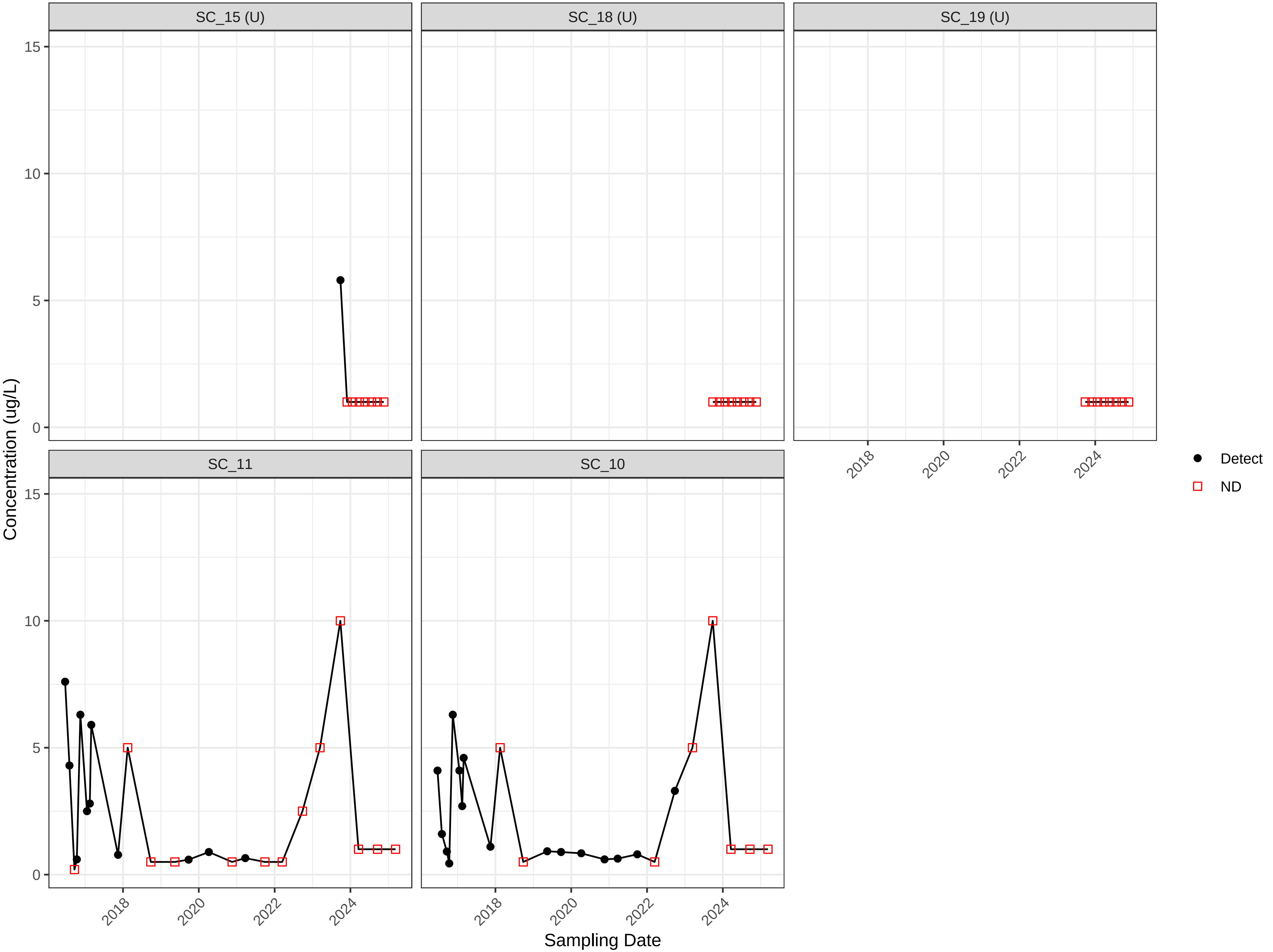
Historical Time Series Plots for Cobalt_(Total)

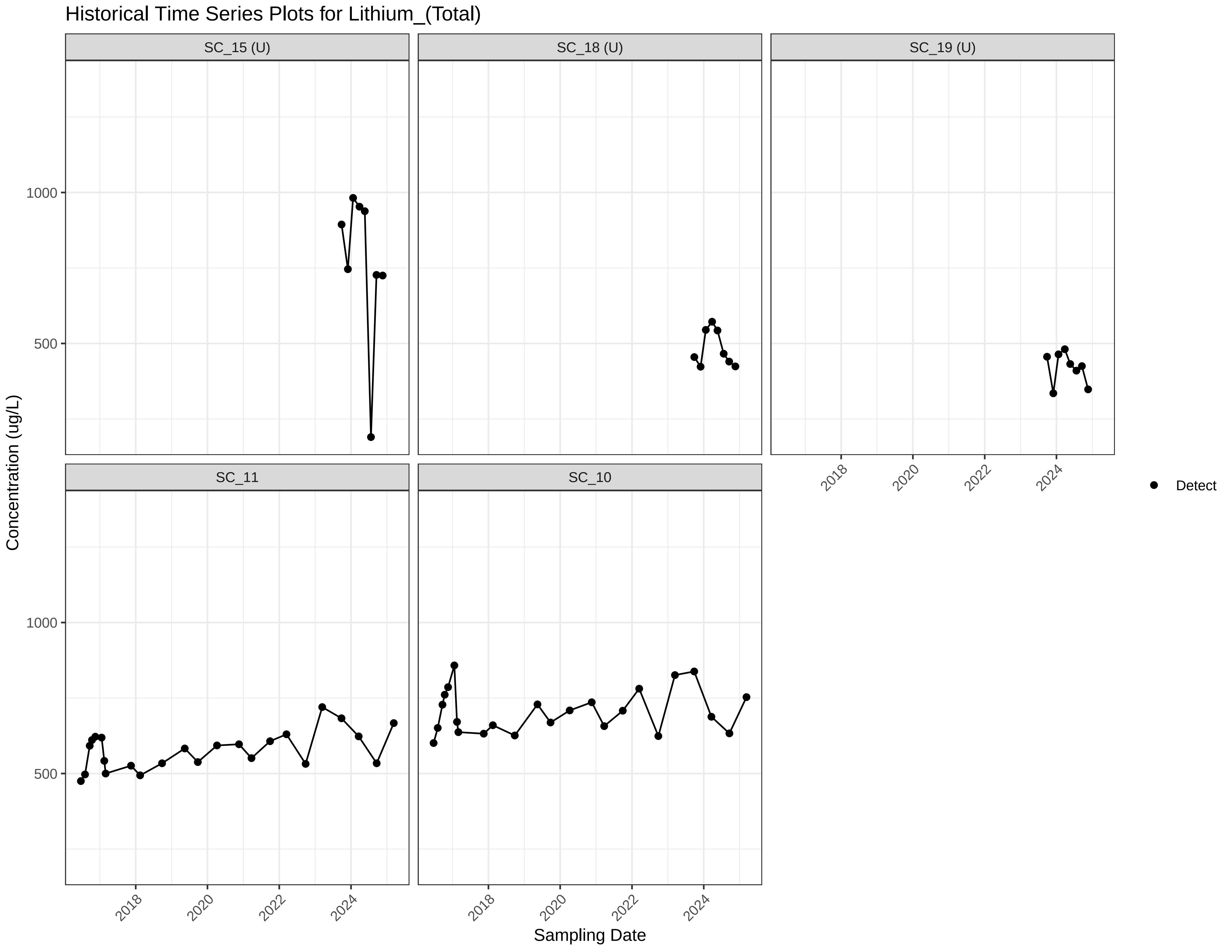




Historical Time Series Plots for Fluoride_(Total)
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
Concentration (mg/L)
Sampling Date
1.6
1.2
0.8
0.4
2018
2020
2022
2024
Detect
ND

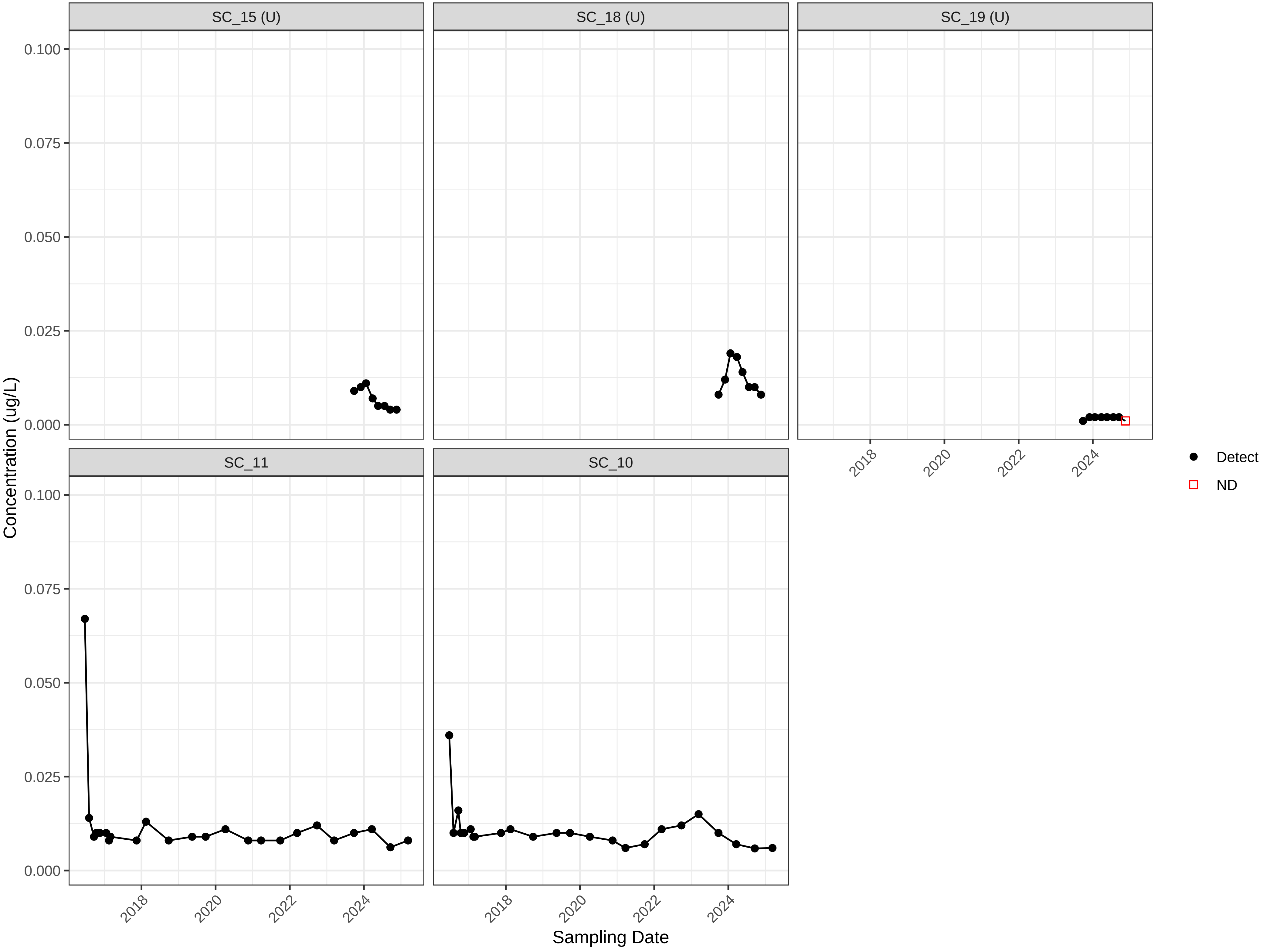
Historical Time Series Plots for Lead_(Total)



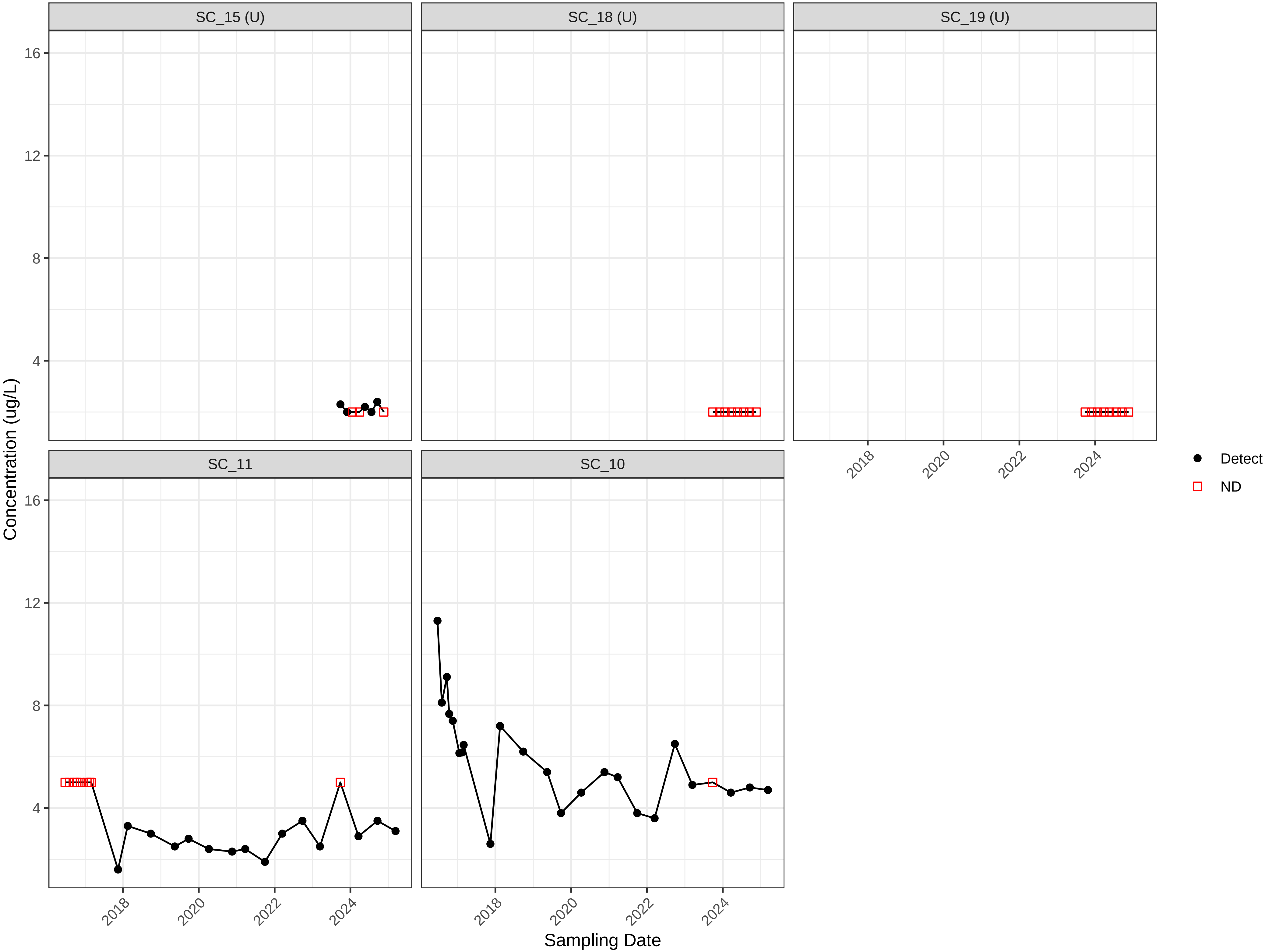


Historical Time Series Plots for Lithium_(Total)
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
Concentration (ug/L)
1000
500
2018
2020
2022
2024
Sampling Date
Detect

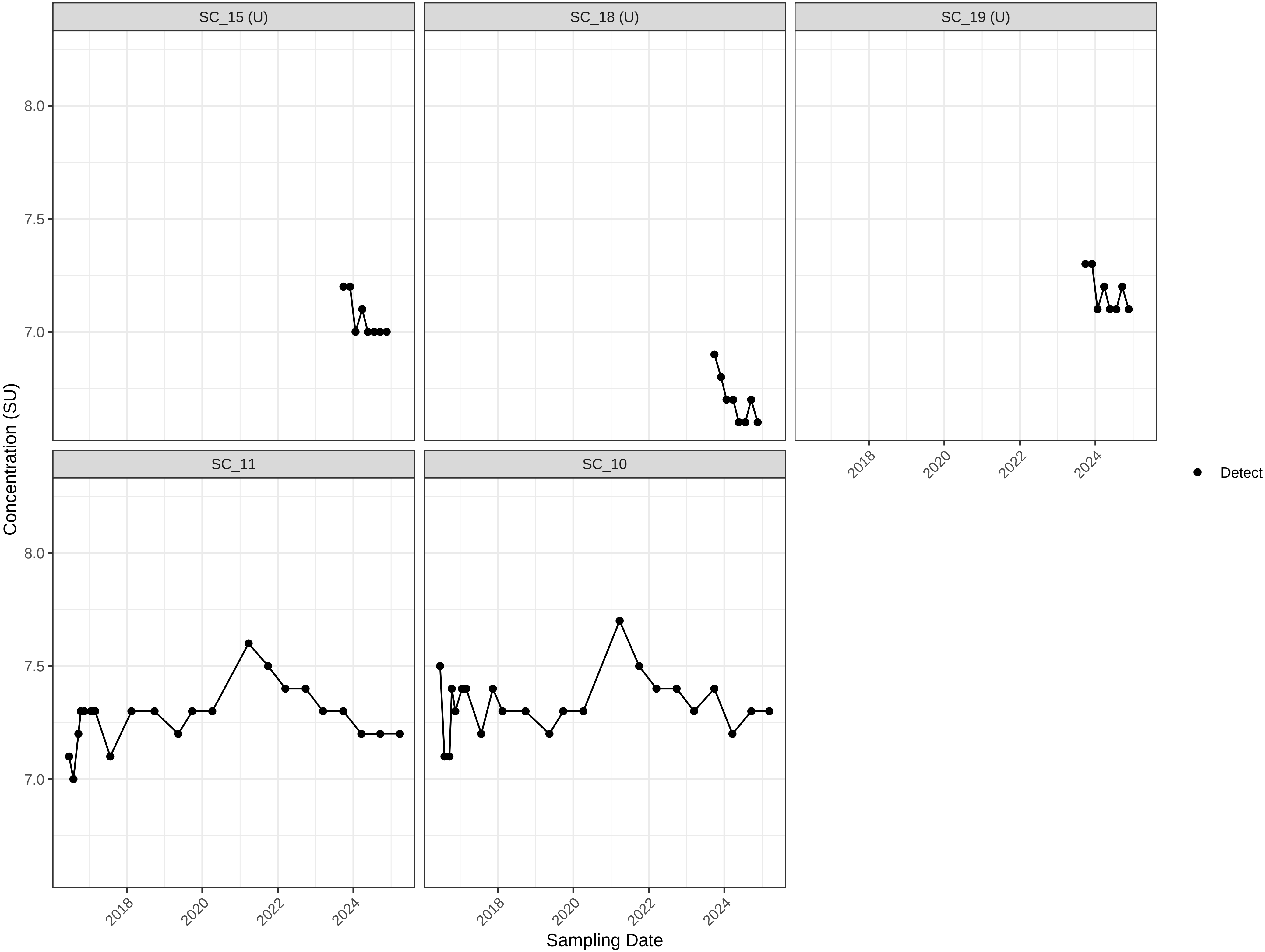
Historical Time Series Plots for Mercury_(Total)



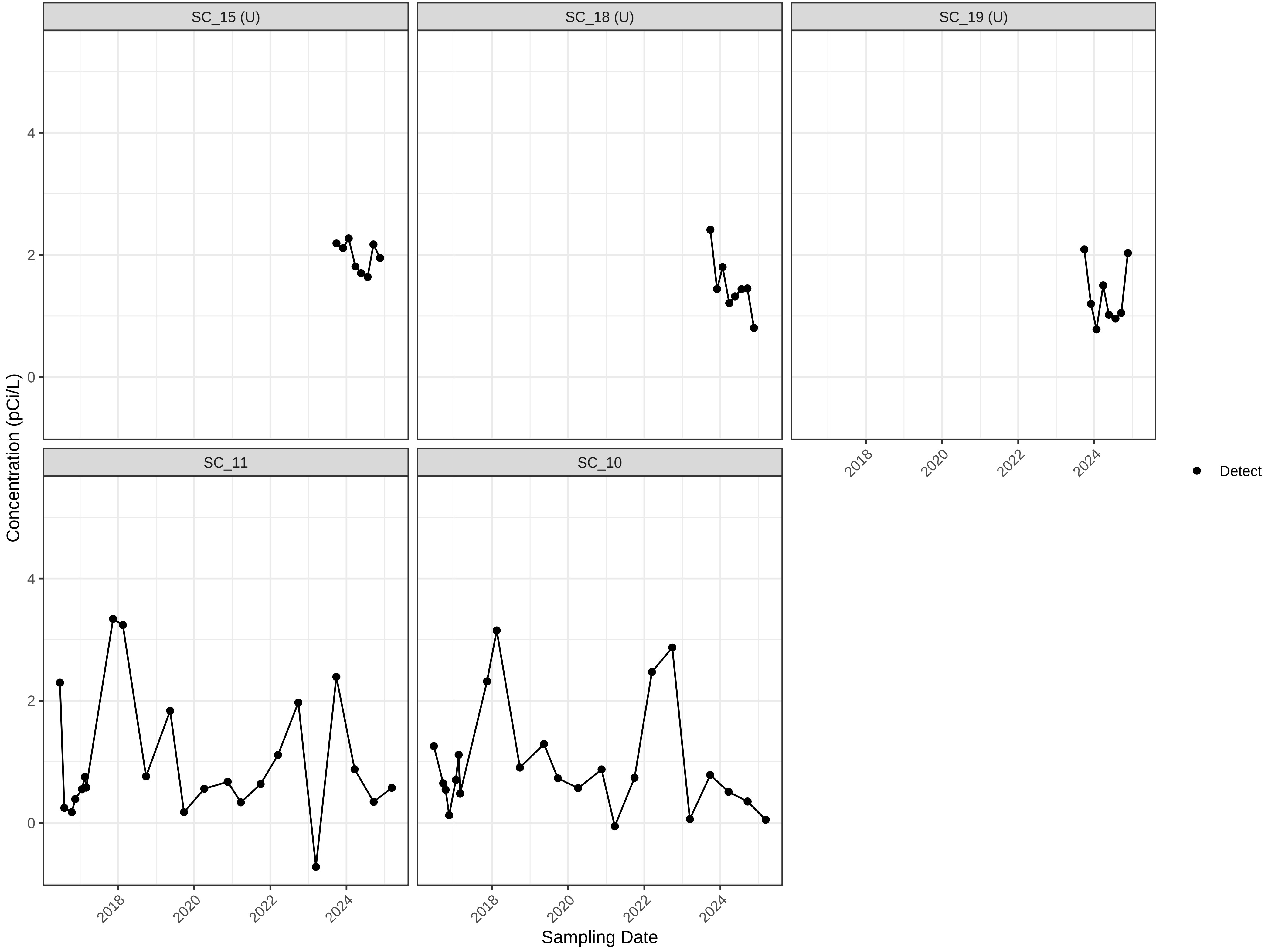
Historical Time Series Plots for Molybdenum_(Total)

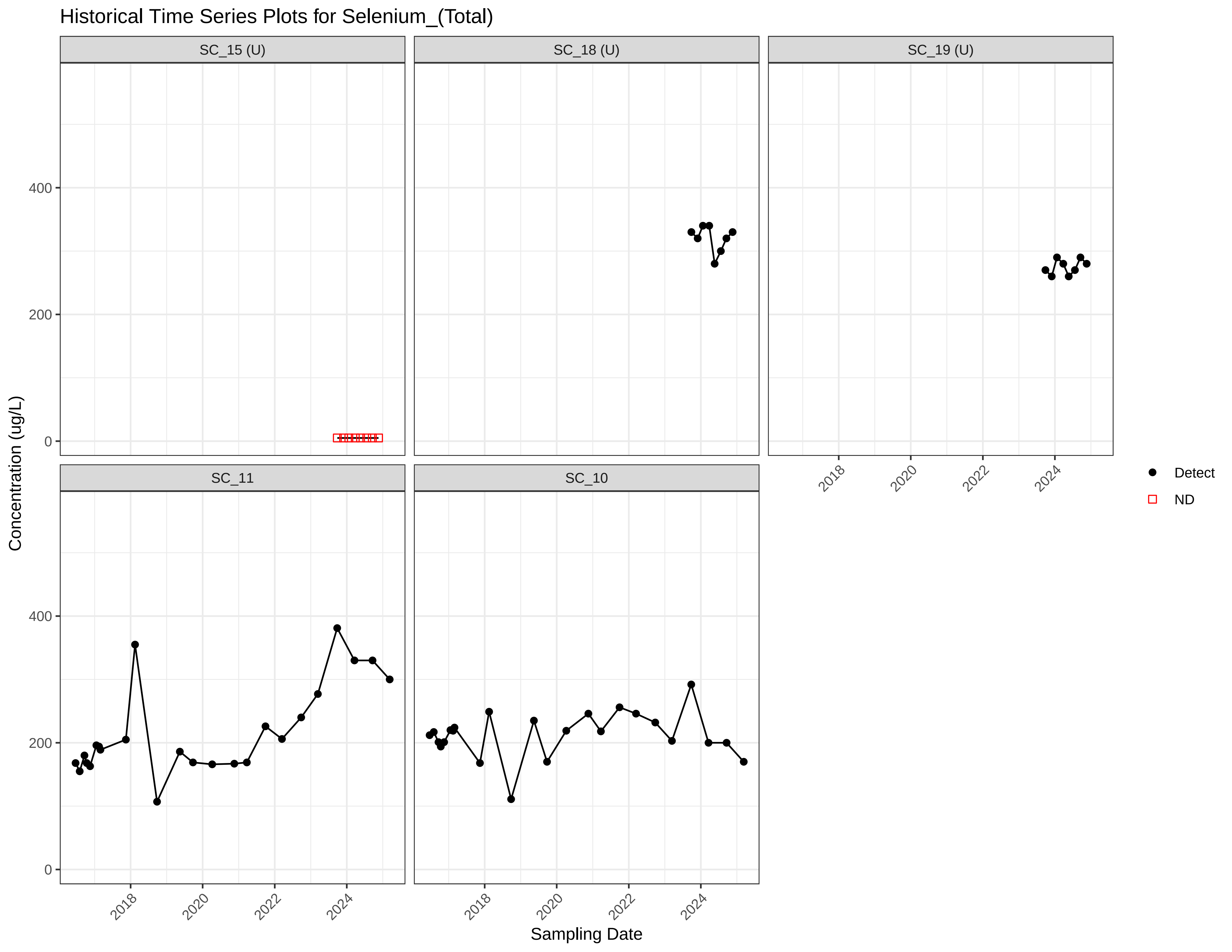


Historical Time Series Plots for pH

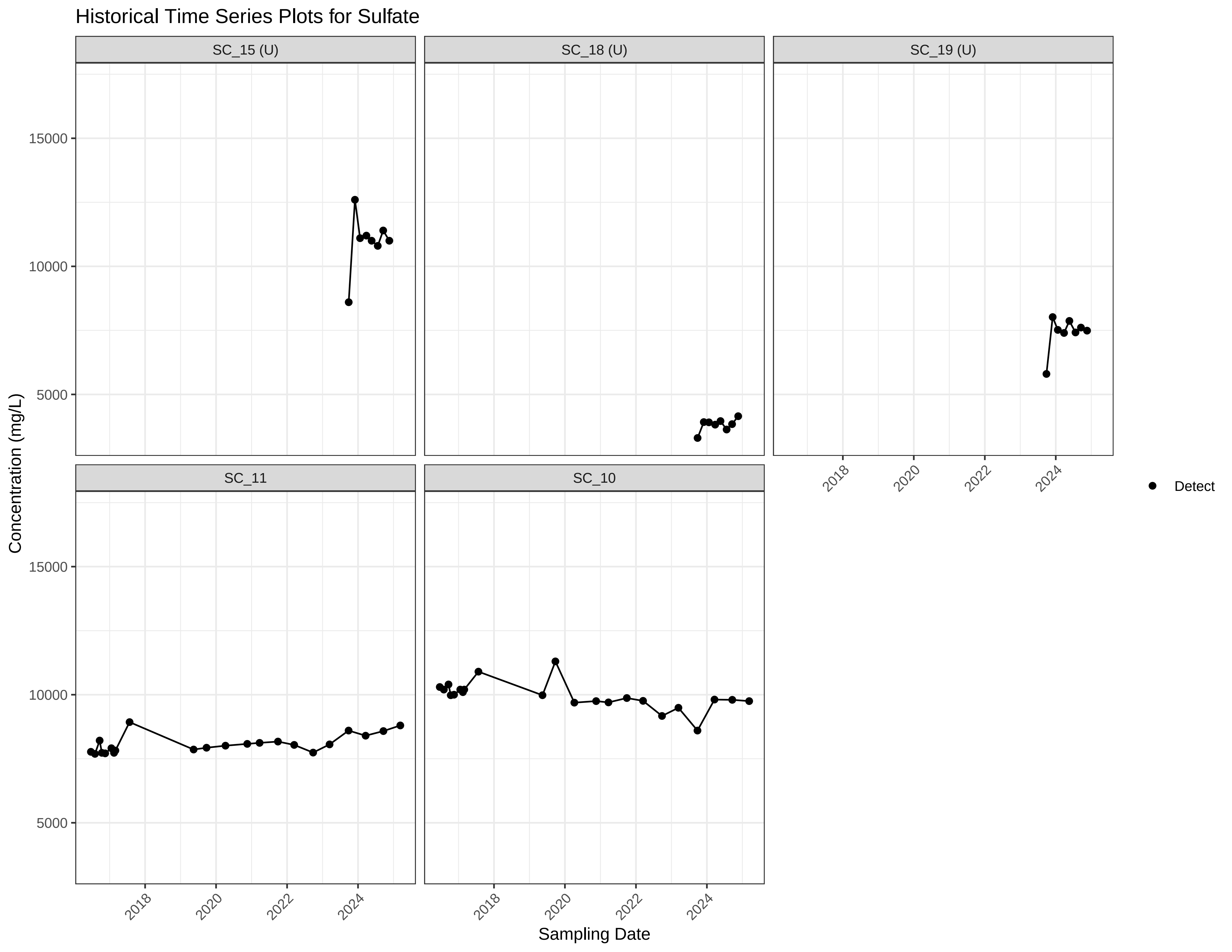


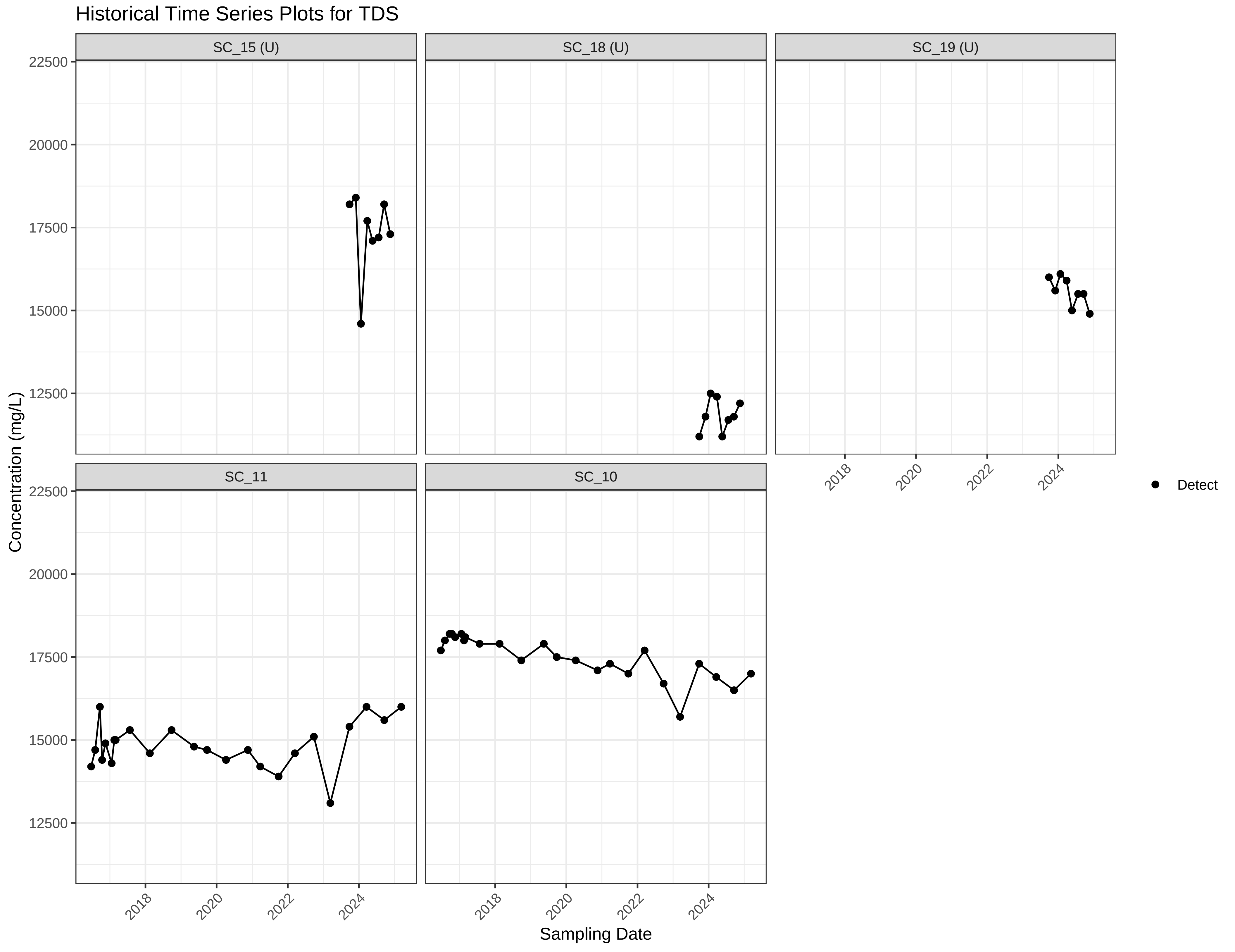
Historical Time Series Plots for Rad226+228



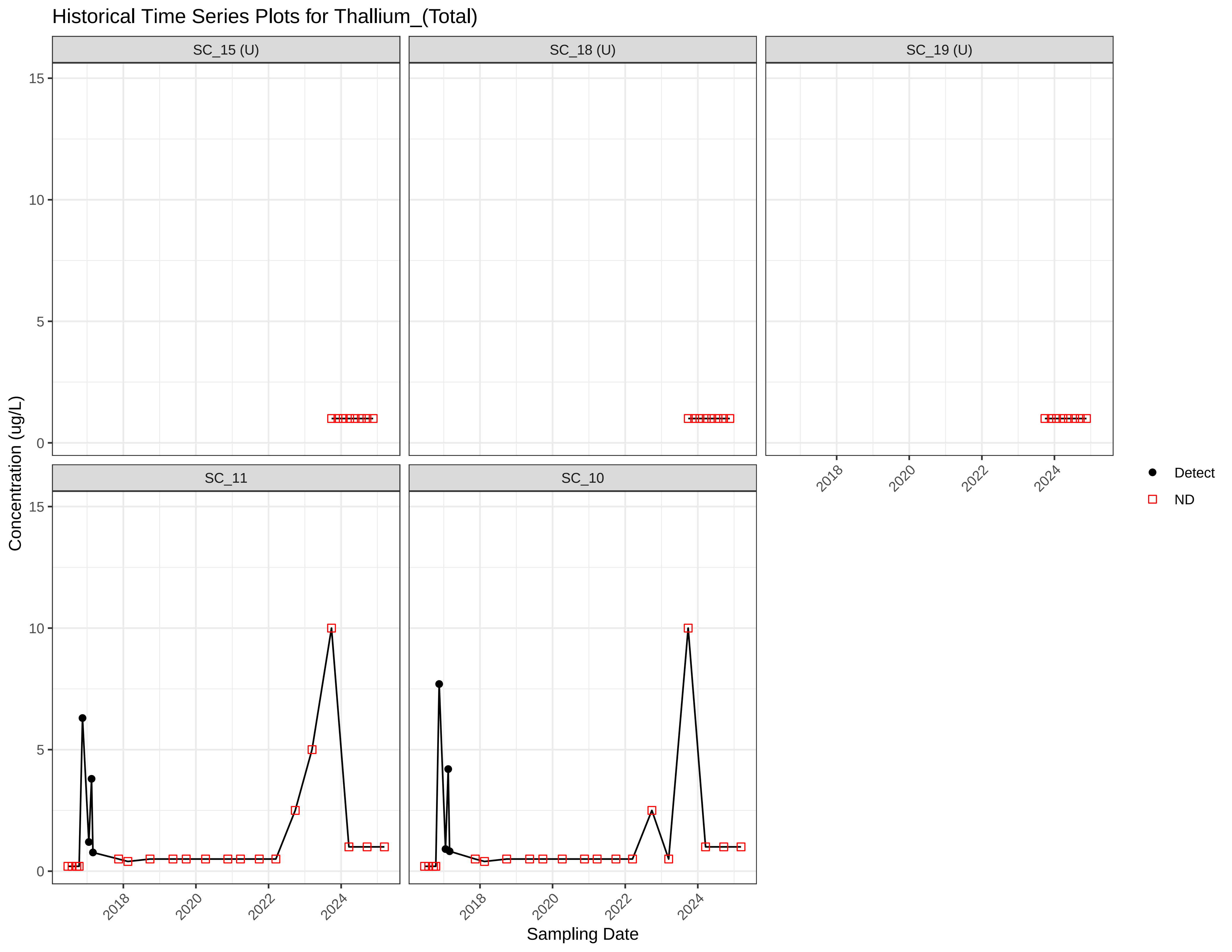


Historical Time Series Plots for Selenium_(Total)
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
Concentration (ug/L)
Sampling Date
0
200
400
2018
2020
2022
2024
Detect
ND


Historical Time Series Plots for Sulfate
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
Concentration (mg/L)
15000
10000
5000
2018
2020
2022
2024
Sampling Date
Detect

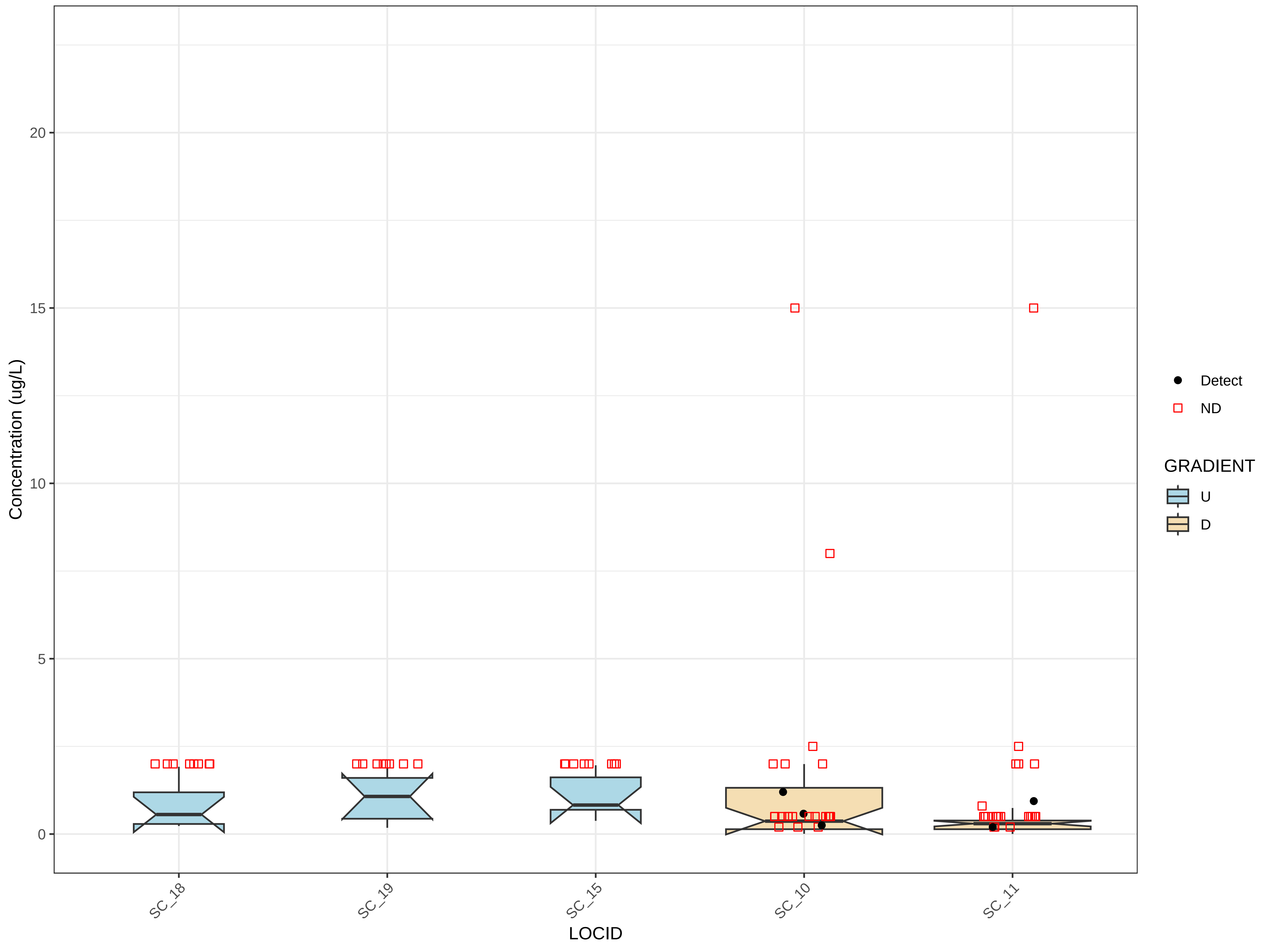


Historical Time Series Plots for TDS
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
Concentration (mg/L)
22500
20000
17500
15000
12500
2018
2020
2022
2024
Sampling Date
Detect

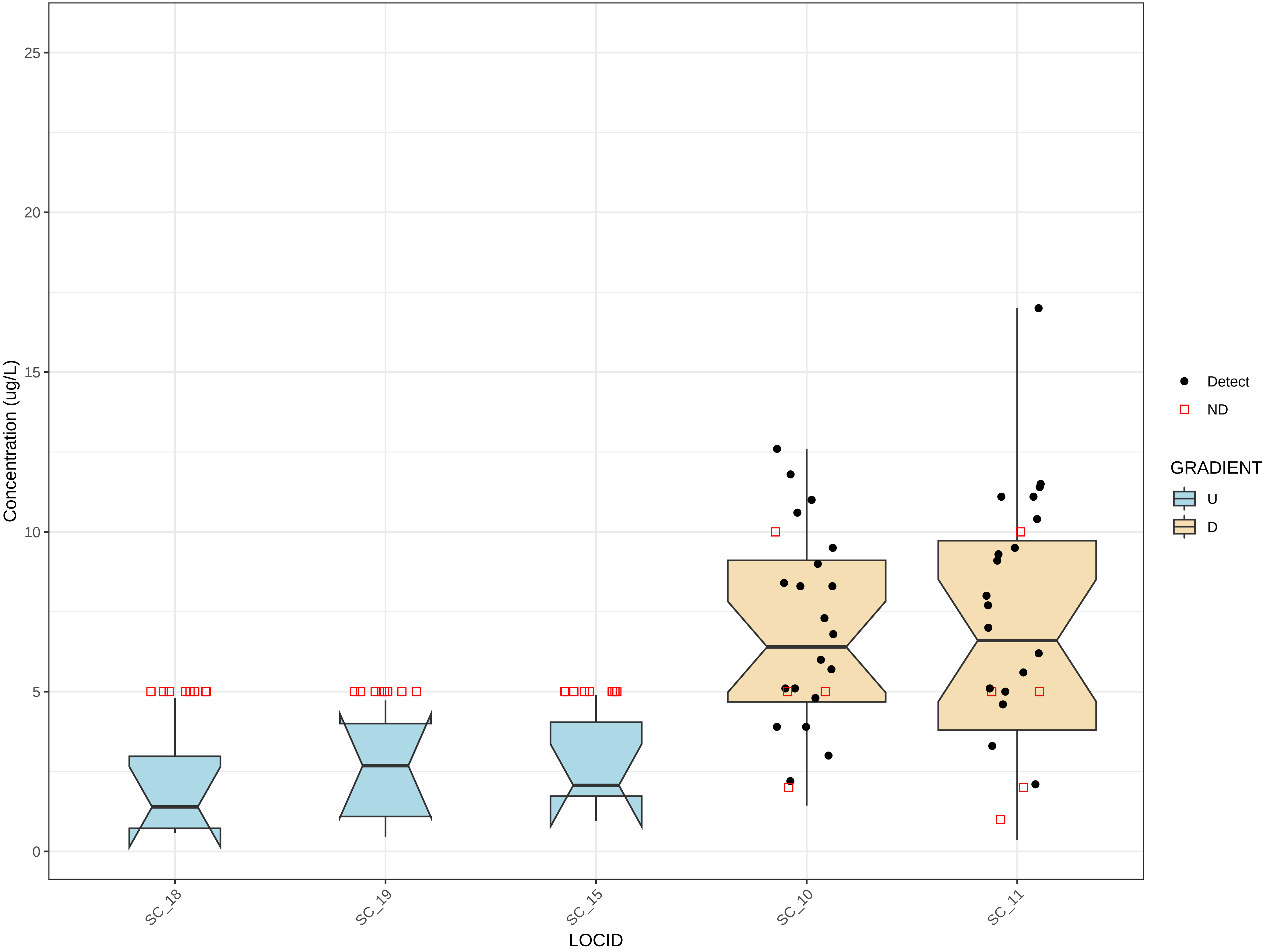


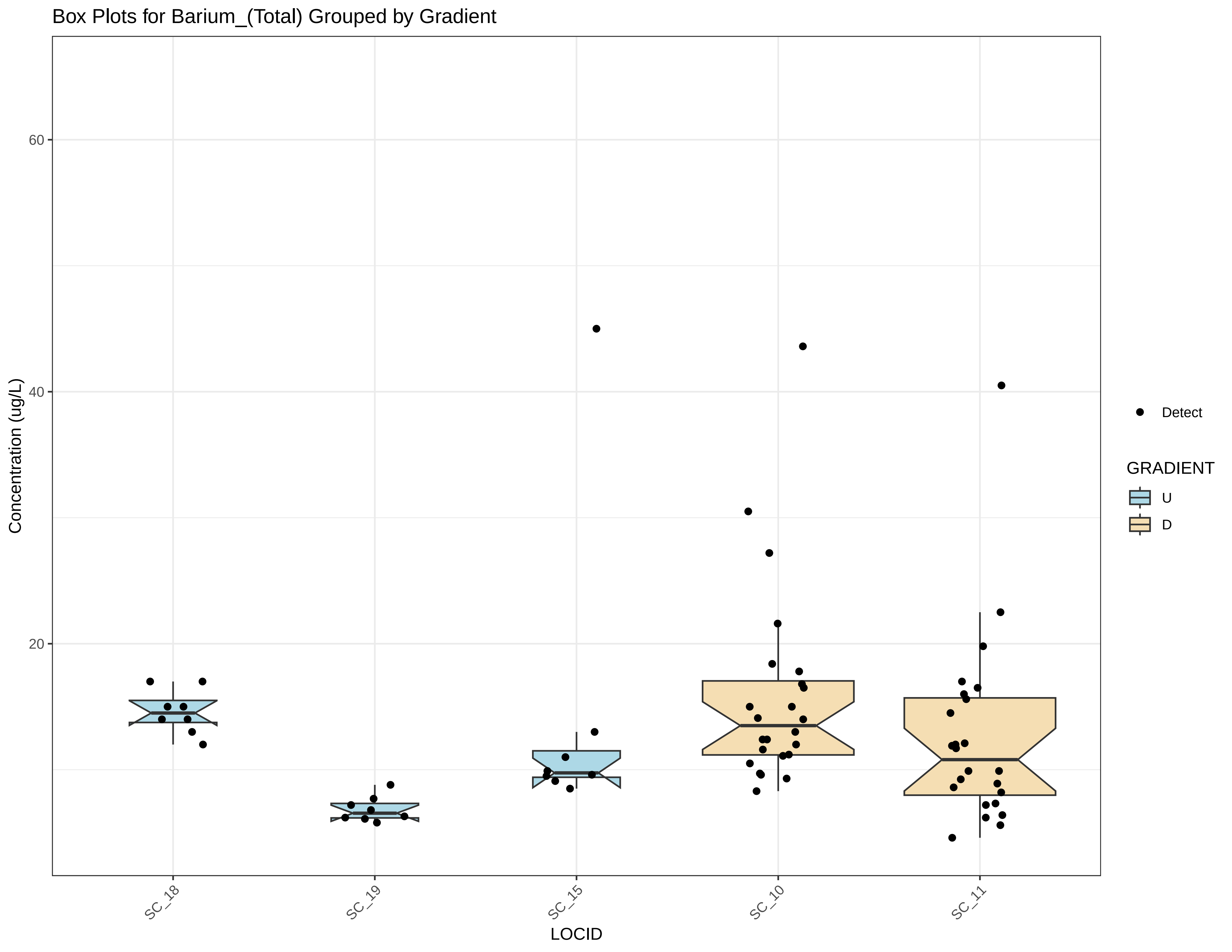
Historical Time Series Plots for Thallium_(Total)
SC_15 (U)
SC_18 (U)
SC_19 (U)
SC_11
SC_10
Concentration (ug/L)
Sampling Date
0
5
10
15
2018
2020
2022
2024
Detect
ND

Box Plots for Antimony_(Total) Grouped by Gradient

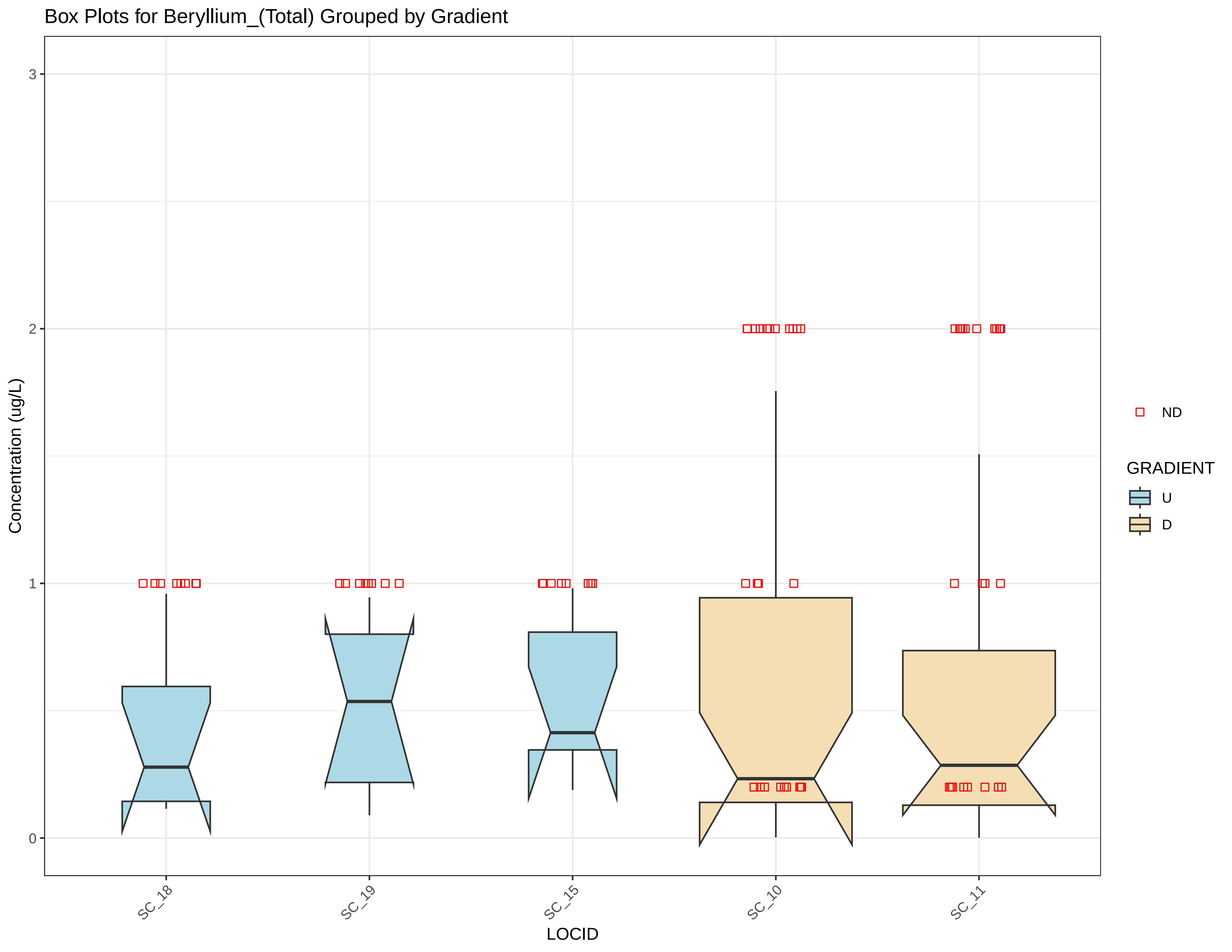


Box Plots for Arsenic_(Total) Grouped by Gradient

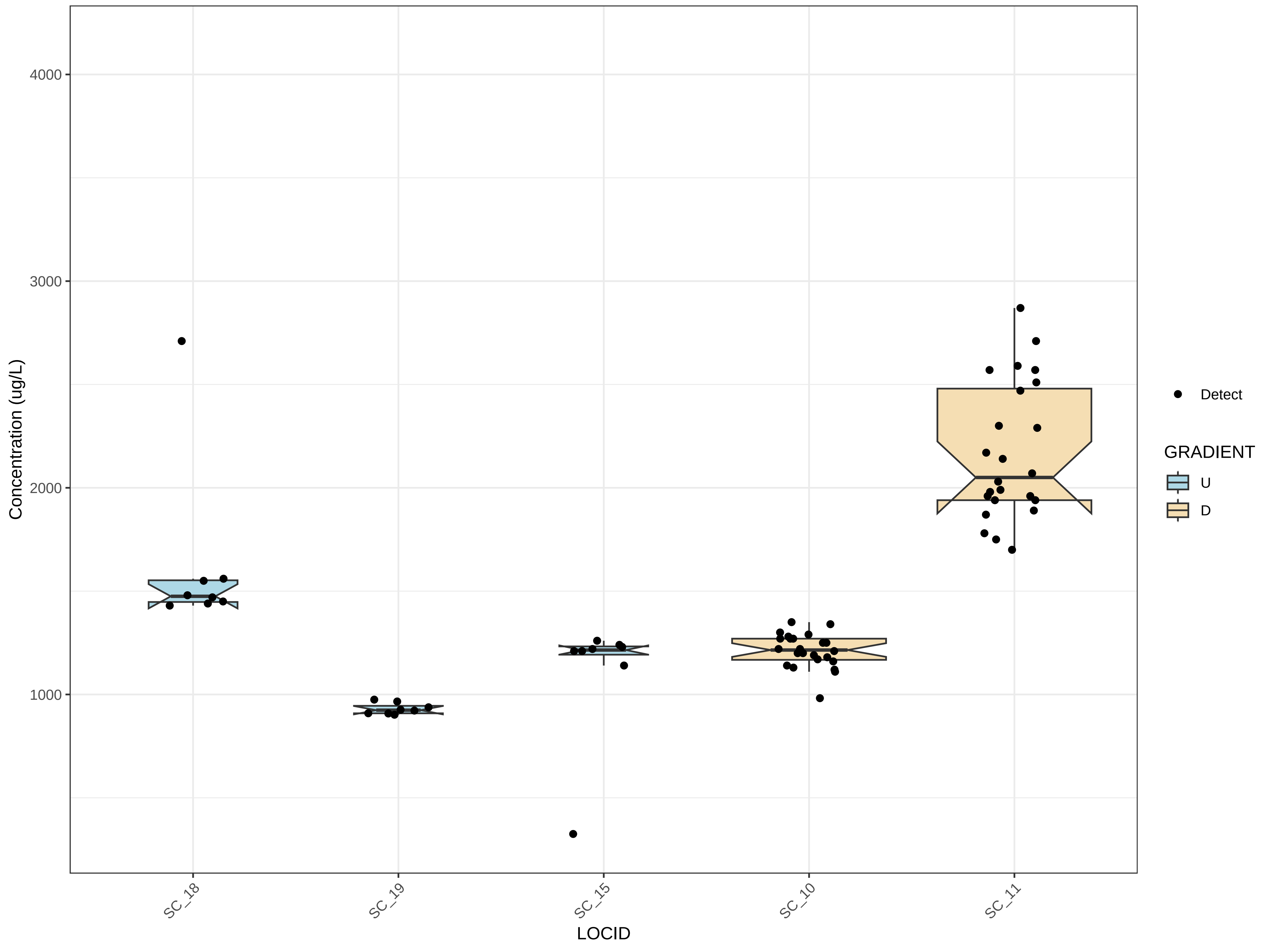


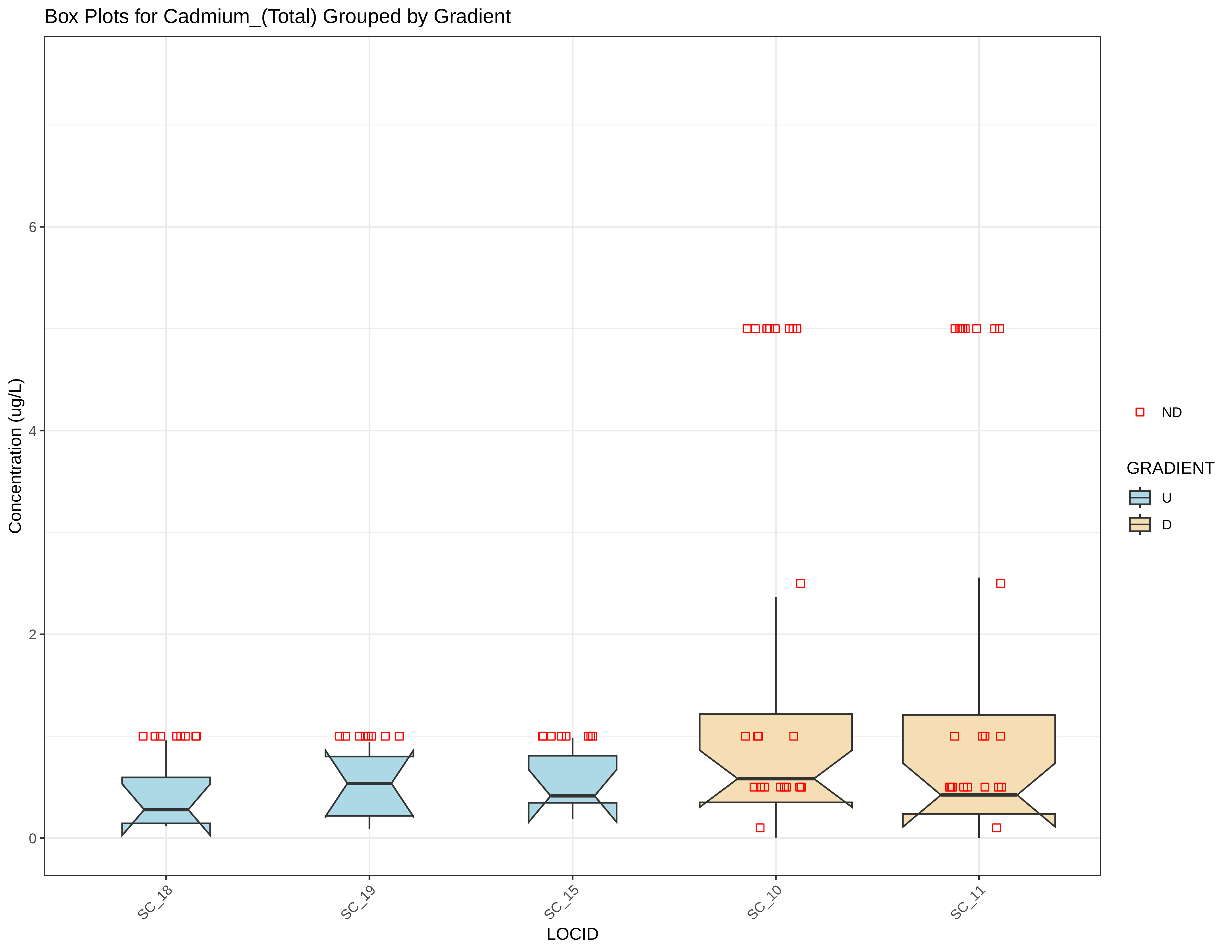


Box Plots for Barium_(Total) Grouped by Gradient
Concentration (ug/L)
60
40
20
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
GRADIENT
U
D

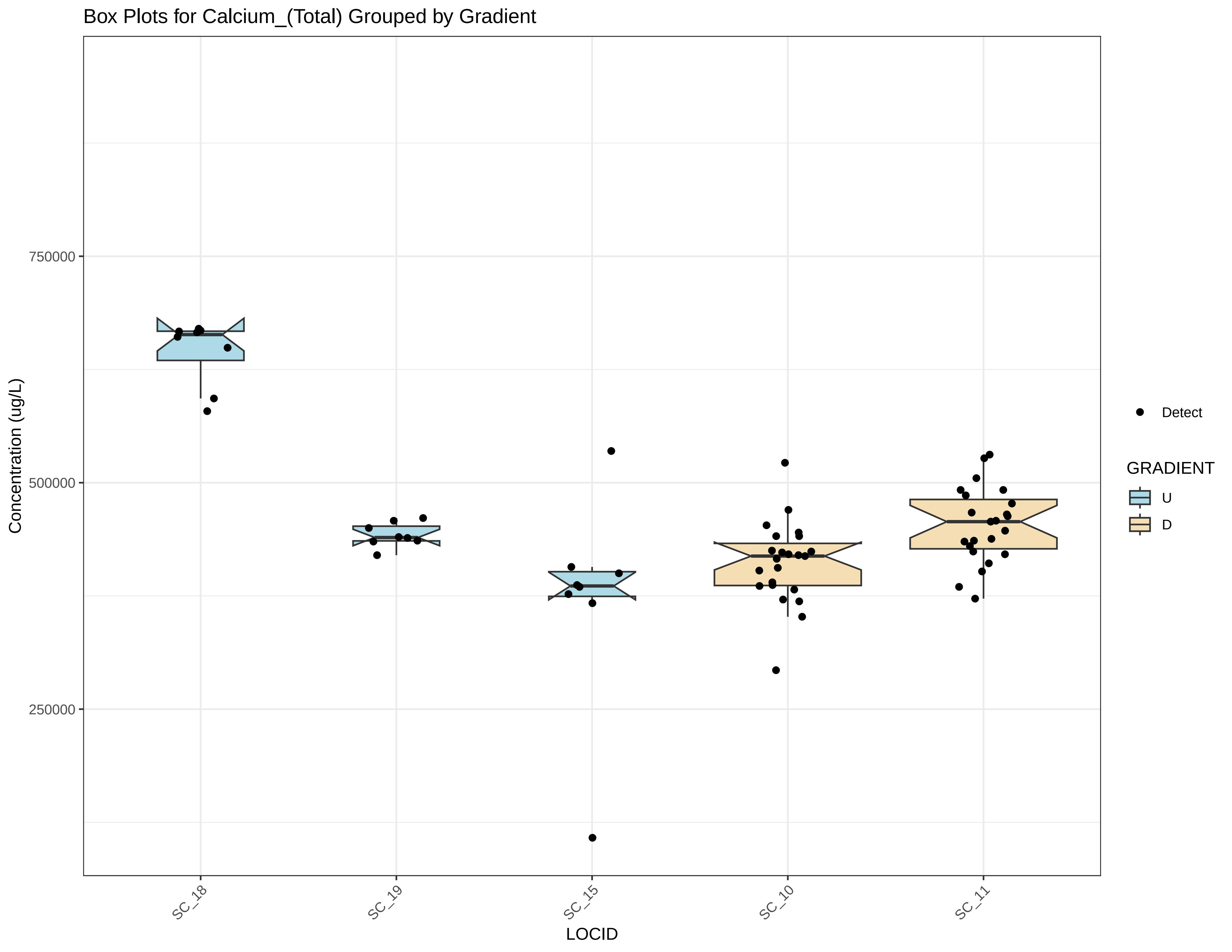

Box Plots for Beryllium_(Total) Grouped by Gradient
Concentration (ug/L)
0
1
2
3
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
ND
GRADIENT
U
D

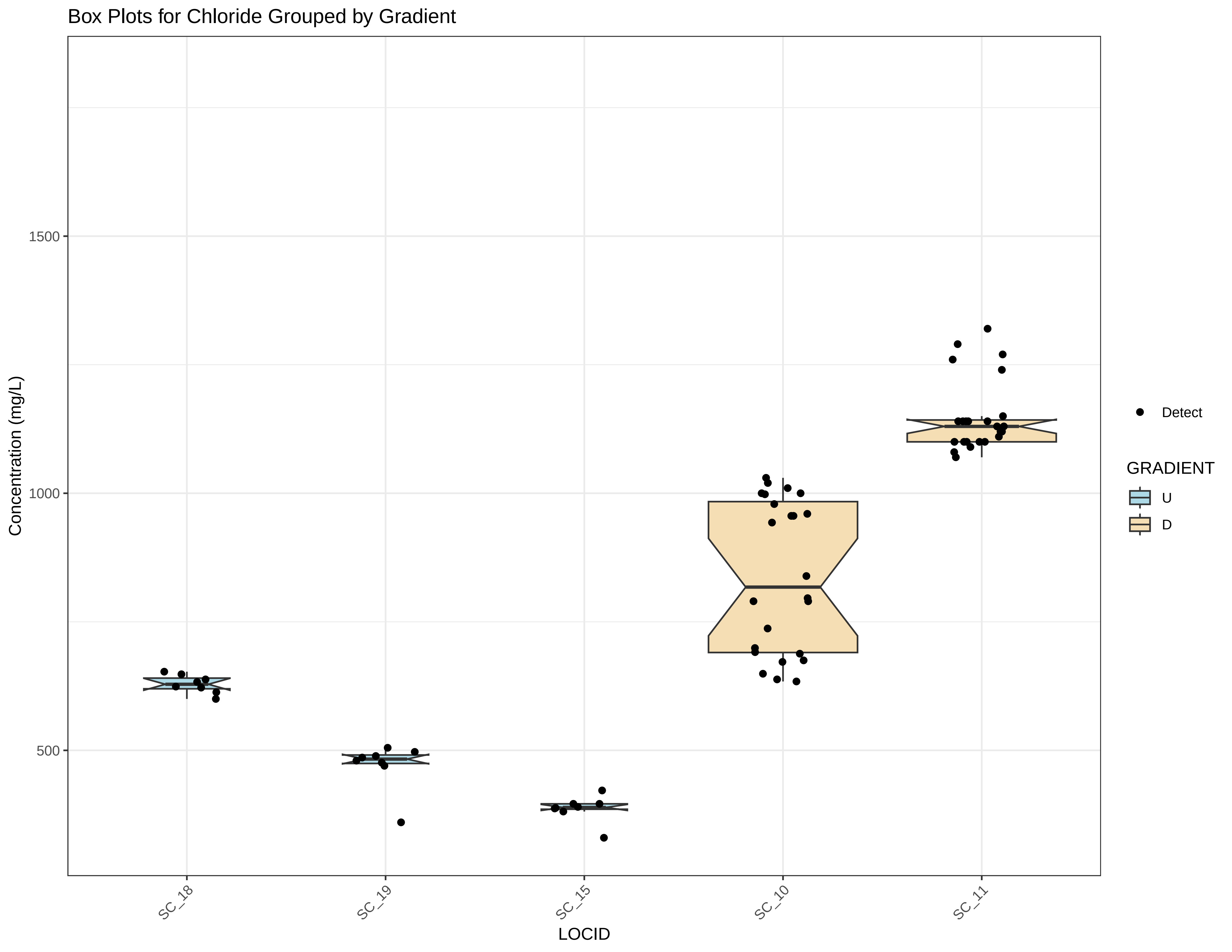
Box Plots for Boron_(Total) Grouped by Gradient



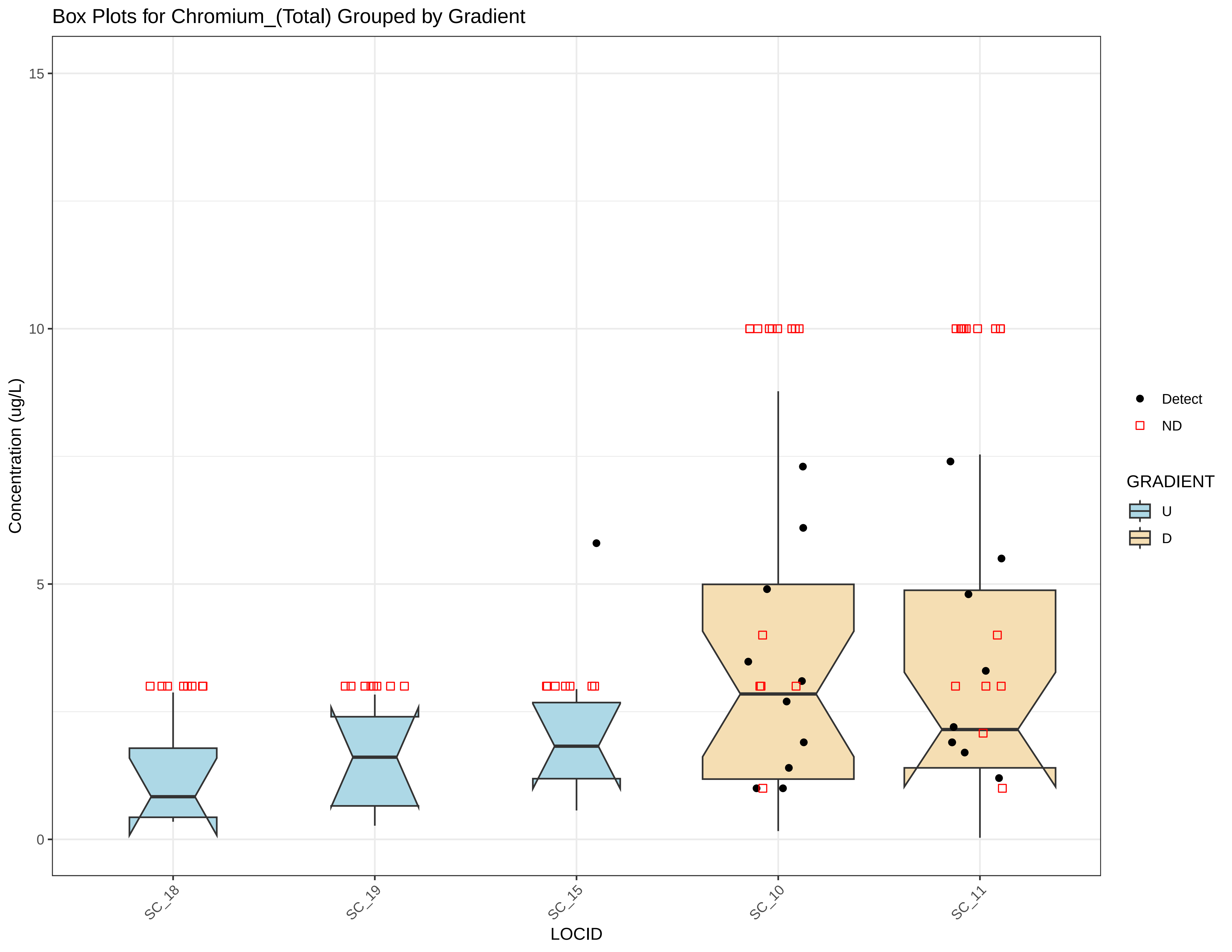


Box Plots for Cadmium_(Total) Grouped by Gradient
Concentration (ug/L)
0
2
4
6
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
ND
GRADIENT
U
D

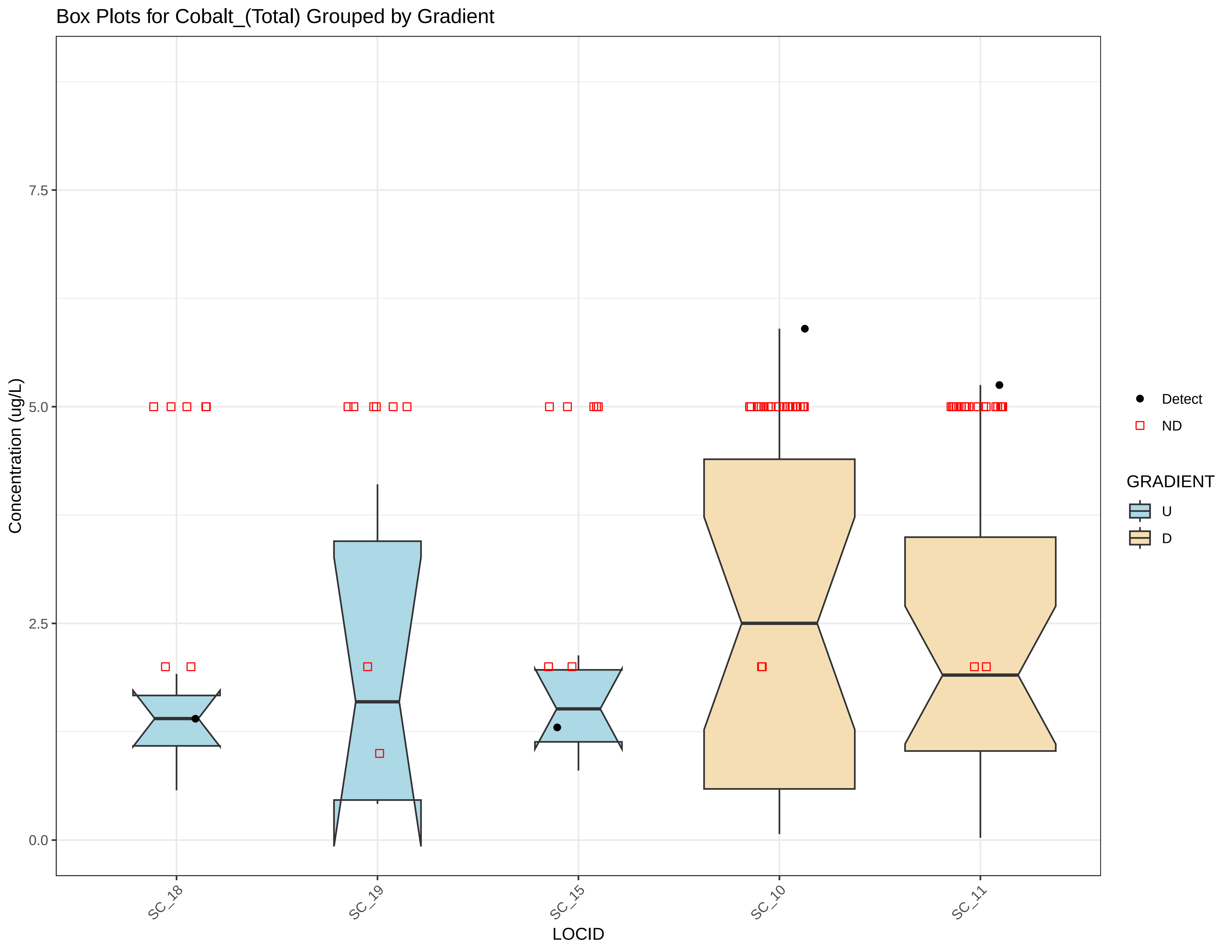

Box Plots for Calcium_(Total) Grouped by Gradient
Concentration (ug/L)
750000
500000
250000
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
GRADIENT
U
D

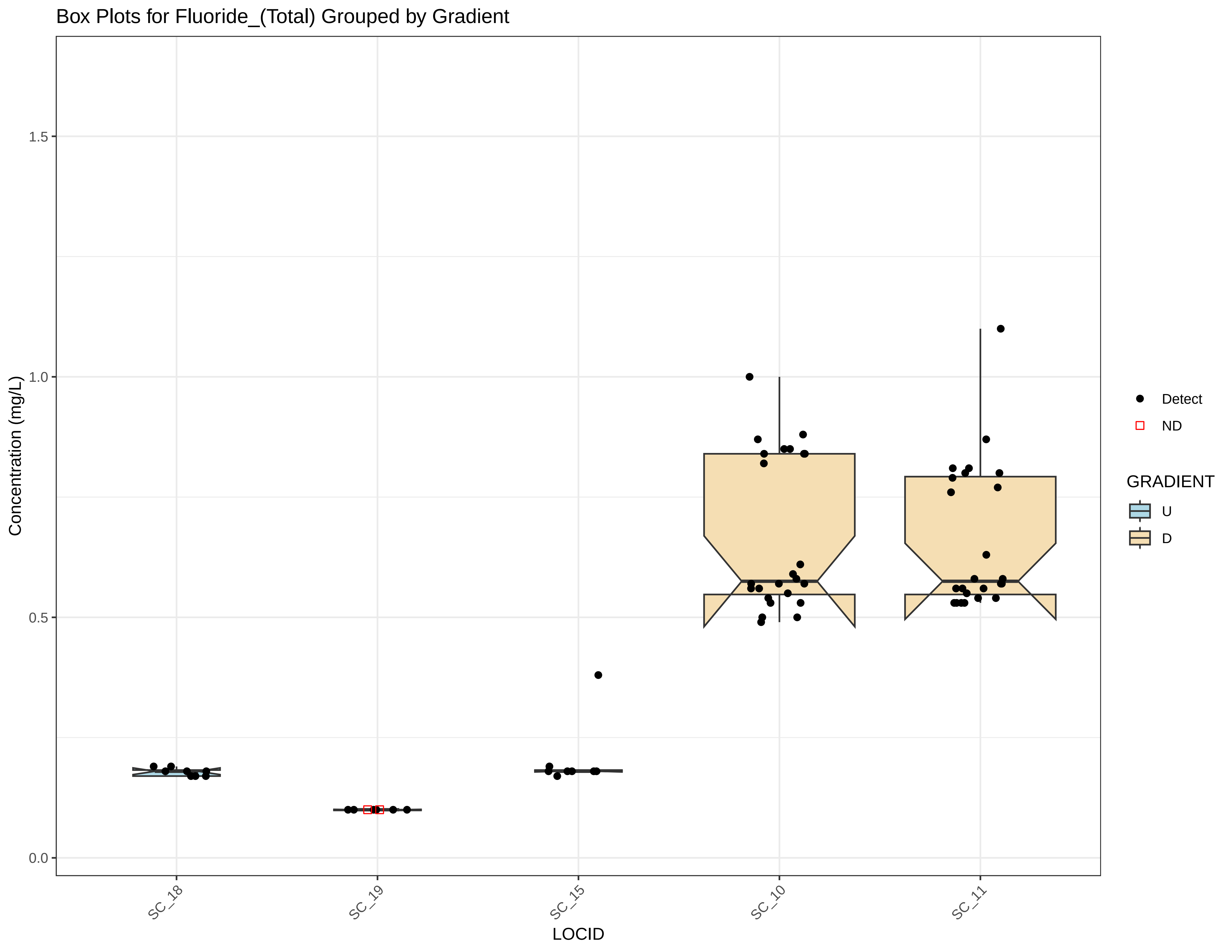


Box Plots for Chloride Grouped by Gradient
Concentration (mg/L)
1500
1000
500
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
GRADIENT
U
D



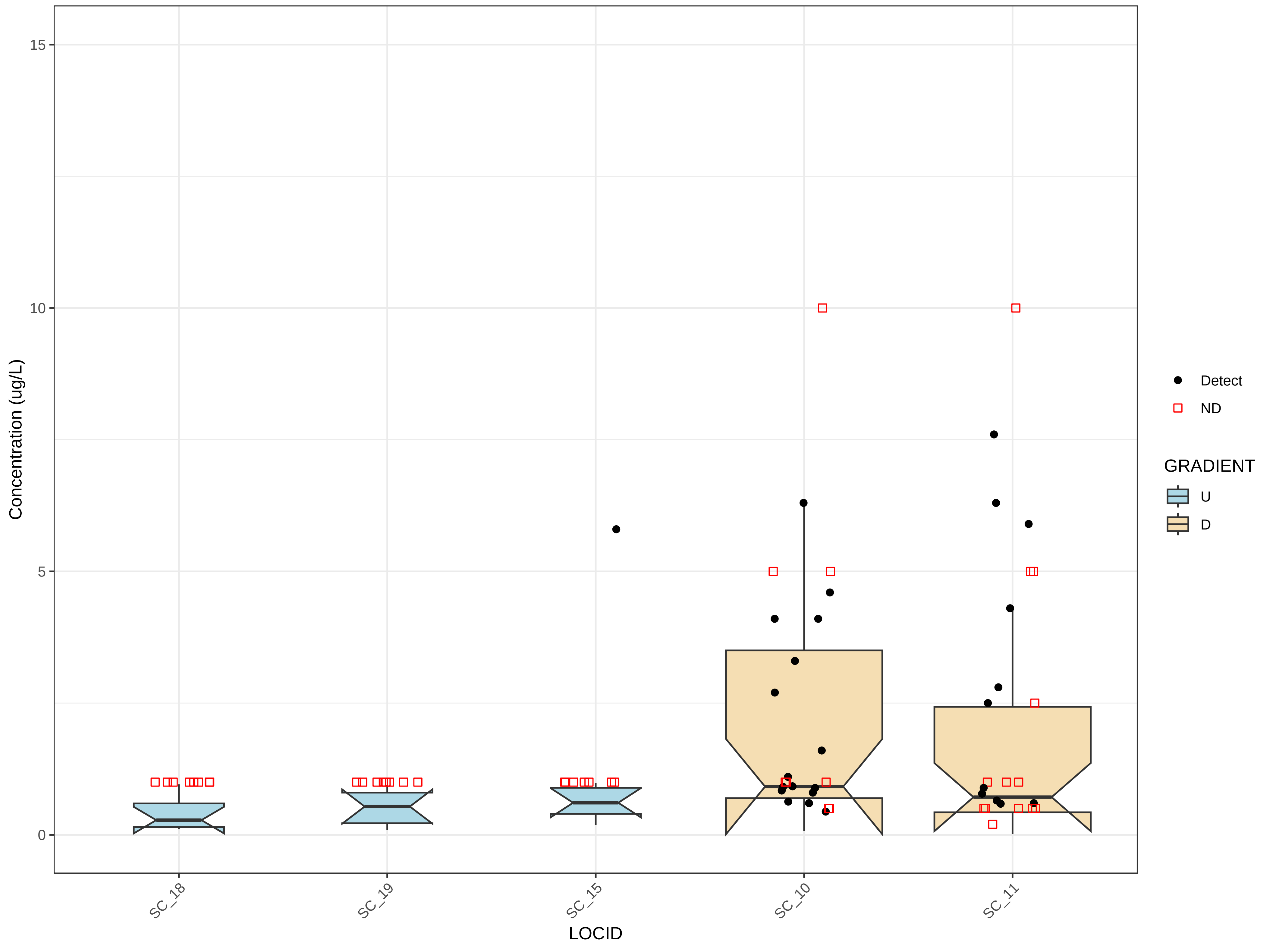
Box Plots for Chromium_(Total) Grouped by Gradient
Concentration (ug/L)
15
10
5
0
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
ND
GRADIENT
U
D

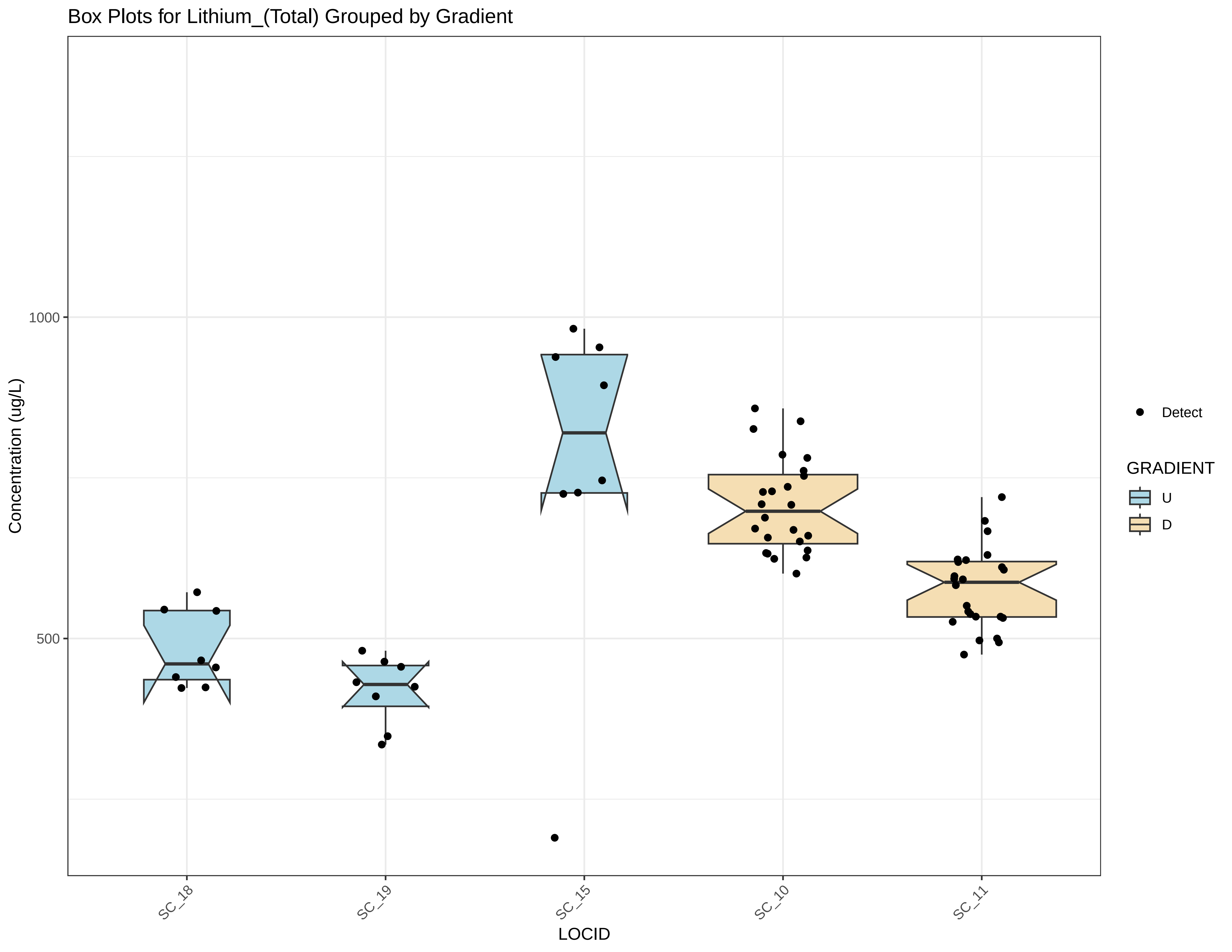

Box Plots for Cobalt_(Total) Grouped by Gradient
Concentration (ug/L)
0.0
2.5
5.0
7.5
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
ND
GRADIENT
U
D



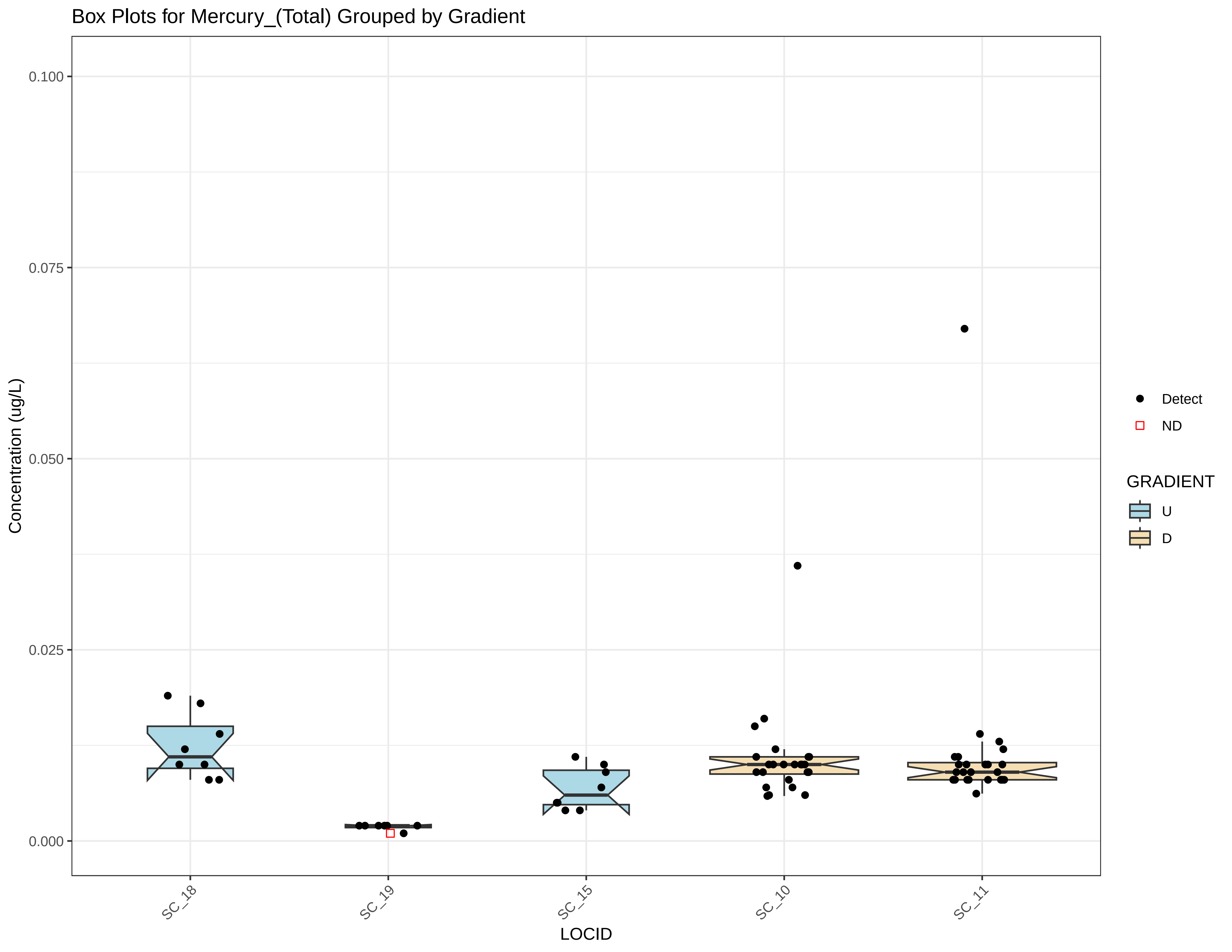
Box Plots for Fluoride_(Total) Grouped by Gradient
Concentration (mg/L)
1.5
1.0
0.5
0.0
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
ND
GRADIENT
U
D

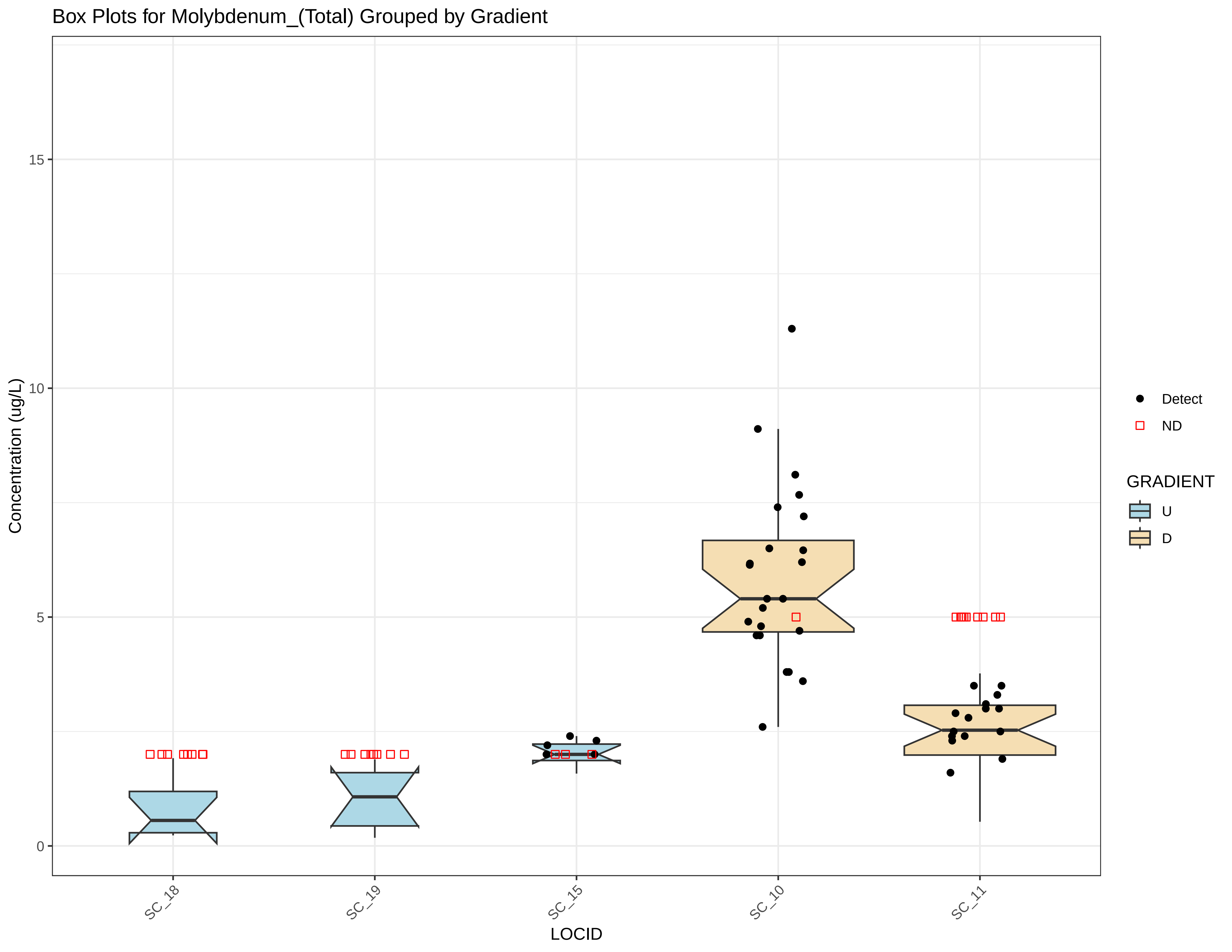
Box Plots for Lead_(Total) Grouped by Gradient



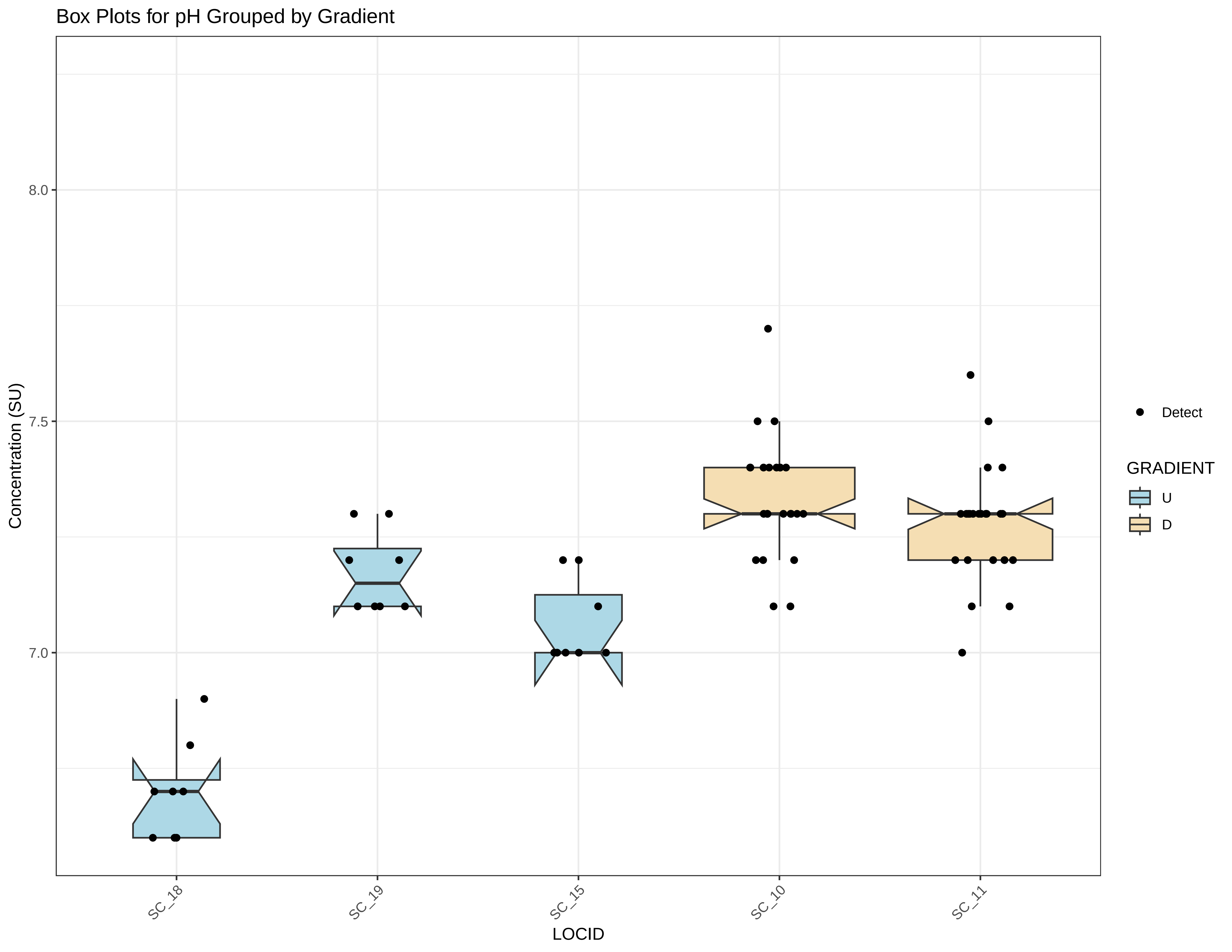


Box Plots for Lithium_(Total) Grouped by Gradient
Concentration (ug/L)
1000
500
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
GRADIENT
U
D

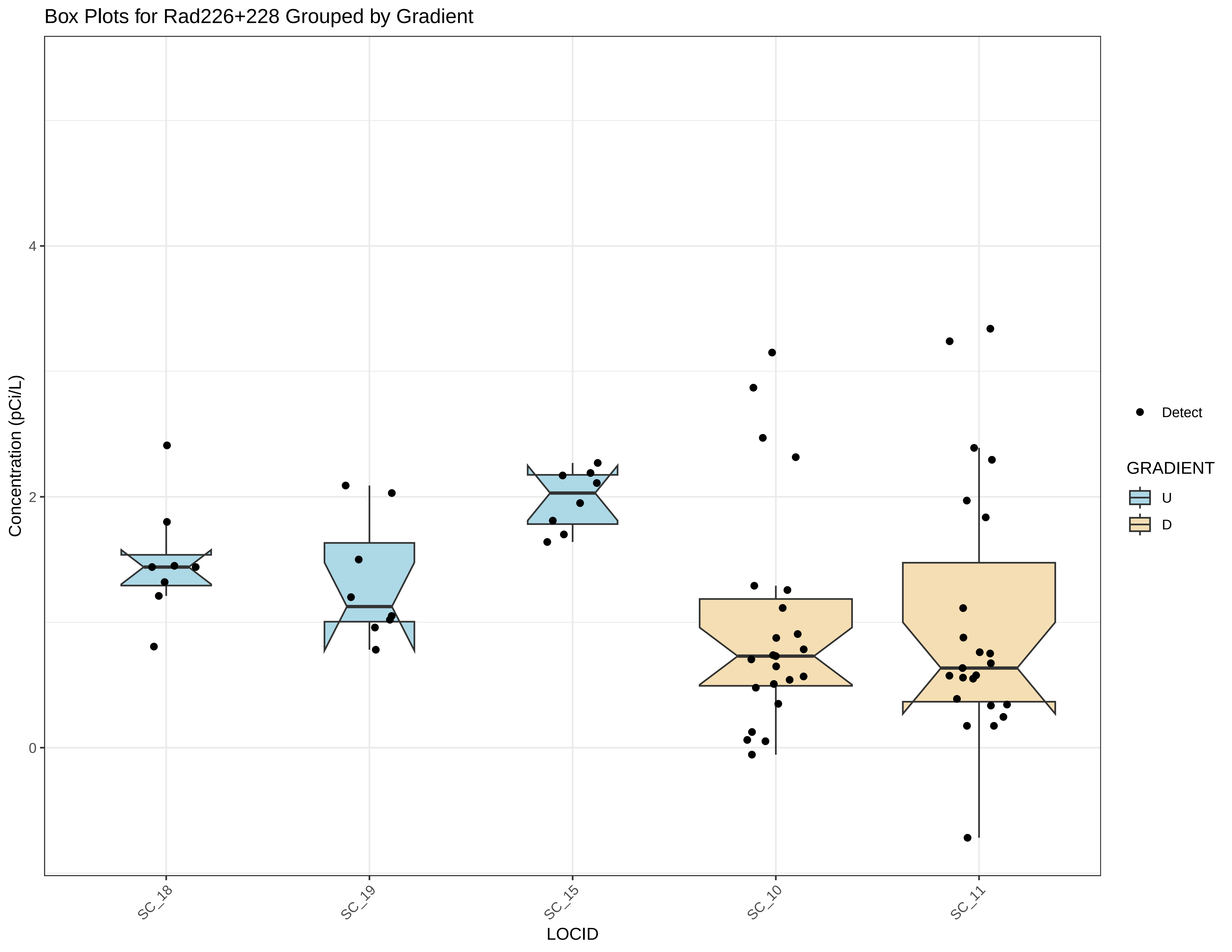

Box Plots for Mercury_(Total) Grouped by Gradient
Concentration (ug/L)
0.100
0.075
0.050
0.025
0.000
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
ND
GRADIENT
U
D



Box Plots for Molybdenum_(Total) Grouped by Gradient
Concentration (ug/L)
0
5
10
15
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
ND
GRADIENT
U
D

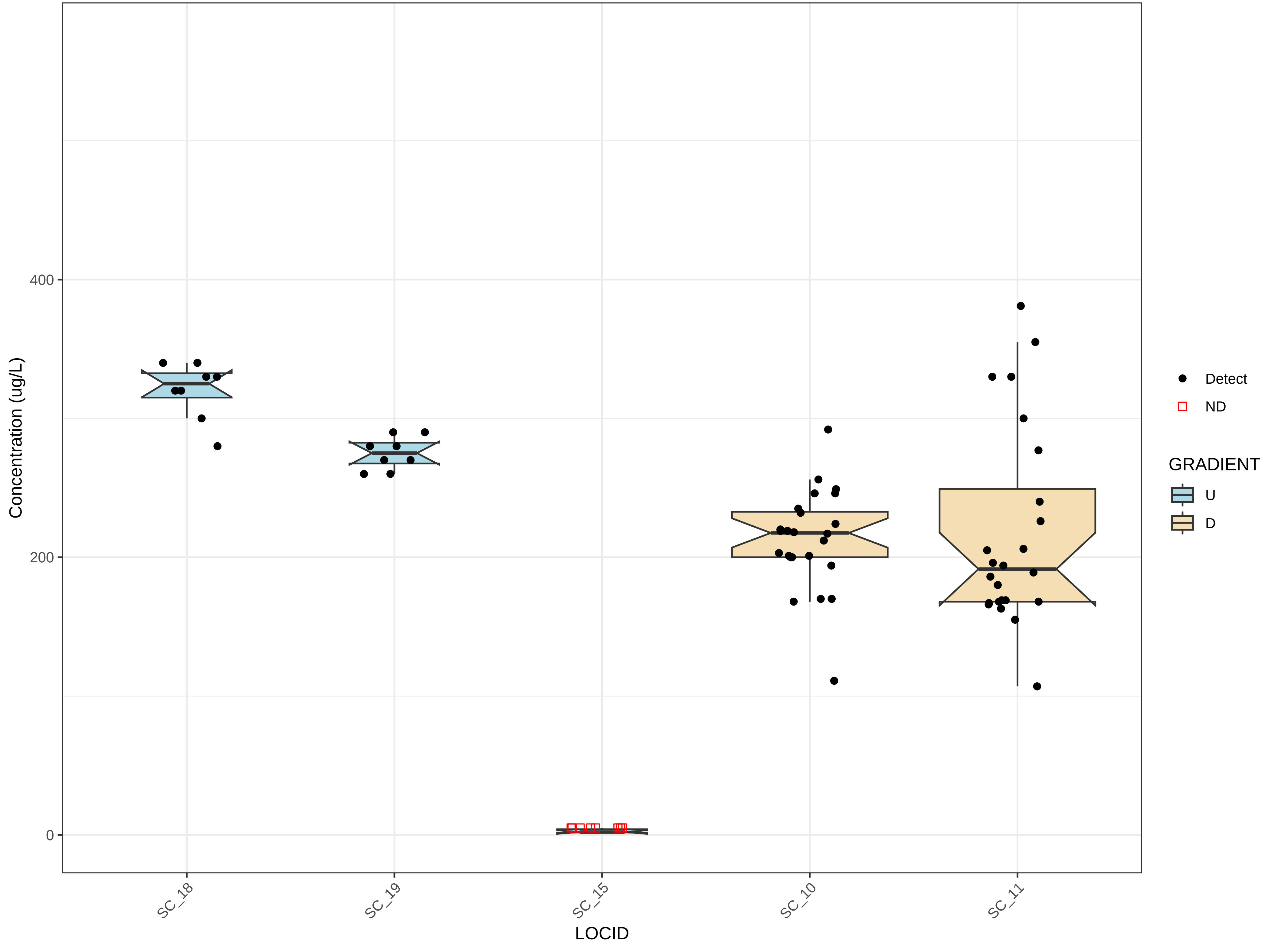


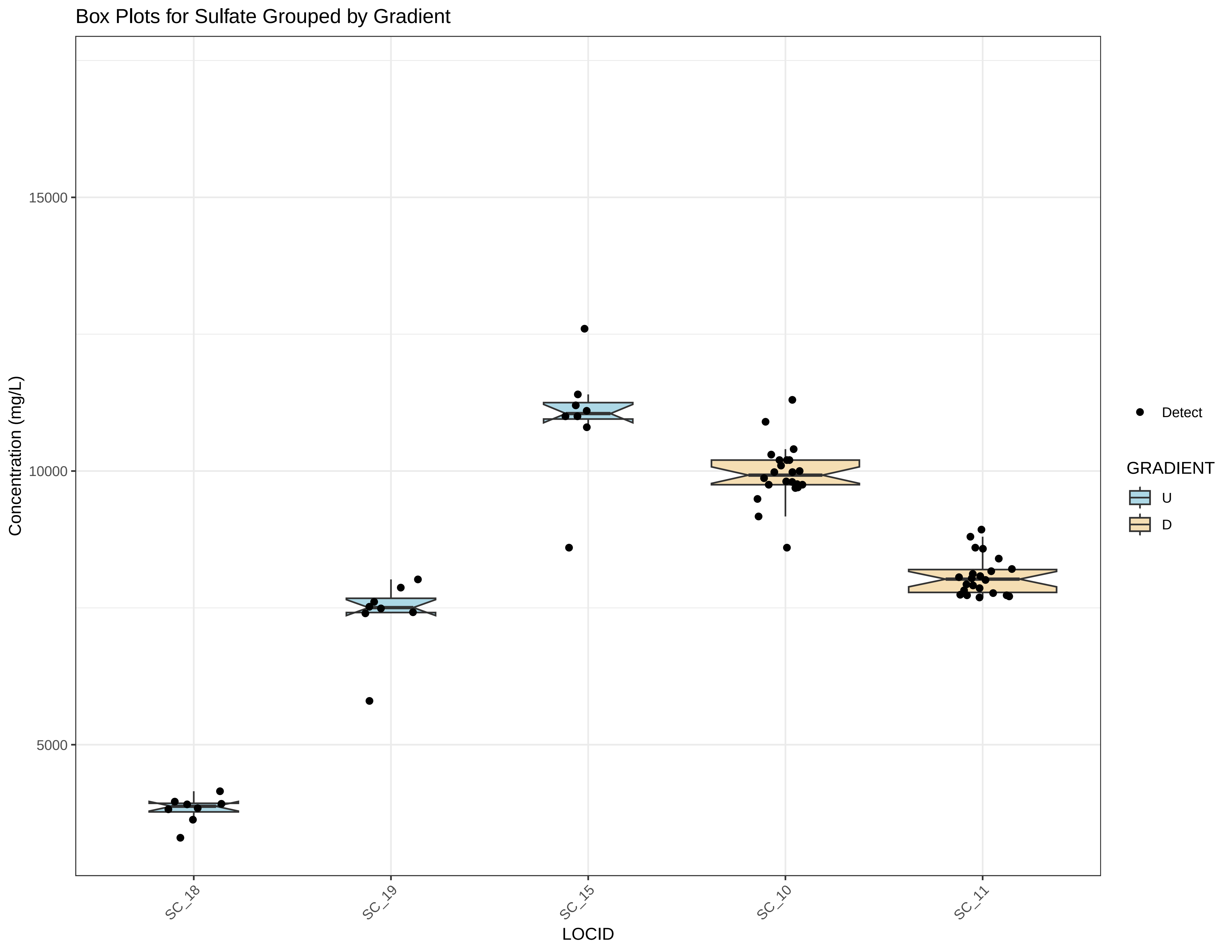
Box Plots for pH Grouped by Gradient
Concentration (SU)
8.0
7.5
7.0
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
GRADIENT
U
D



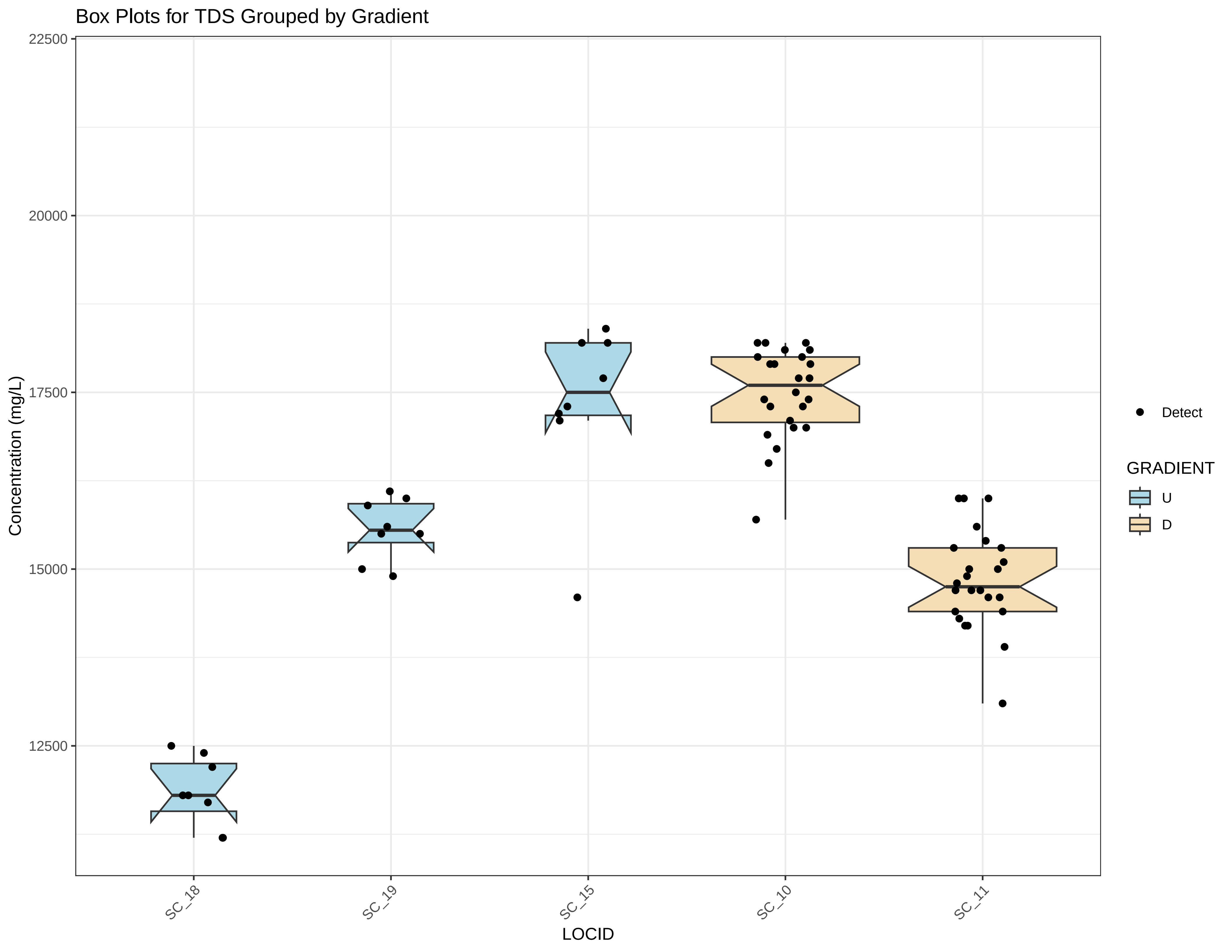
Box Plots for Rad226+228 Grouped by Gradient
Concentration (pCi/L)
0
2
4
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
GRADIENT
U
D

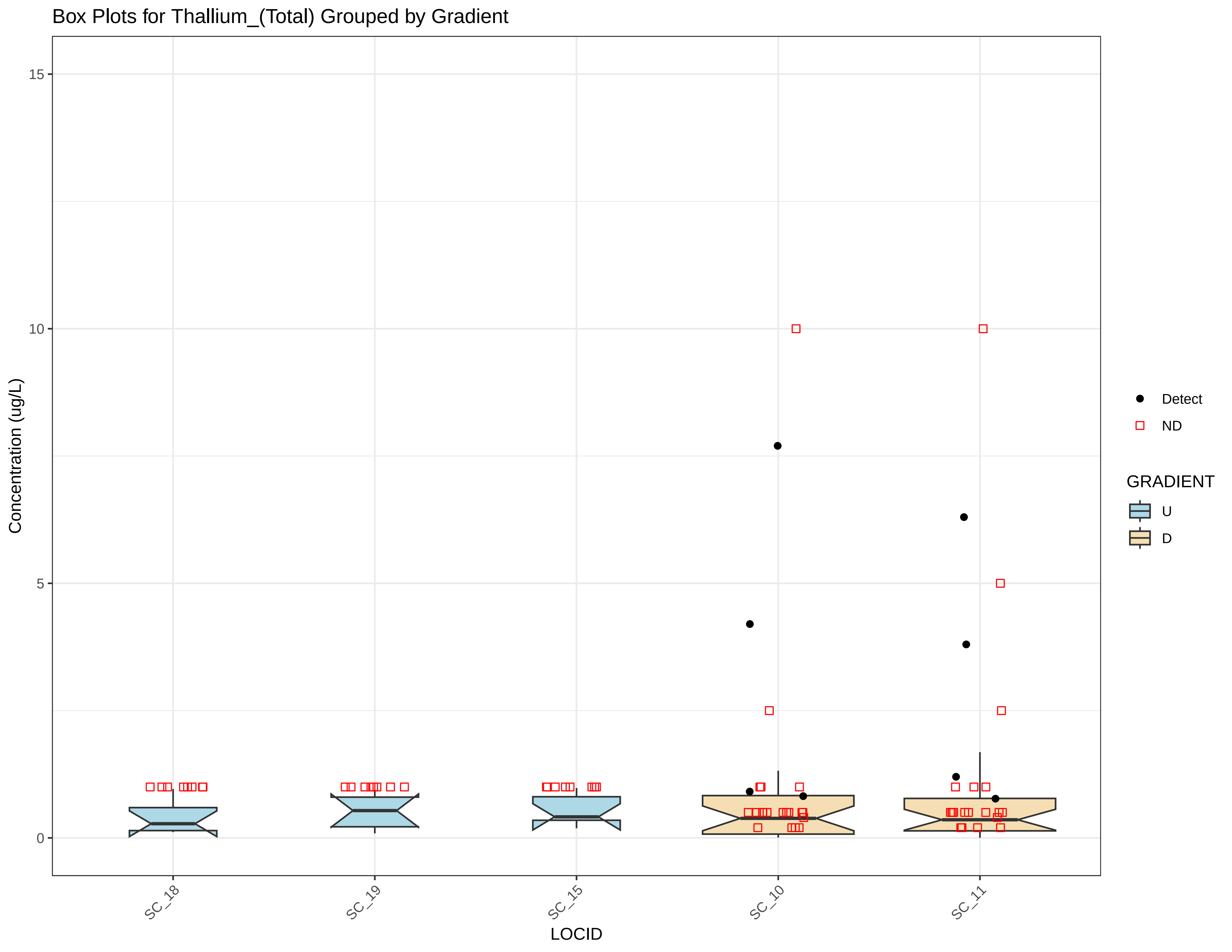
Box Plots for Selenium_(Total) Grouped by Gradient



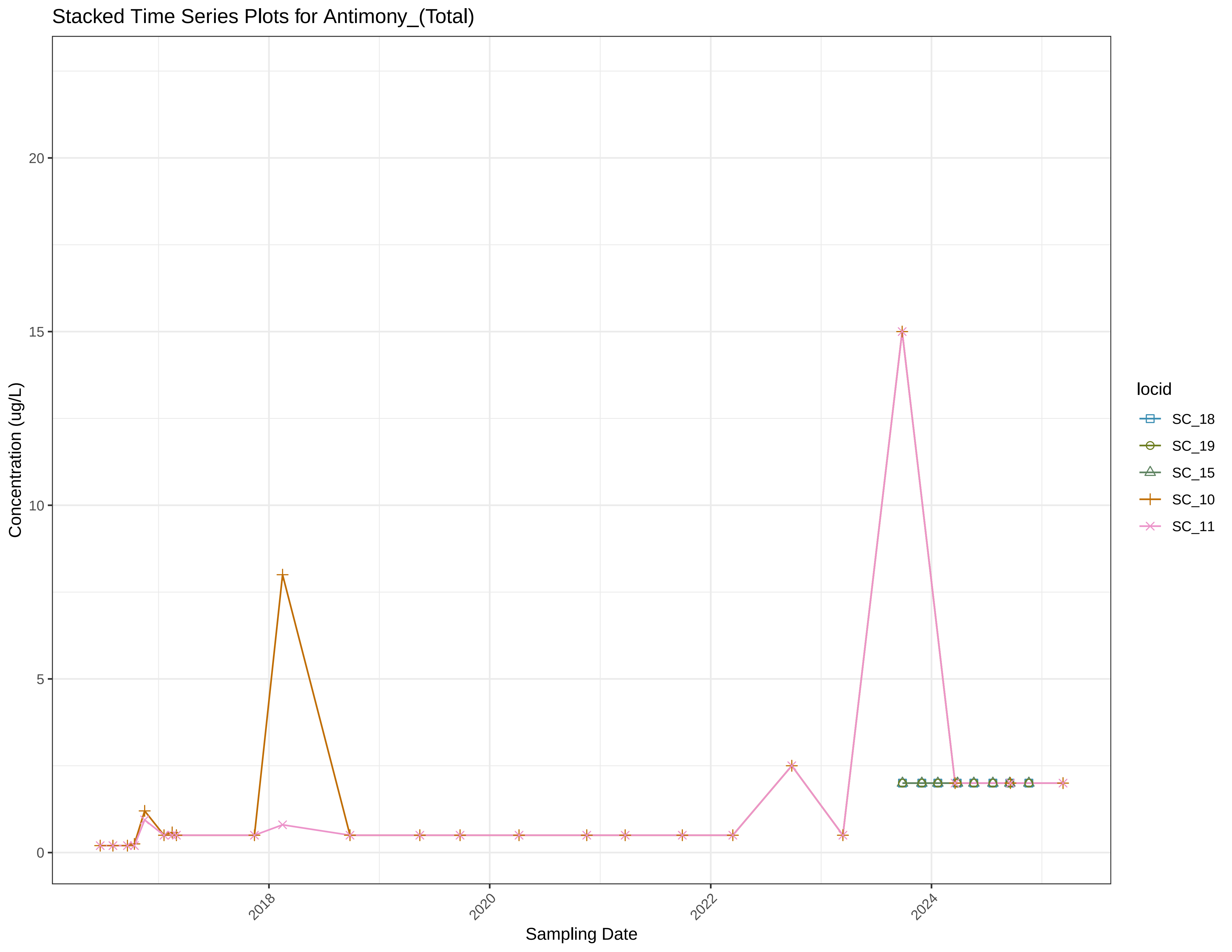


Box Plots for Sulfate Grouped by Gradient
Concentration (mg/L)
15000
10000
5000
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
GRADIENT
U
D


Box Plots for TDS Grouped by Gradient
22500
20000
17500
15000
12500
Concentration (mg/L)
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
GRADIENT
U
D

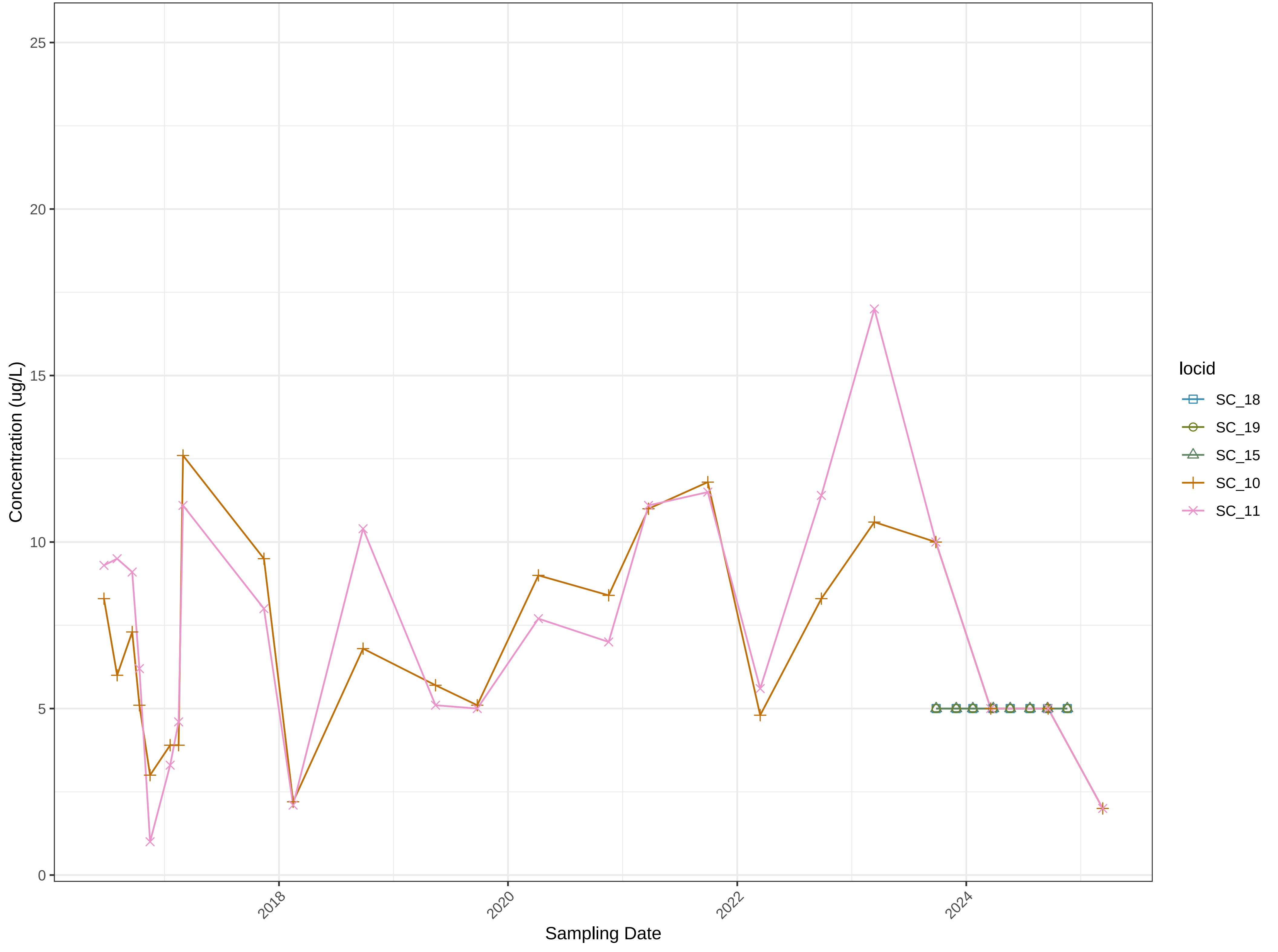


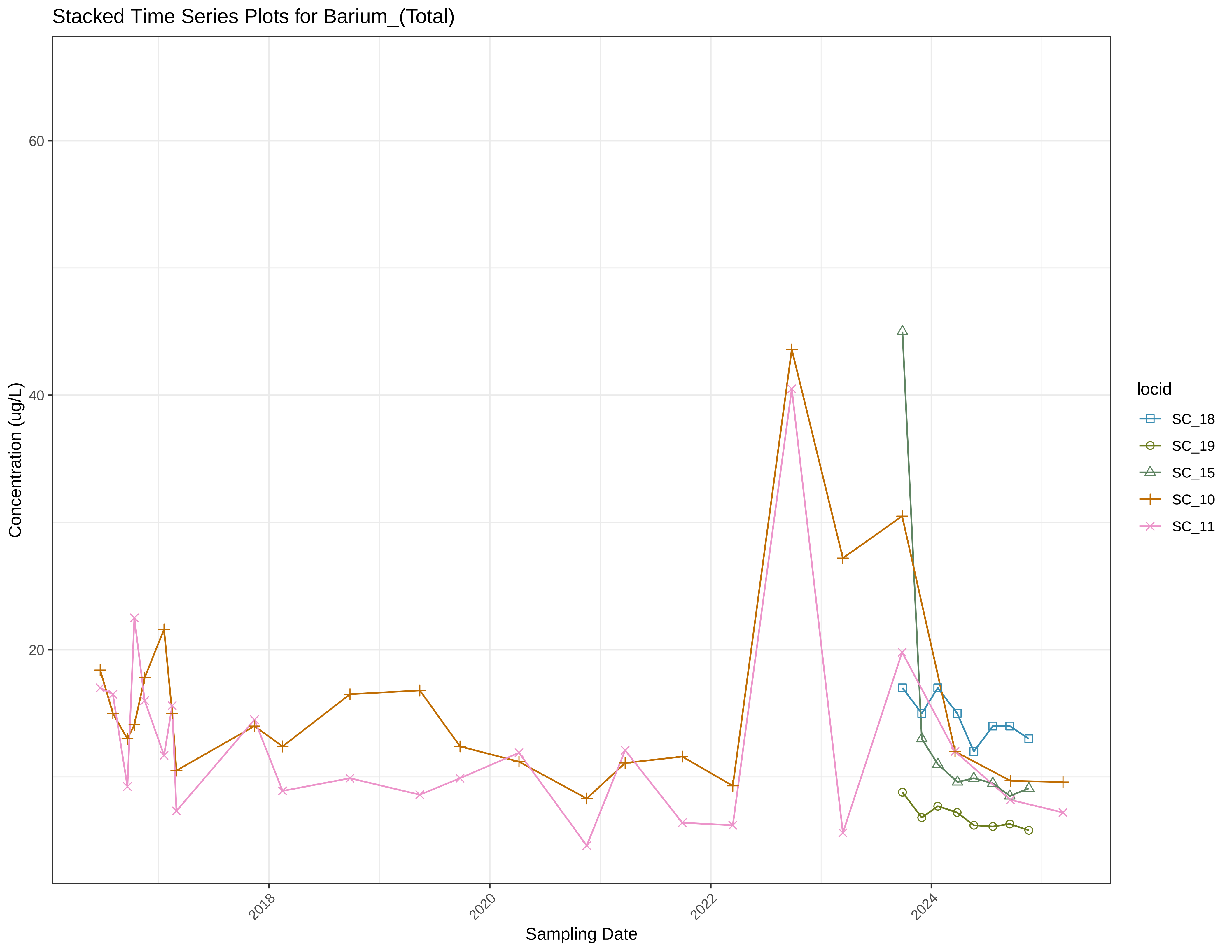
Box Plots for Thallium_(Total) Grouped by Gradient
15
10
5
0
Concentration (ug/L)
SC_18
SC_19
SC_15
SC_10
SC_11
LOCID
Detect
ND
GRADIENT
U
D

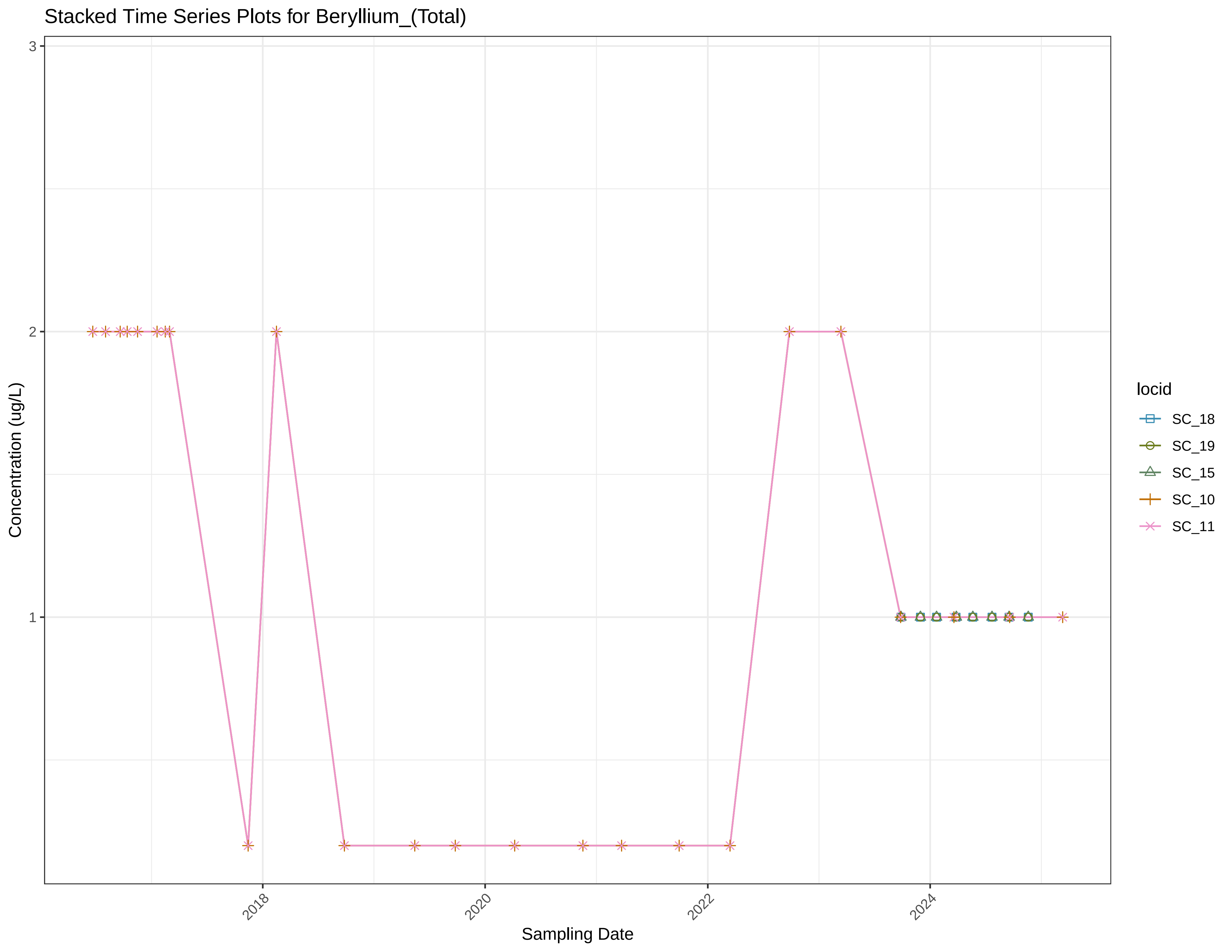


Stacked Time Series Plots for Antimony_(Total)
Concentration (ug/L)
Sampling Date
0
5
10
15
20
2018
2020
2022
2024
locid
SC_18
SC_19
SC_15
SC_10
SC_11

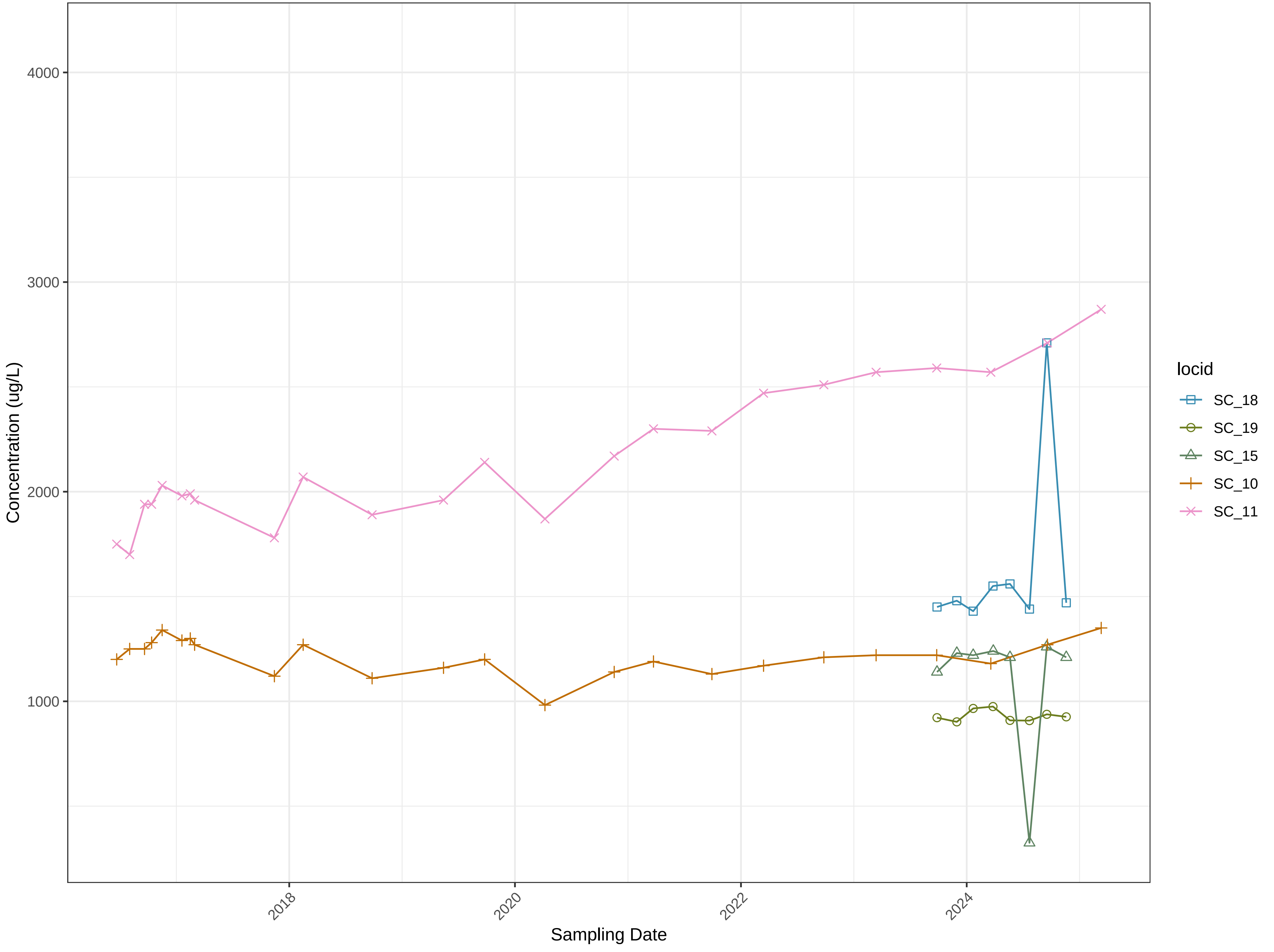
Stacked Time Series Plots for Arsenic_(Total)

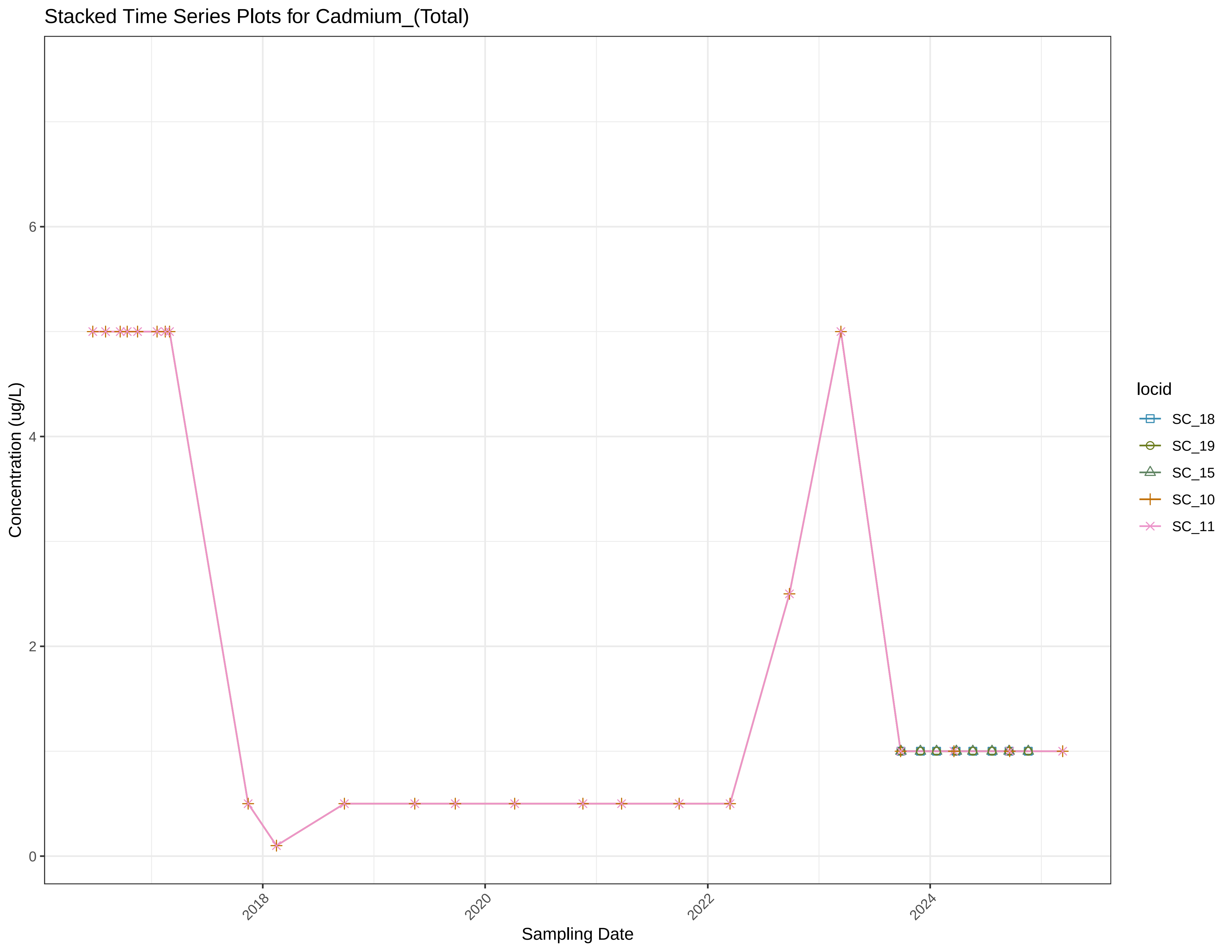



Stacked Time Series Plots for Barium_(Total)
Concentration (ug/L)
60
40
20
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11

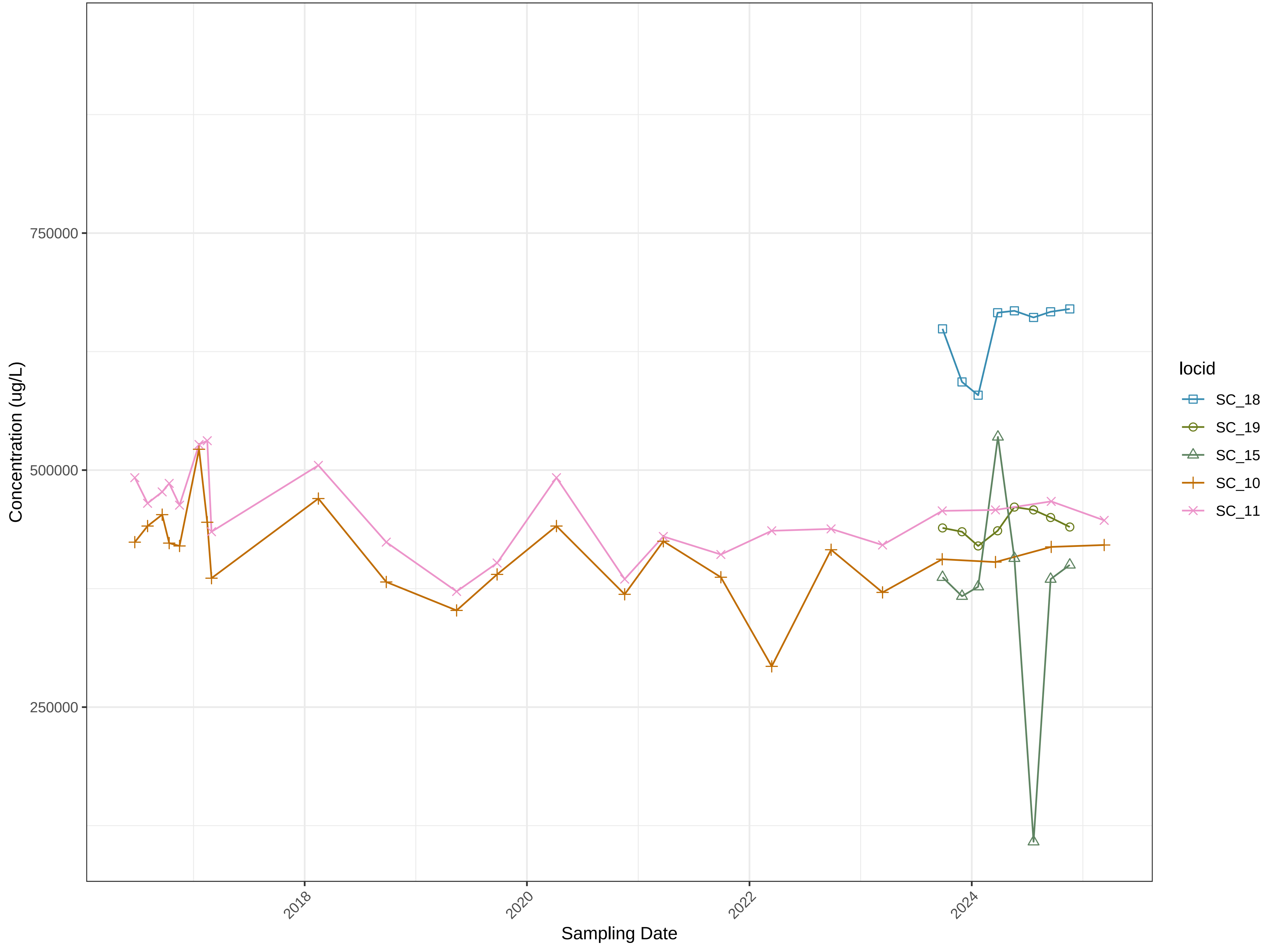

Stacked Time Series Plots for Beryllium_(Total)
Concentration (ug/L)
3
2
1
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11

Stacked Time Series Plots for Boron_(Total)

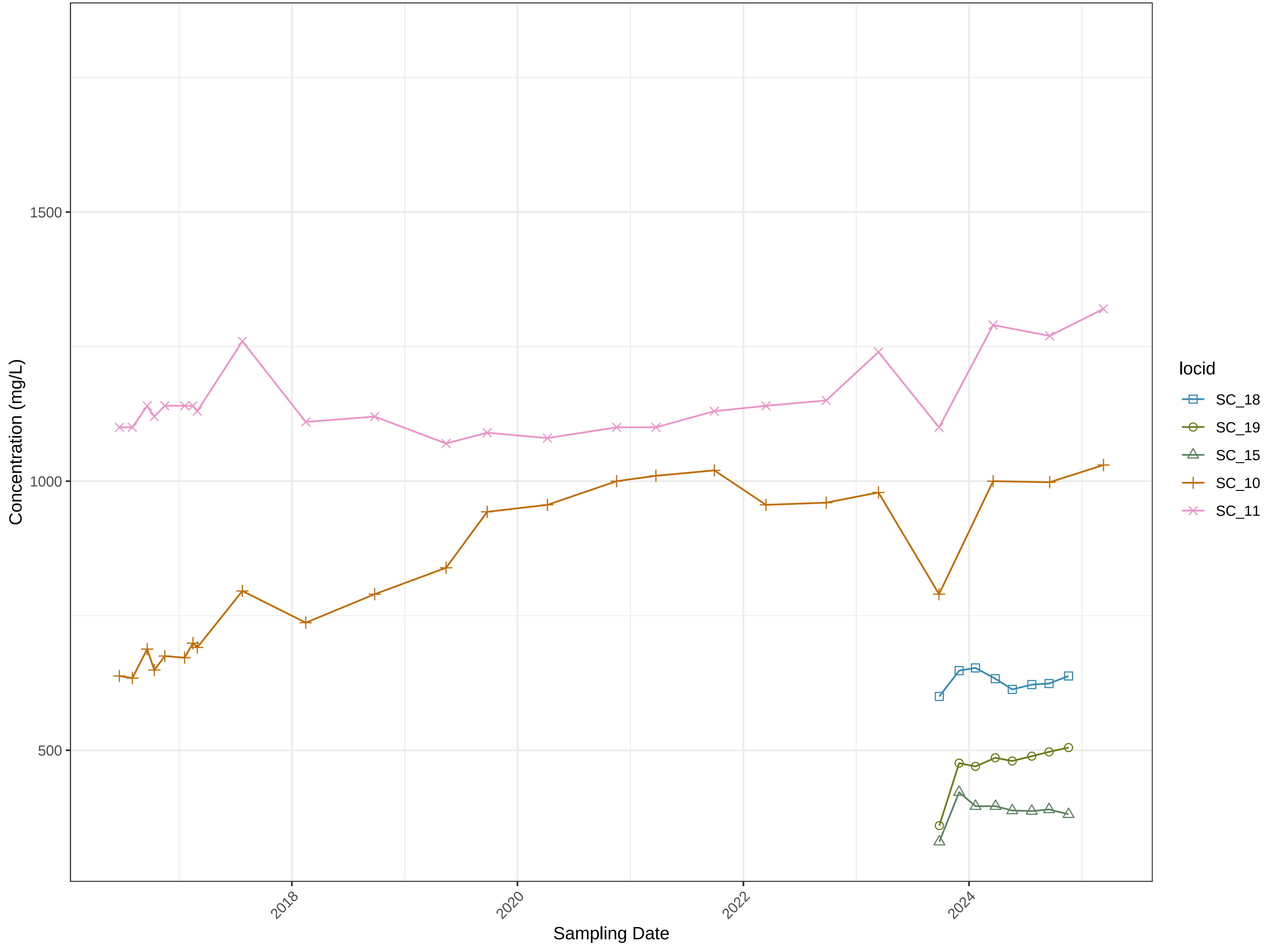



Stacked Time Series Plots for Cadmium_(Total)
Concentration (ug/L)
Sampling Date
0
2
4
6
2018
2020
2022
2024
locid
SC_18
SC_19
SC_15
SC_10
SC_11

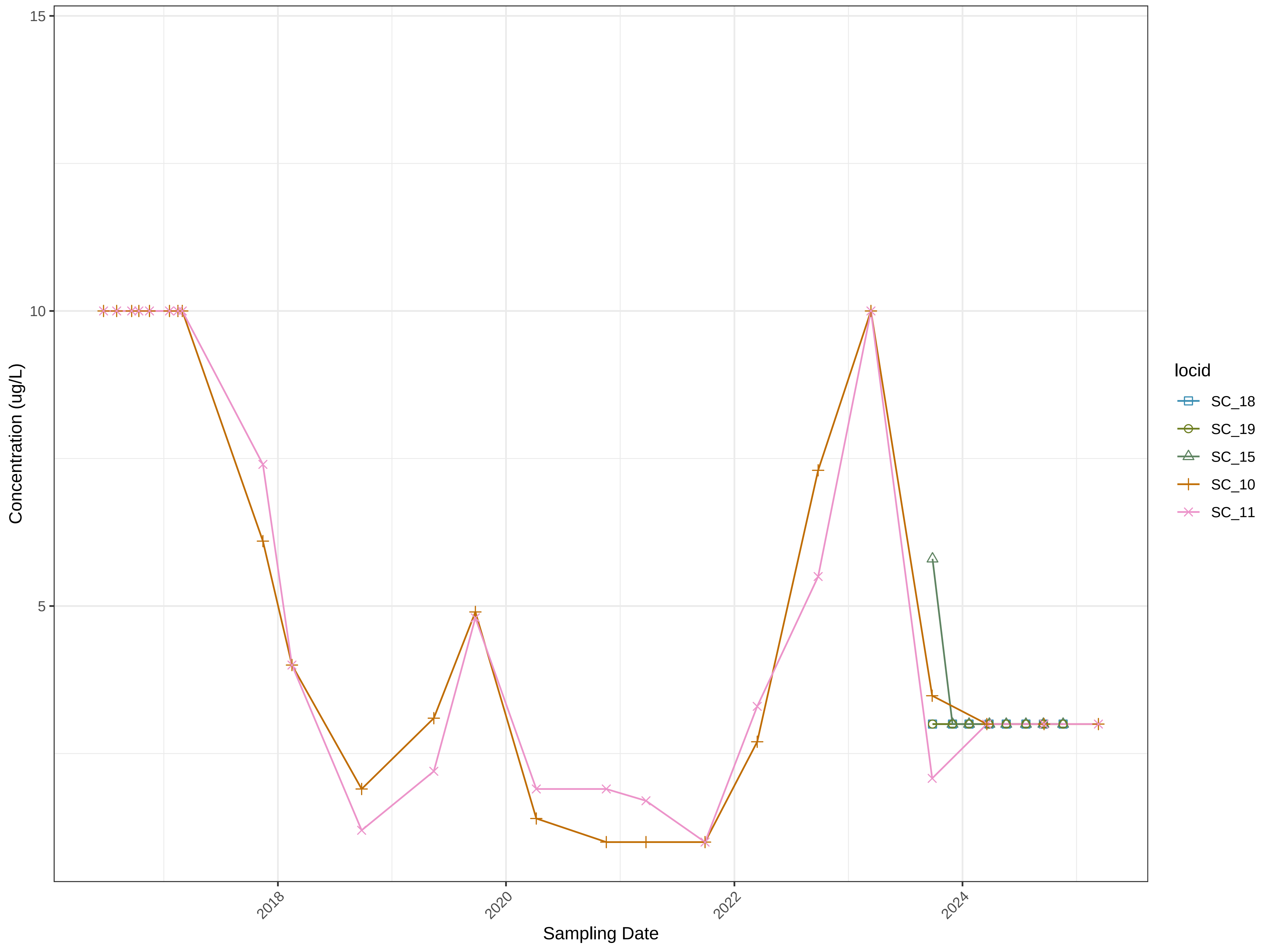
Stacked Time Series Plots for Calcium_(Total)

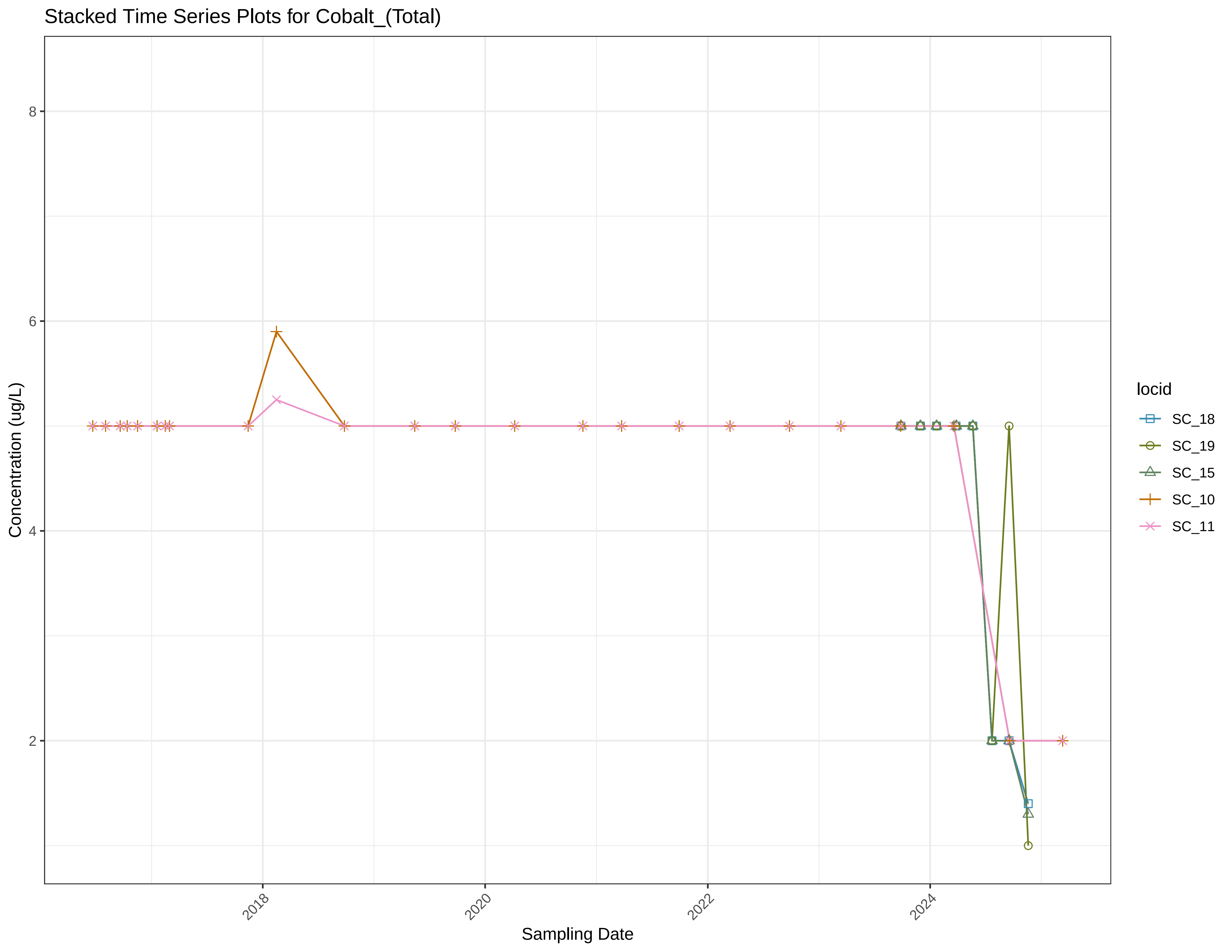


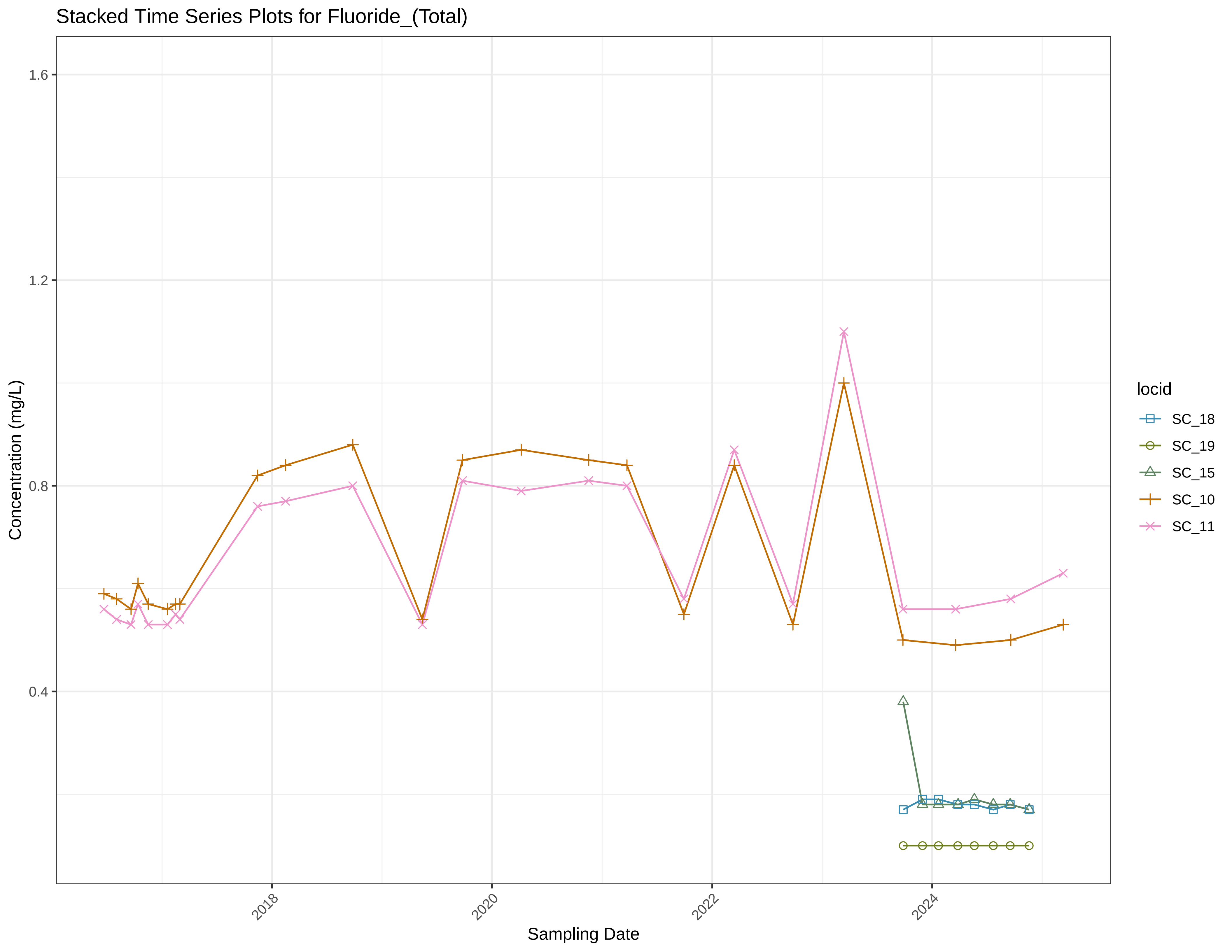
Stacked Time Series Plots for Chloride



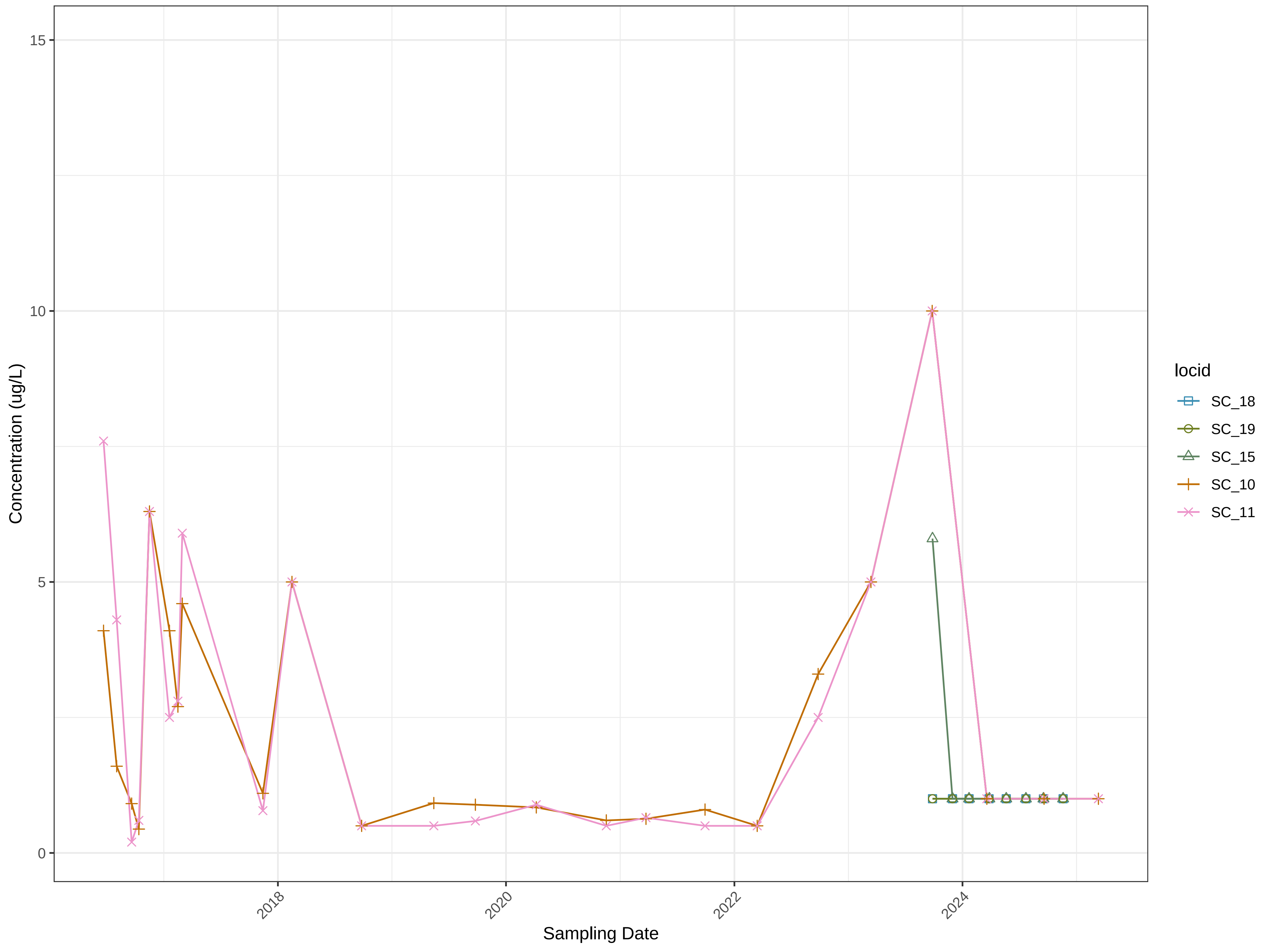
Stacked Time Series Plots for Chromium_(Total)

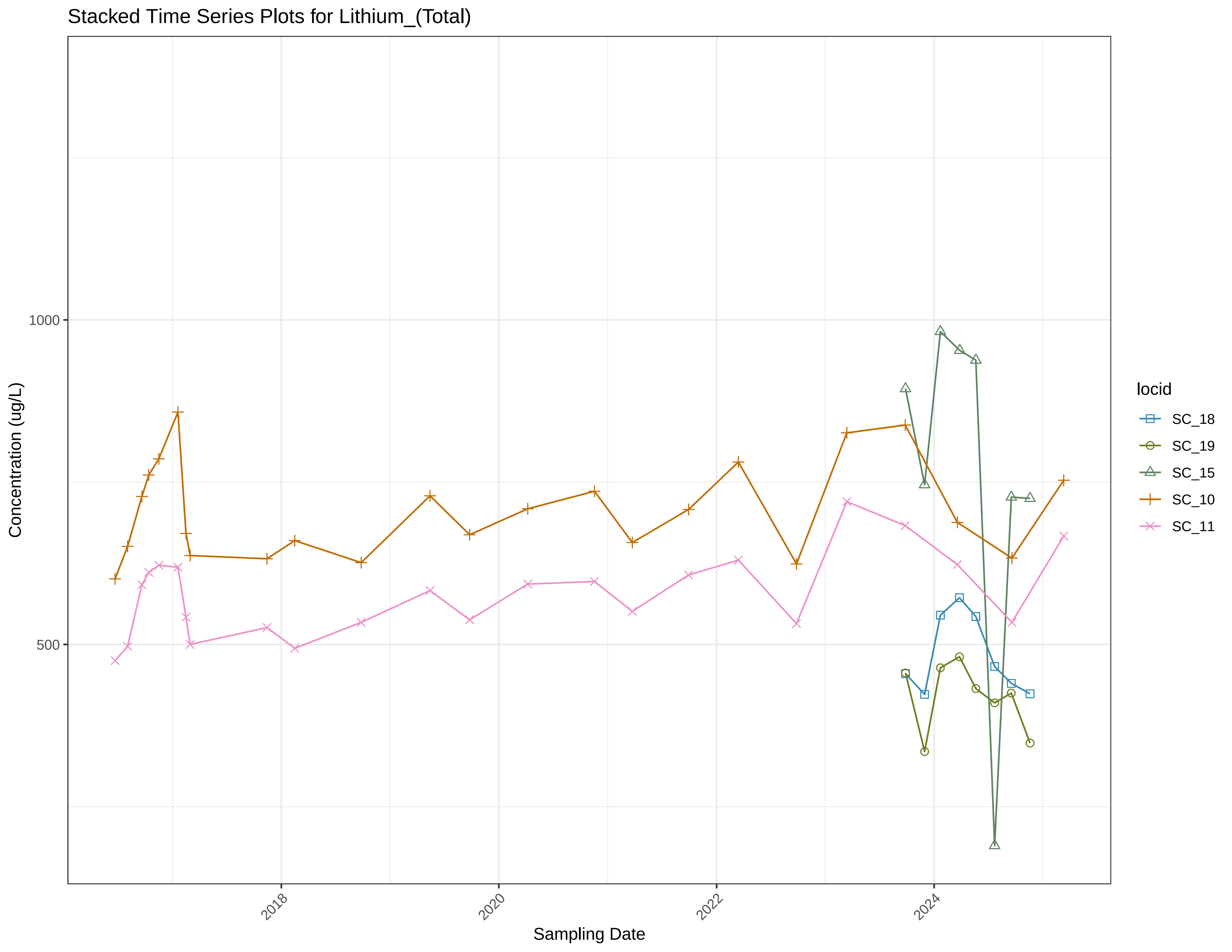



Stacked Time Series Plots for Cobalt_(Total)
Concentration (ug/L)
8
6
4
2
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11

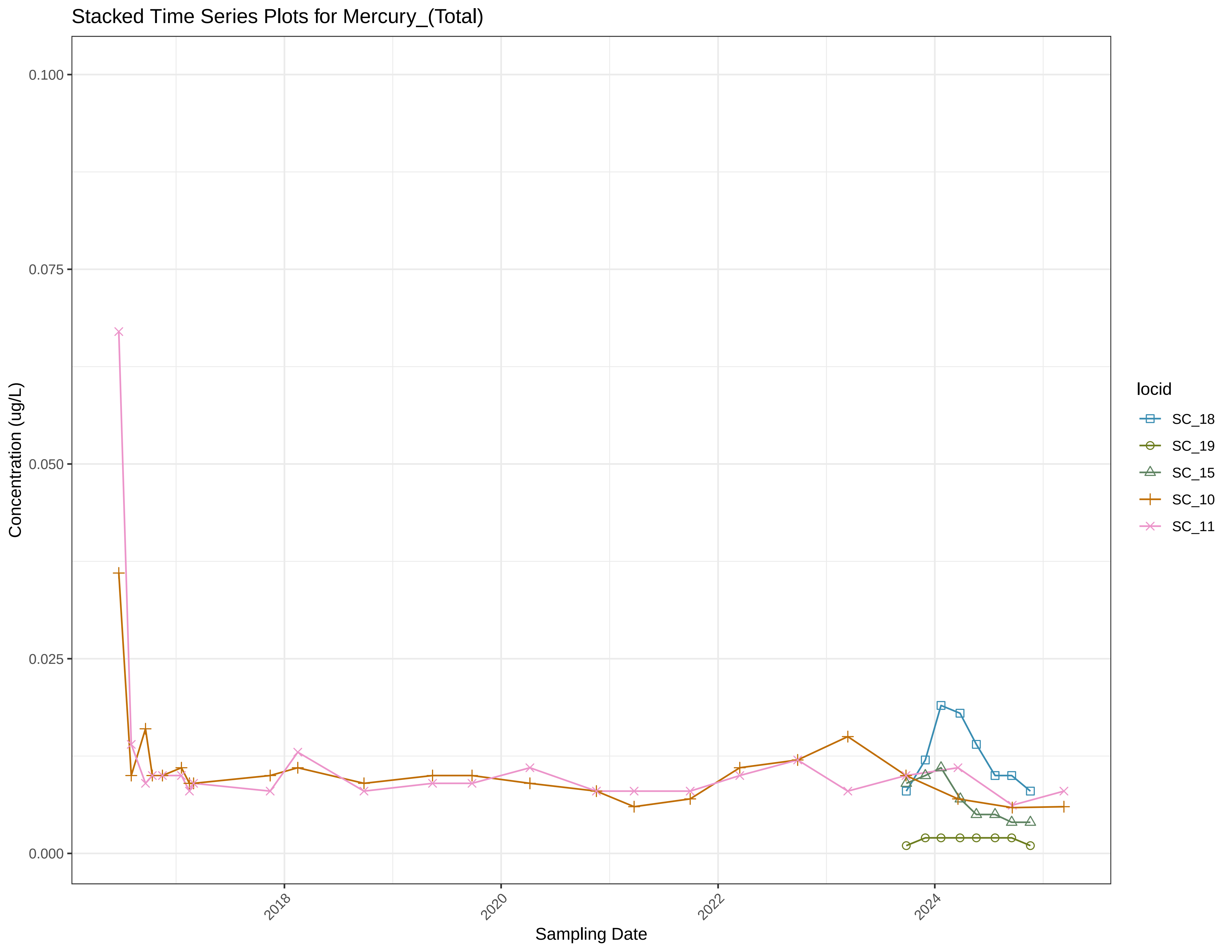

Stacked Time Series Plots for Fluoride_(Total)
Concentration (mg/L)
1.6
1.2
0.8
0.4
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11

Stacked Time Series Plots for Lead_(Total)

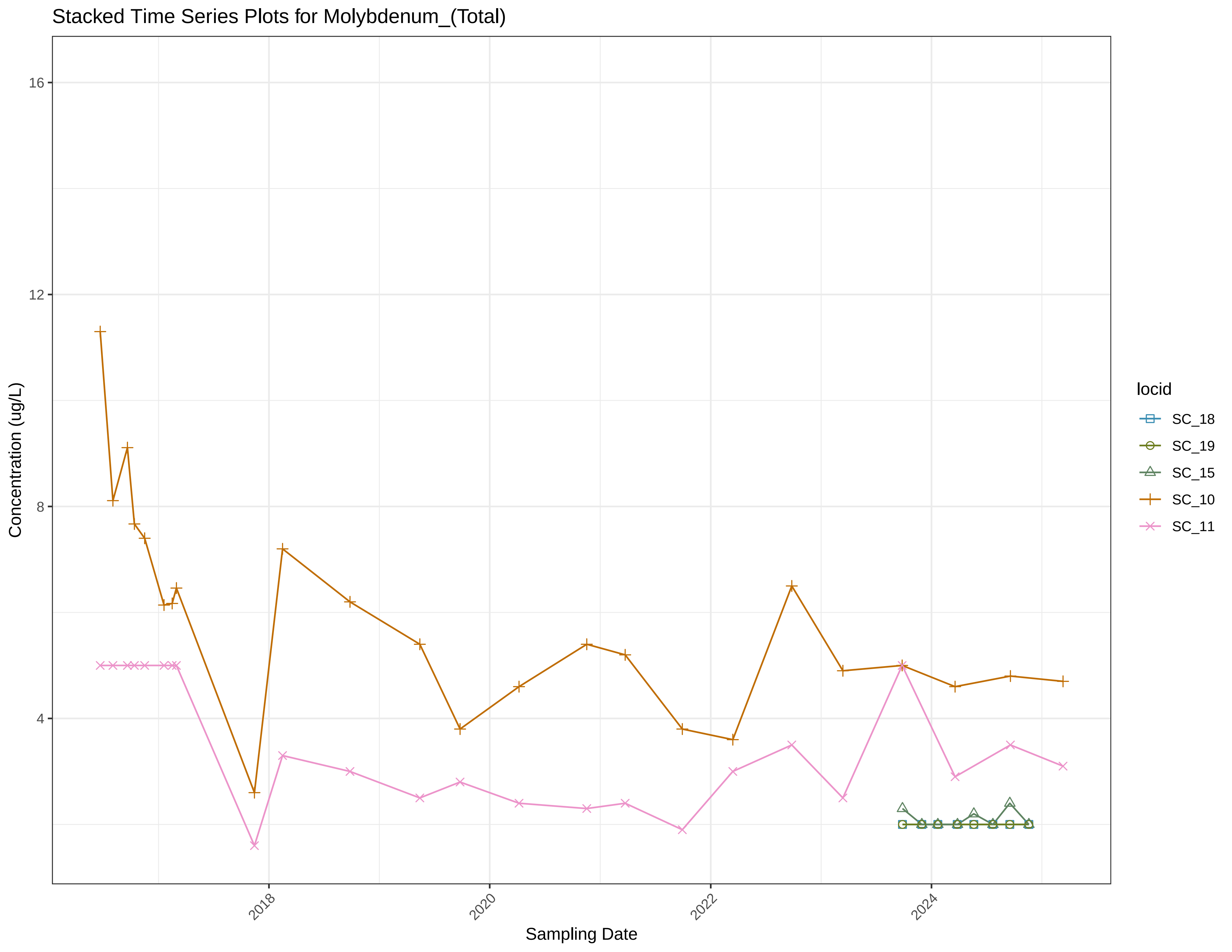




Stacked Time Series Plots for Lithium_(Total)
Concentration (ug/L)
1000
500
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11

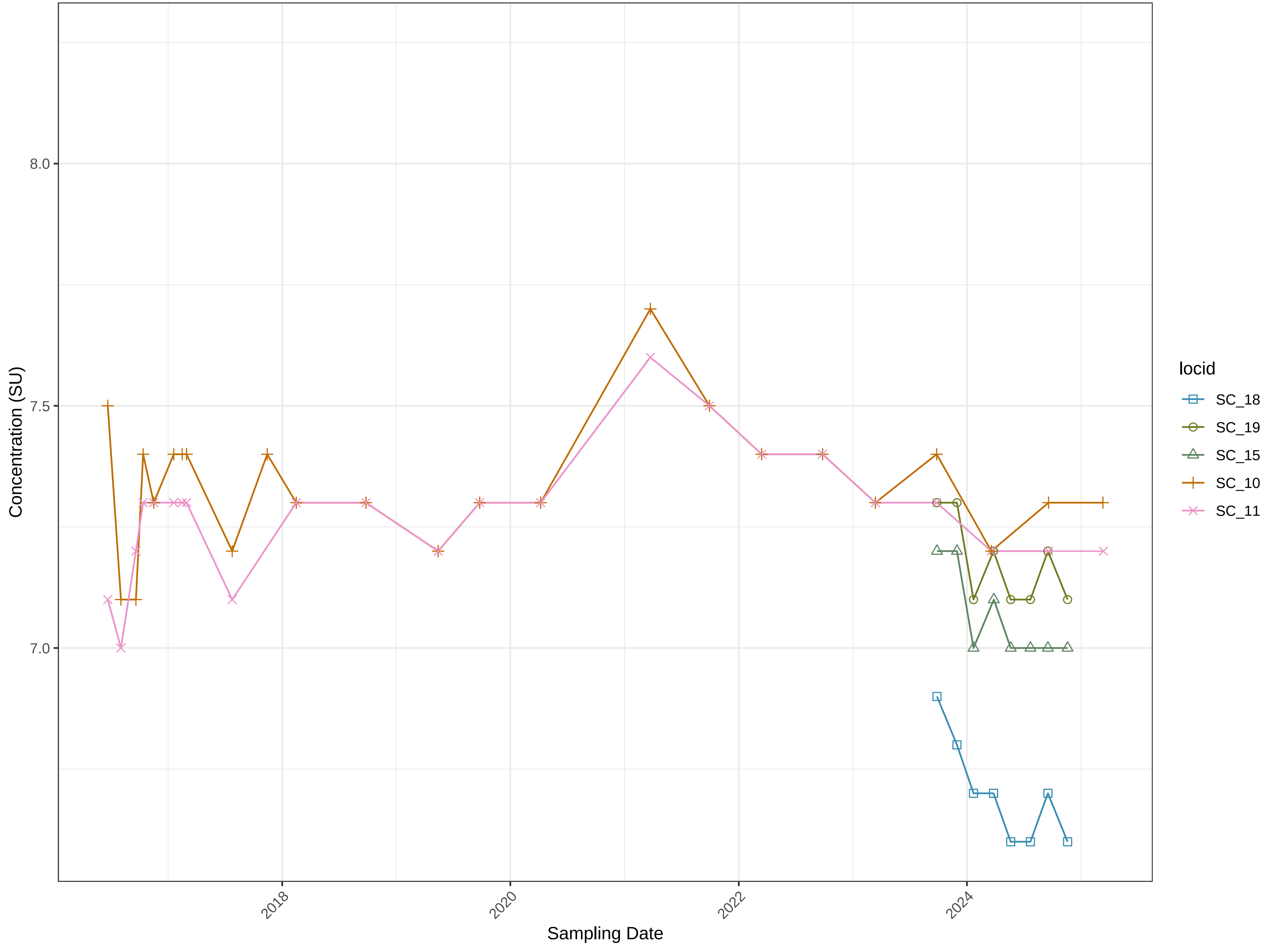


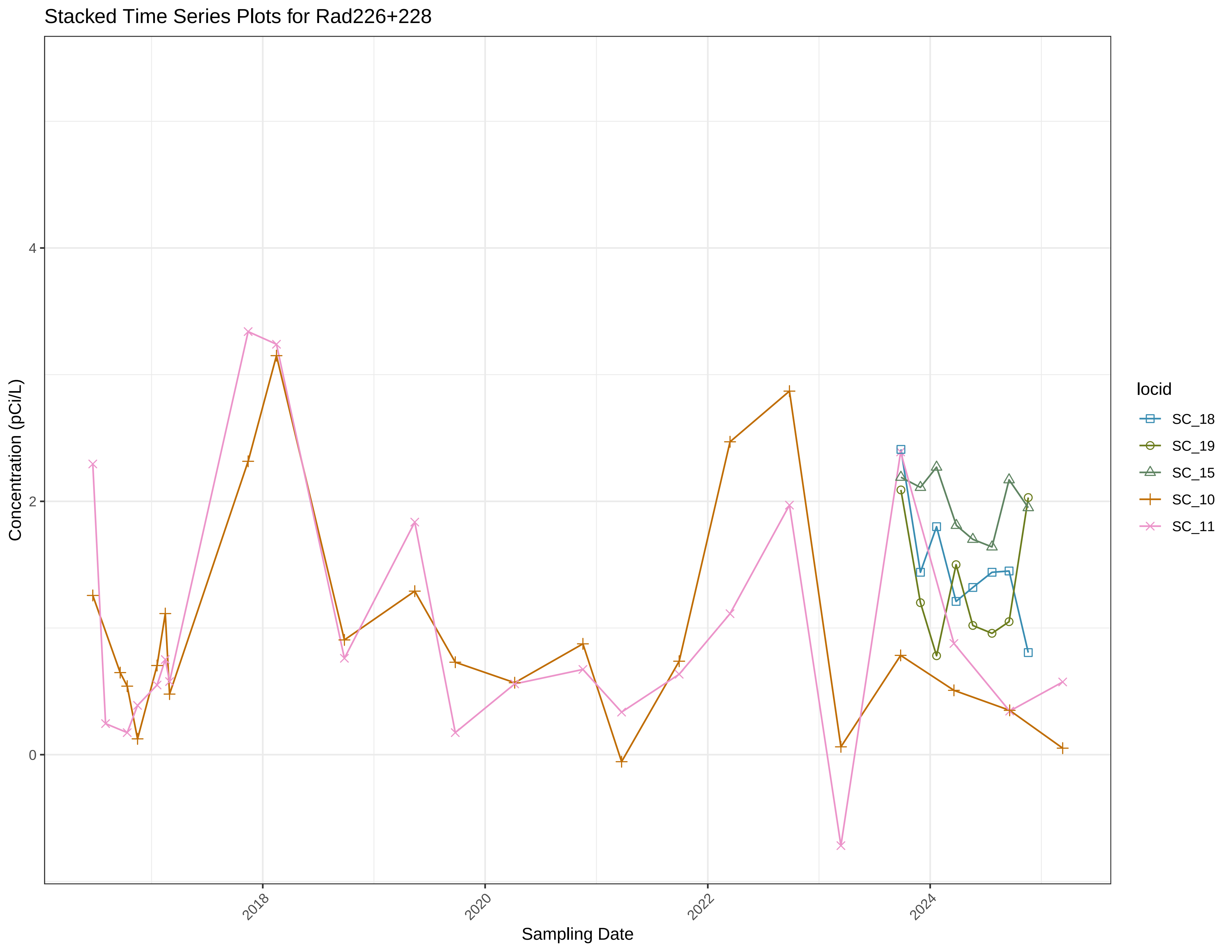
Stacked Time Series Plots for Mercury_(Total)
0.100
0.075
0.050
0.025
0.000
Concentration (ug/L)
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11



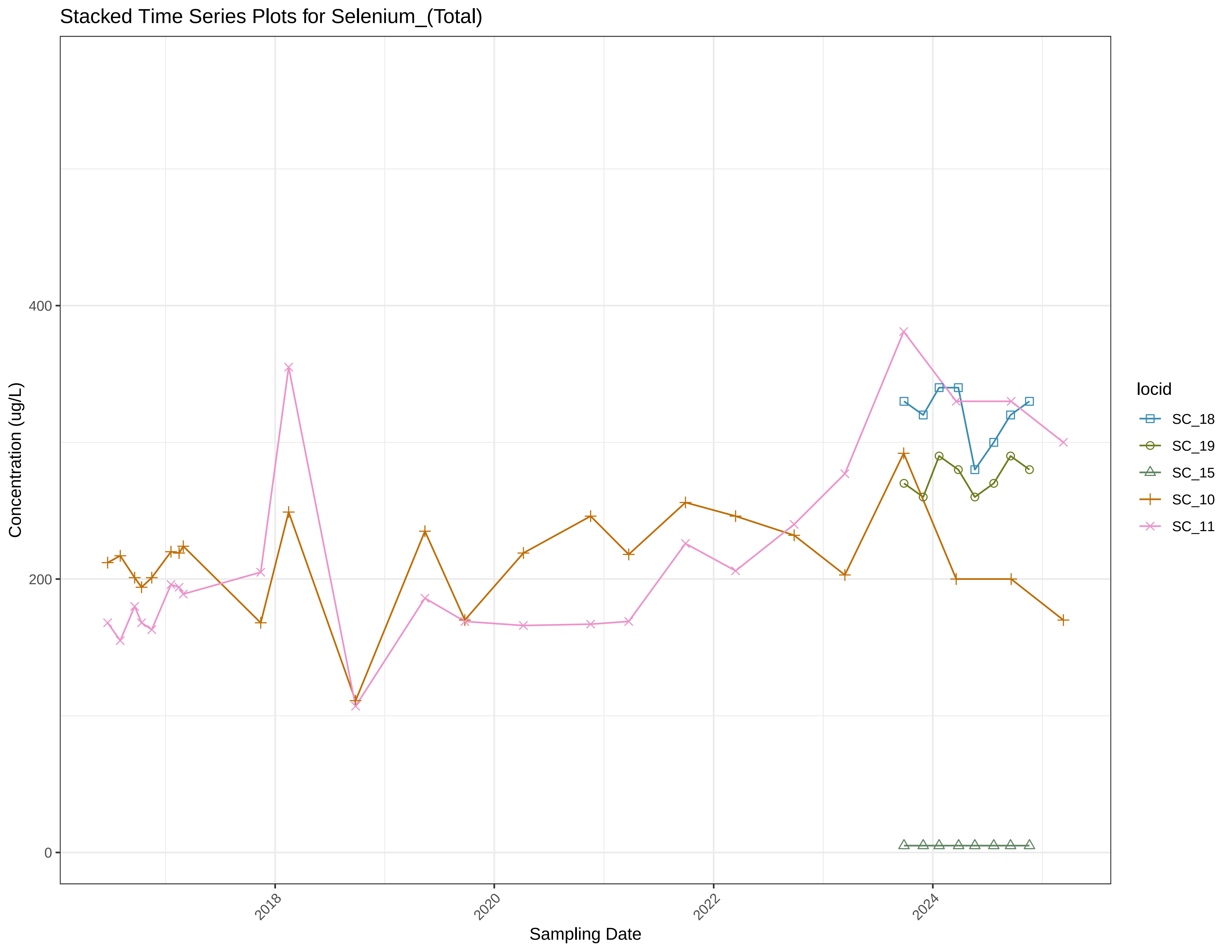
Stacked Time Series Plots for Molybdenum_(Total)
16
12
8
4
Concentration (ug/L)
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11

Stacked Time Series Plots for pH

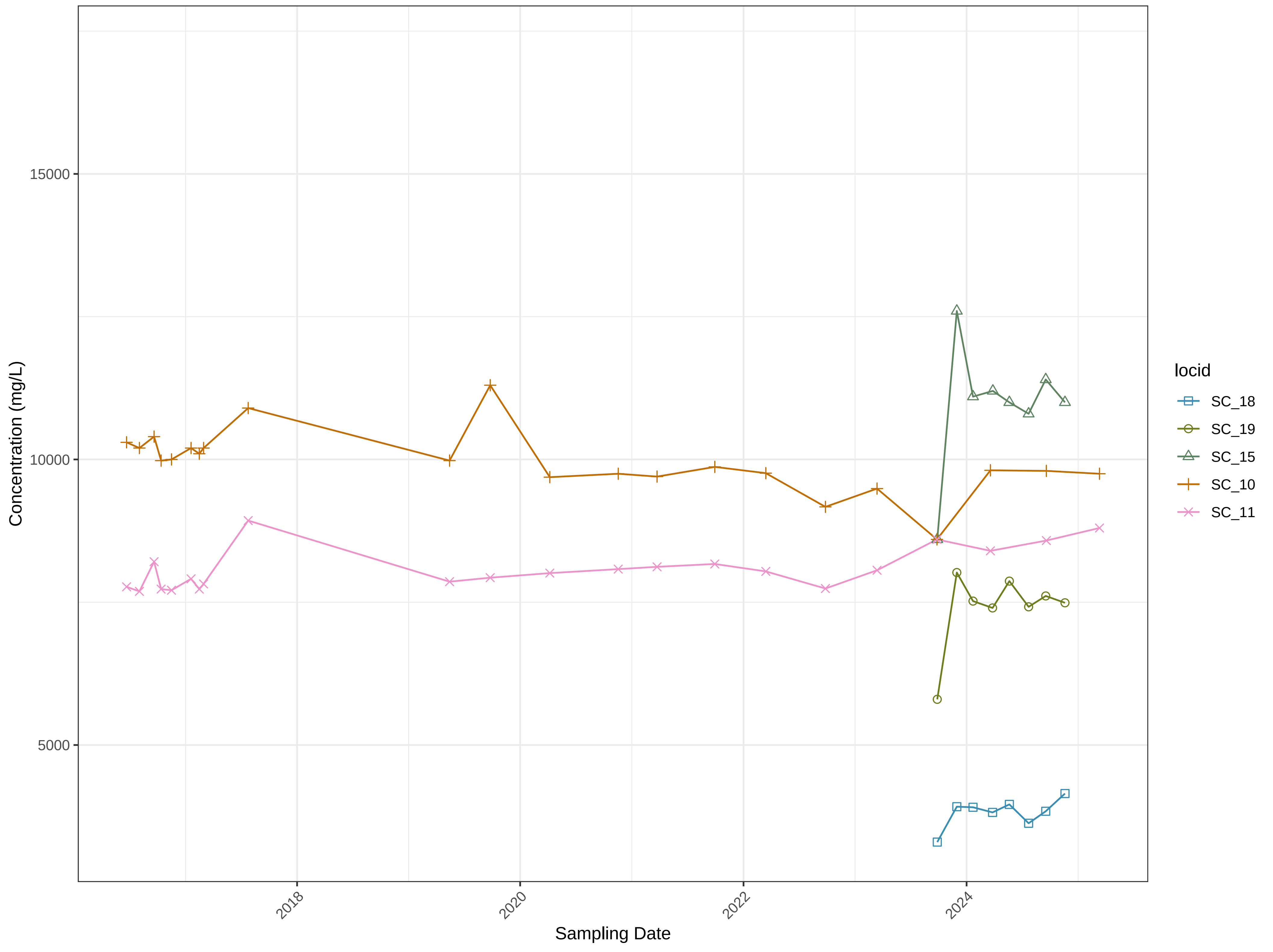


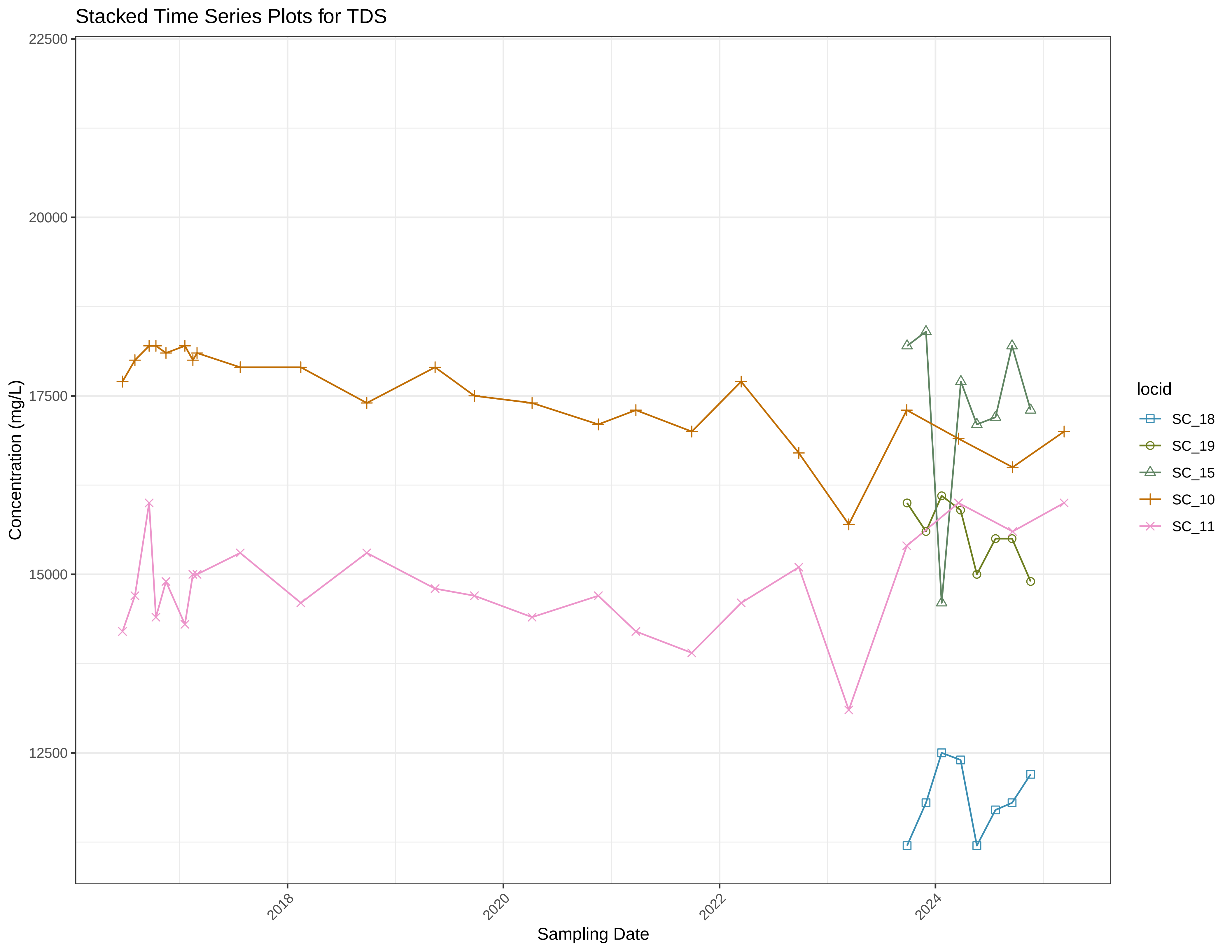


Stacked Time Series Plots for Rad226+228
Concentration (pCi/L)
4
2
0
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11


Stacked Time Series Plots for Selenium_(Total)
Concentration (ug/L)
400
200
0
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11

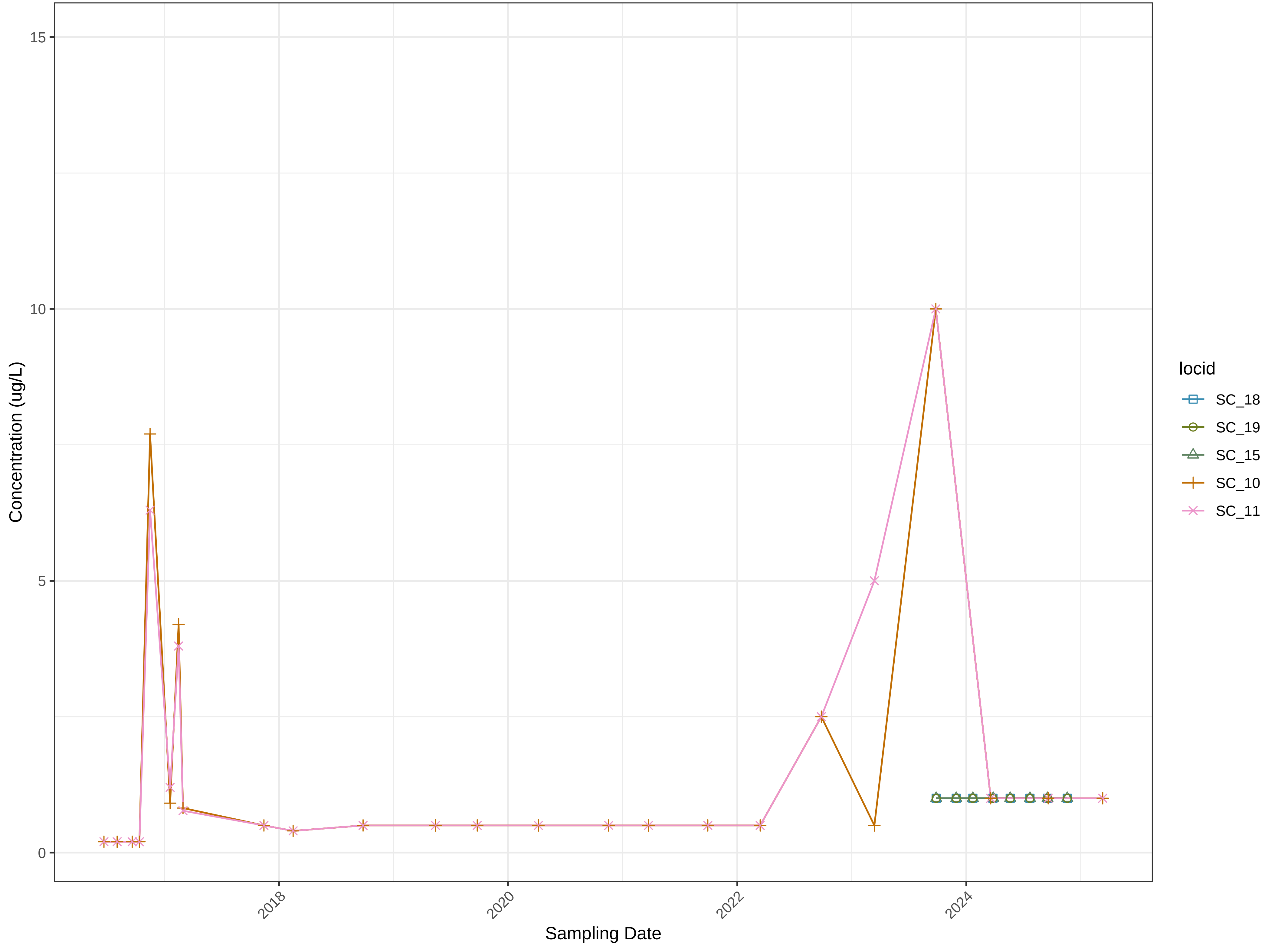
Stacked Time Series Plots for Sulfate





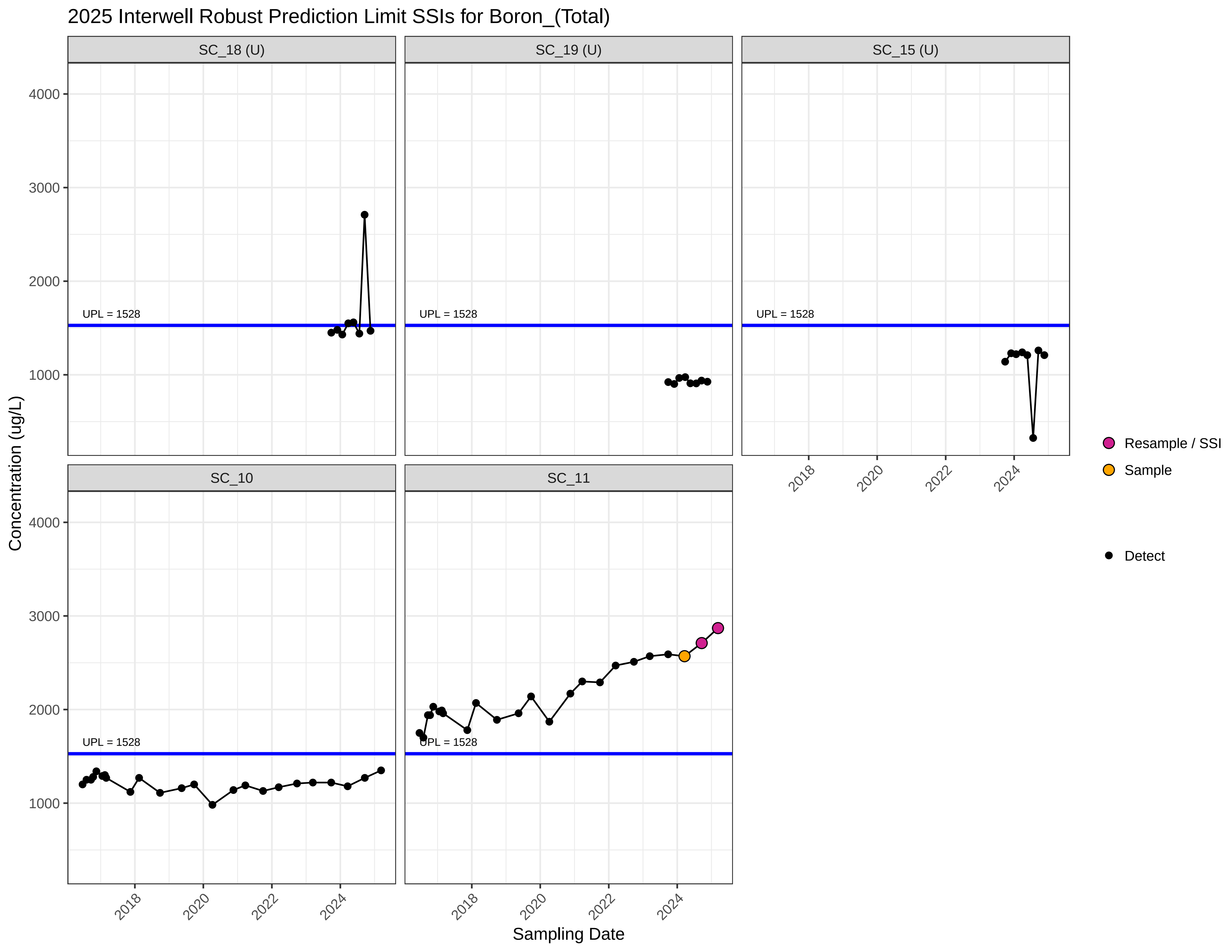
Stacked Time Series Plots for TDS
22500
20000
17500
15000
12500
Concentration (mg/L)
2018
2020
2022
2024
Sampling Date
locid
SC_18
SC_19
SC_15
SC_10
SC_11

Stacked Time Series Plots for Thallium_(Total)

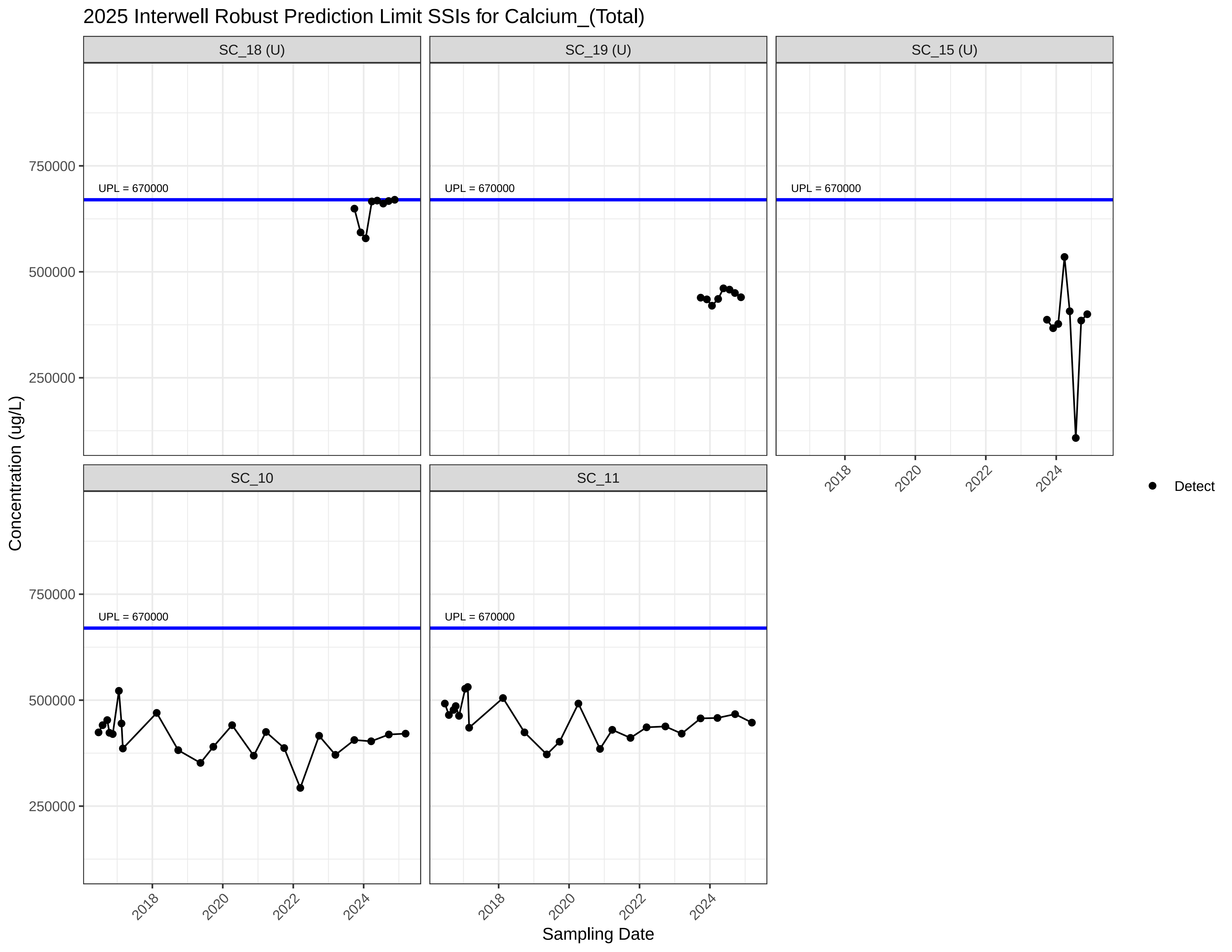


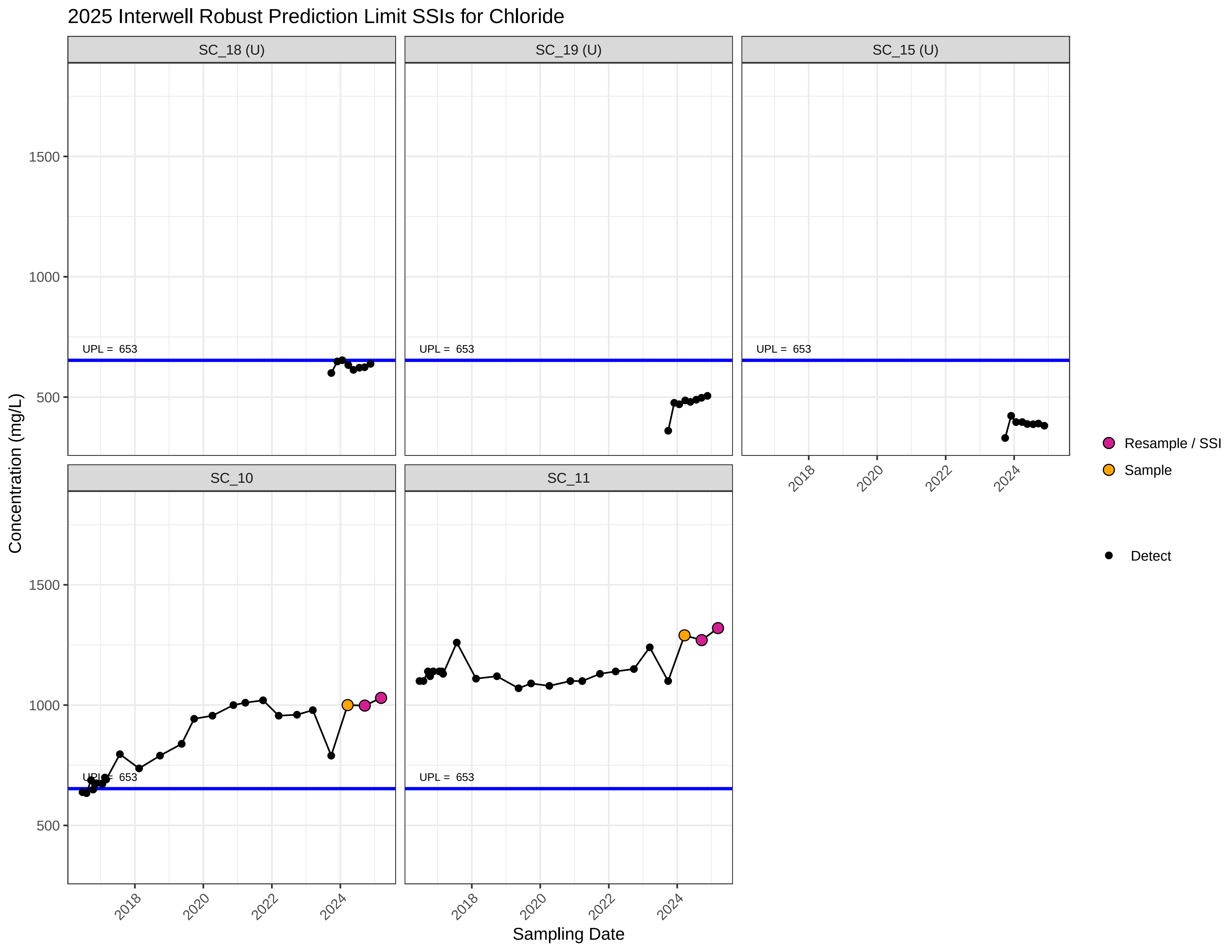
Appendix B

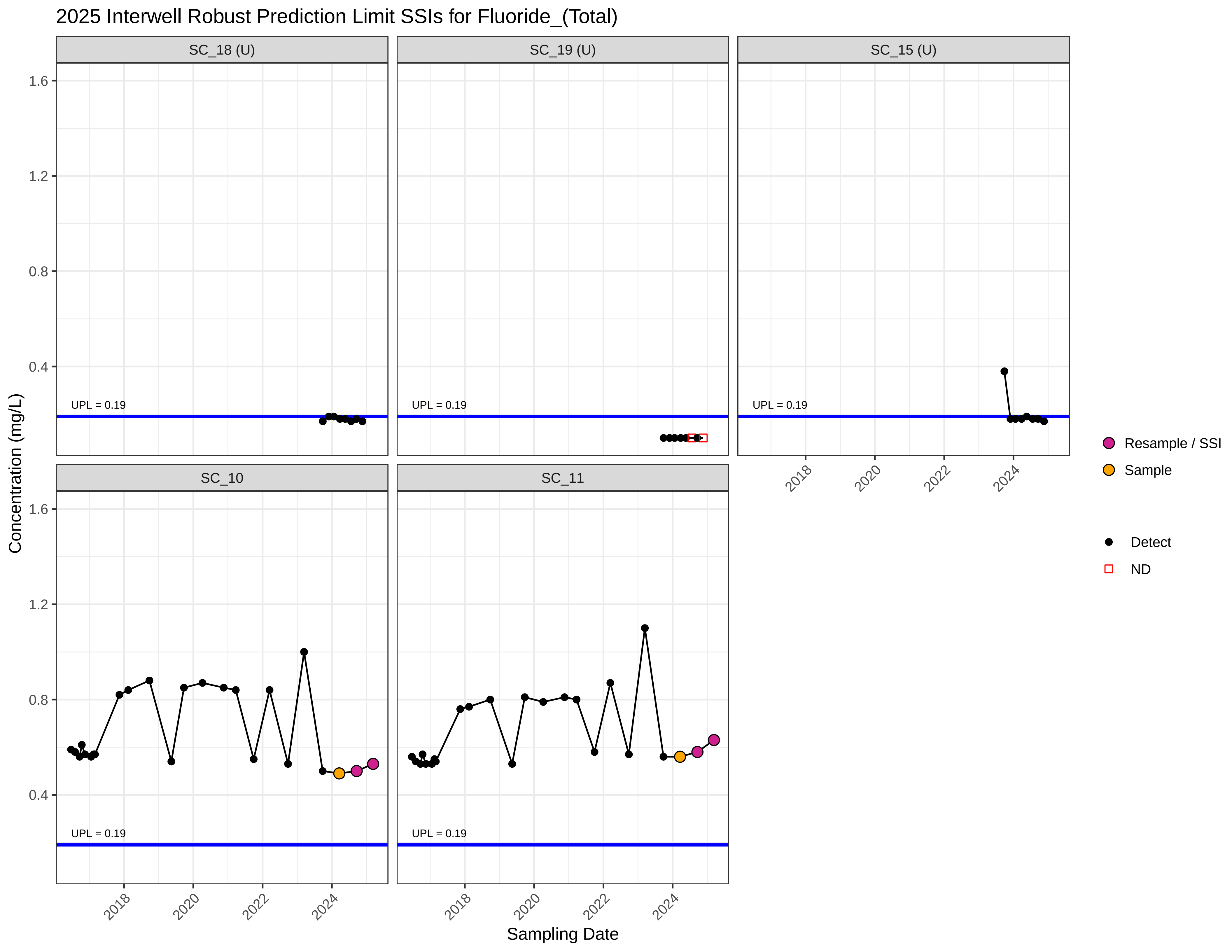
Supporting Graphics

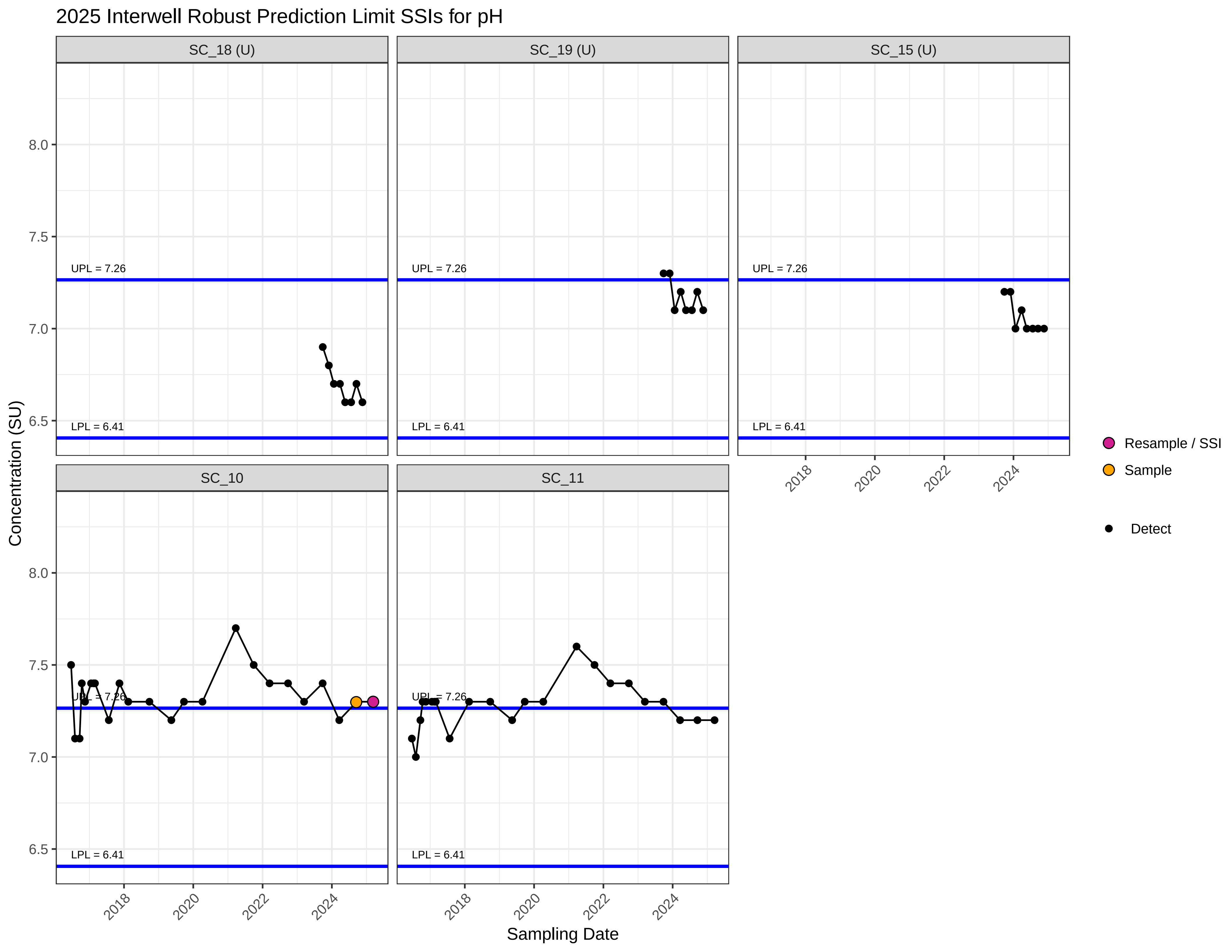


2025 Interwell Robust Prediction Limit SSIs for Boron_(Total)
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
UPL = 1528
4000
3000
2000
1000
2018
2020
2022
2024
Concentration (ug/L)
Sampling Date
Resample / SSI
Sample
Detect

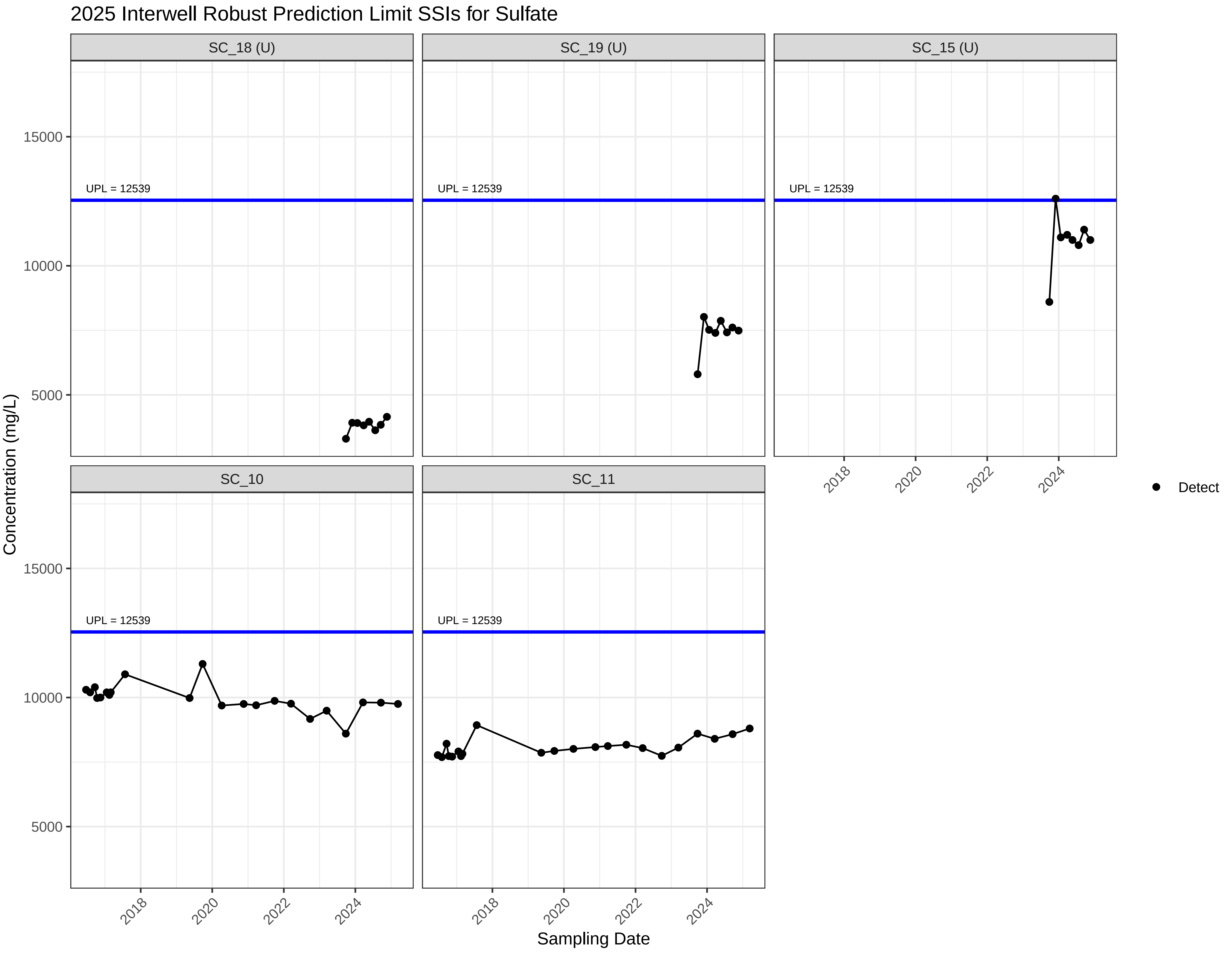

2025 Interwell Robust Prediction Limit SSIs for Calcium_(Total)
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
UPL = 670000
750000
500000
250000
2018
2020
2022
2024
Concentration (ug/L)
Sampling Date
Detect

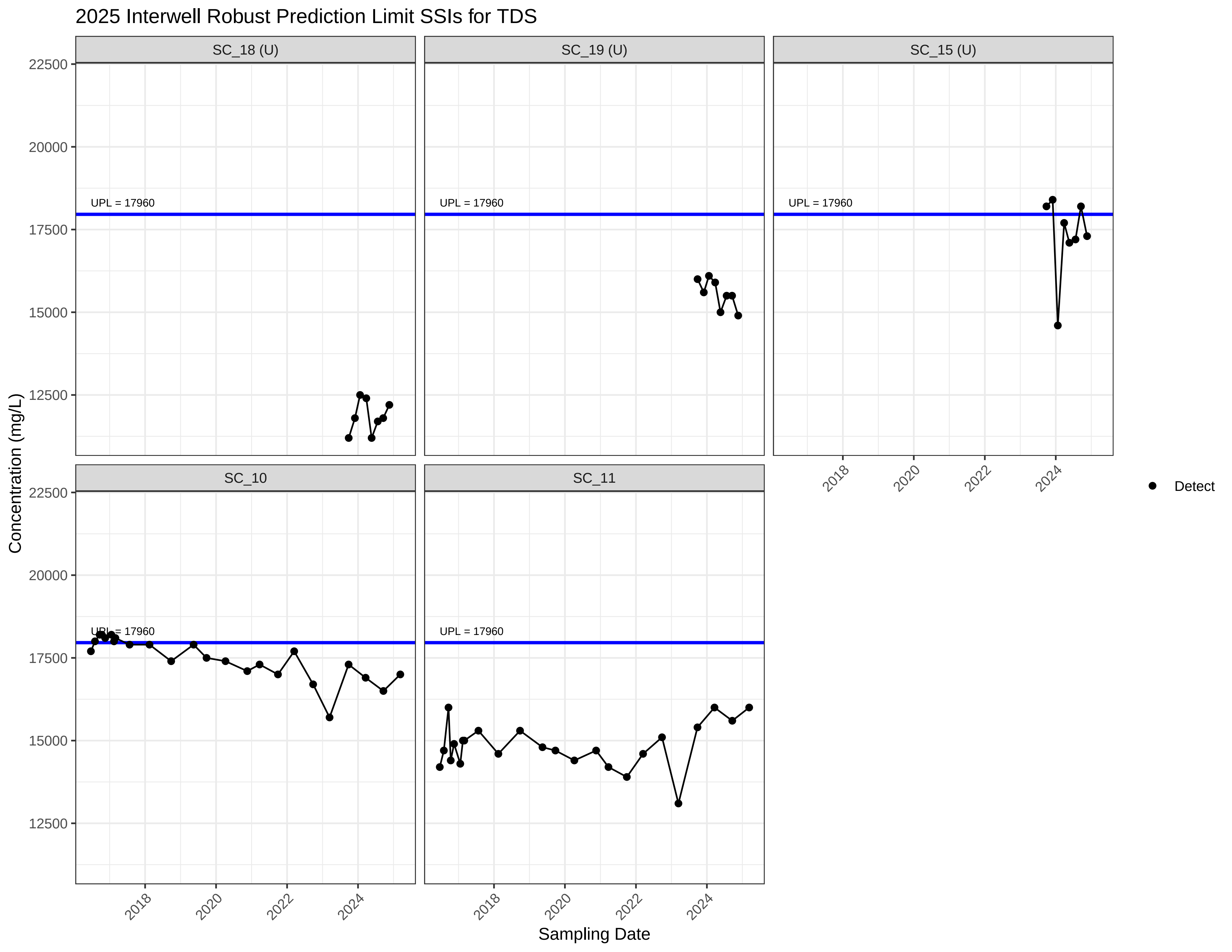

2025 Interwell Robust Prediction Limit SSIs for Chloride
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
UPL = 653
Concentration (mg/L)
Sampling Date
500
1000
1500
2018
2020
2022
2024
Resample / SSI
Sample
Detect

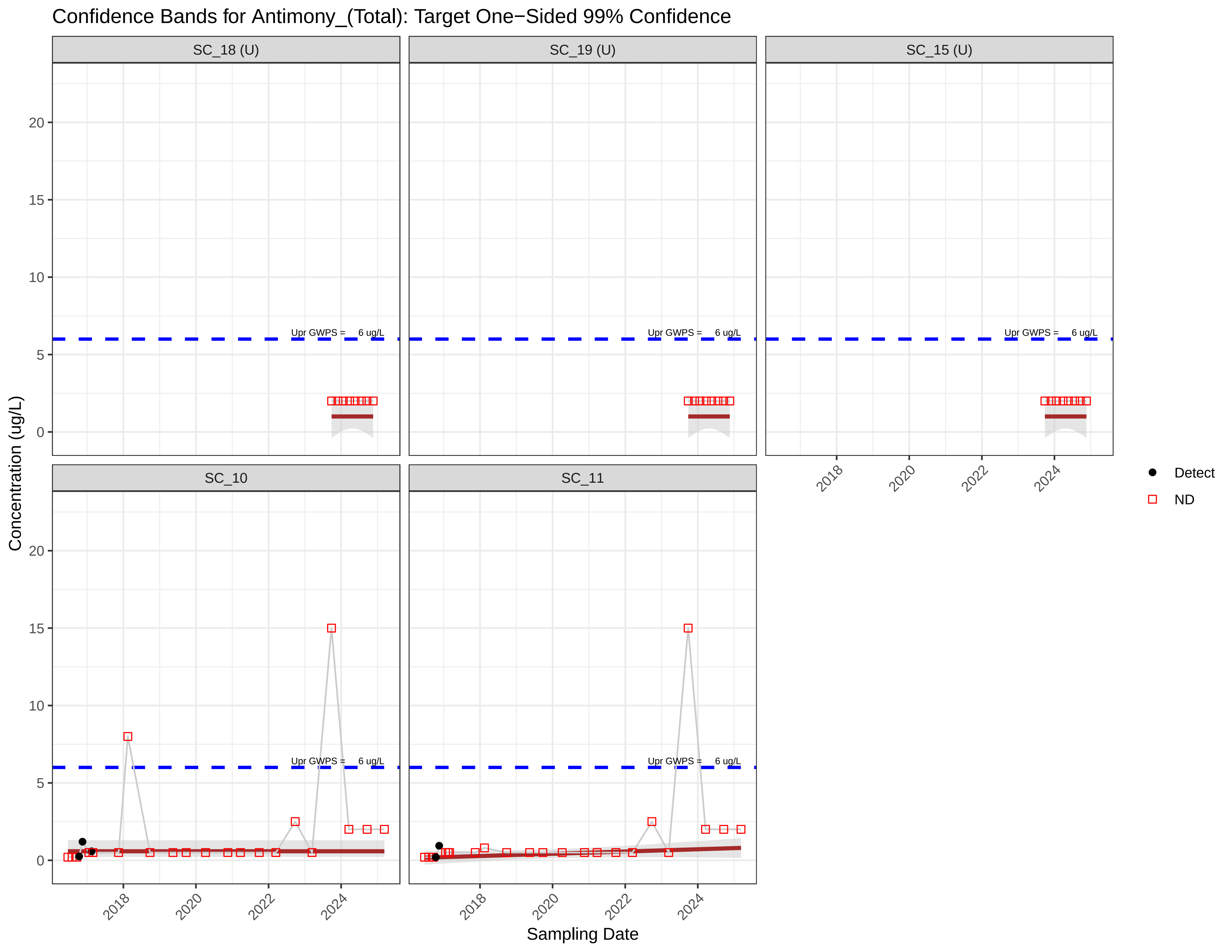

2025 Interwell Robust Prediction Limit SSIs for Fluoride_(Total)
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
UPL = 0.19
Concentration (mg/L)
Sampling Date
0.4
0.8
1.2
1.6
2018
2020
2022
2024
Resample / SSI
Sample
Detect
ND



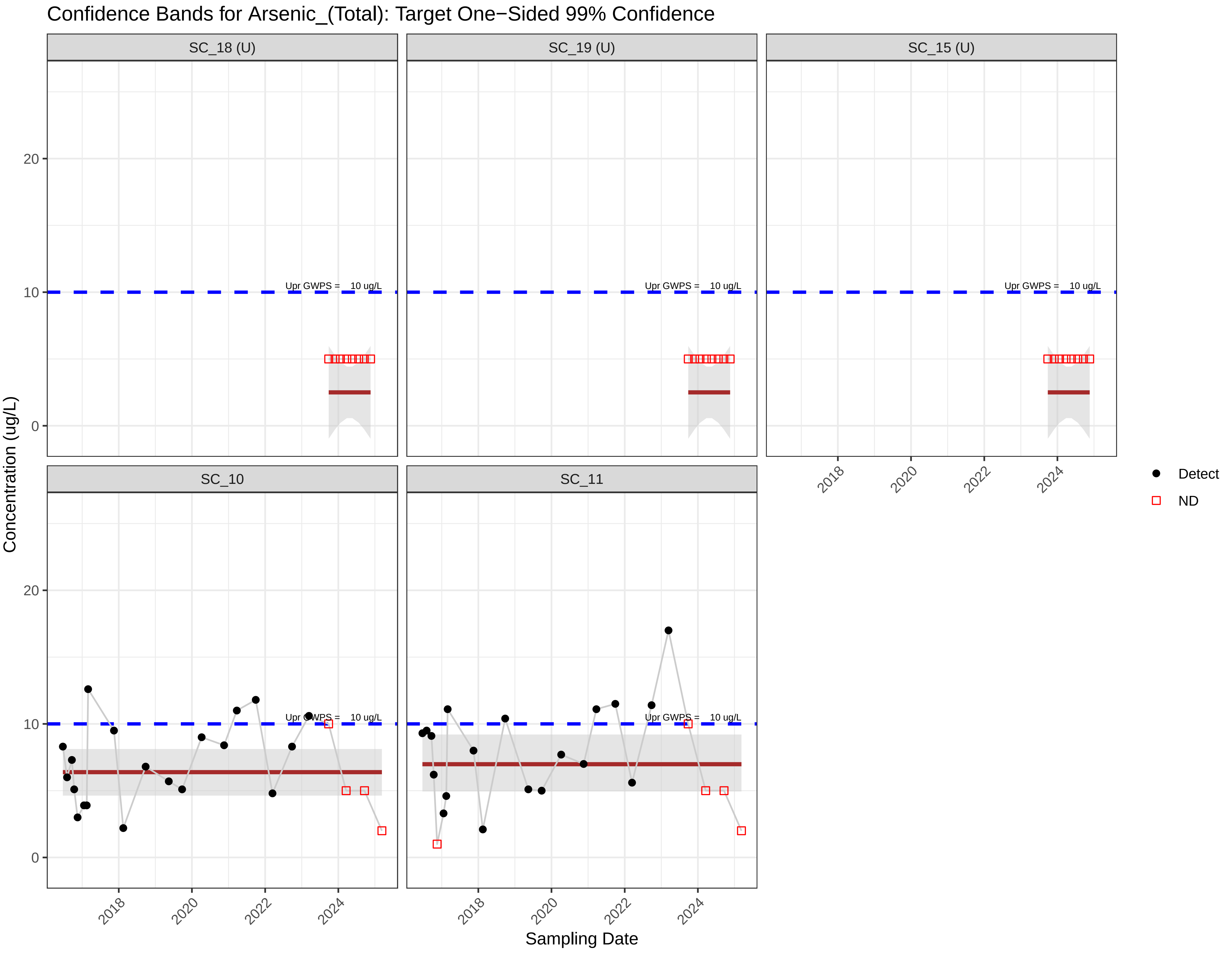
2025 Interwell Robust Prediction Limit SSIs for pH
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
UPL = 7.26
LPL = 6.41
Concentration (SU)
Sampling Date
8.0
7.5
7.0
6.5
2018
2020
2022
2024
Resample / SSI
Sample
Detect


2025 Interwell Robust Prediction Limit SSIs for Sulfate
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
UPL = 12539
15000
10000
5000
2018
2020
2022
2024
Concentration (mg/L)
Sampling Date
Detect

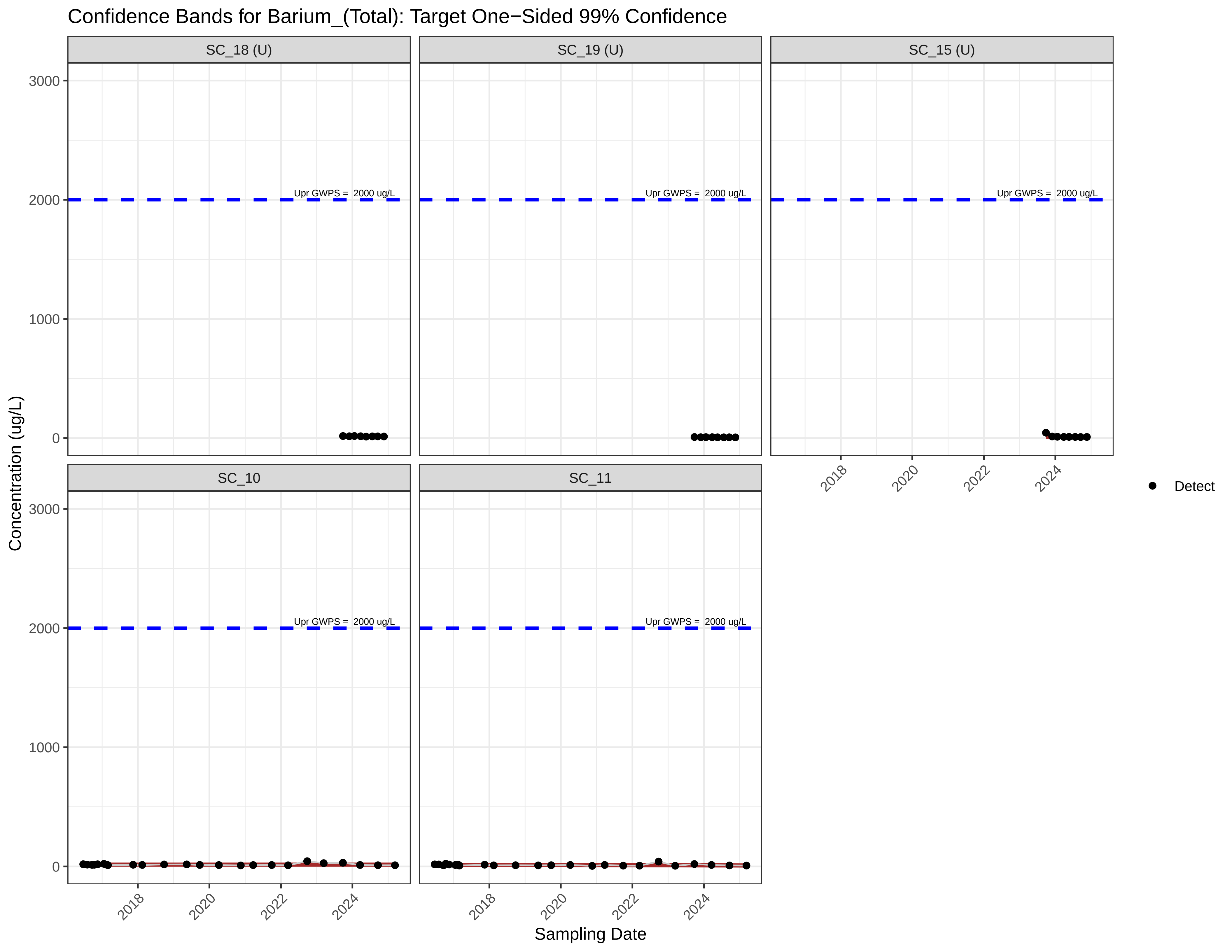

2025 Interwell Robust Prediction Limit SSIs for TDS
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
UPL = 17960
Concentration (mg/L)
22500
20000
17500
15000
12500
2018
2020
2022
2024
Sampling Date
Detect

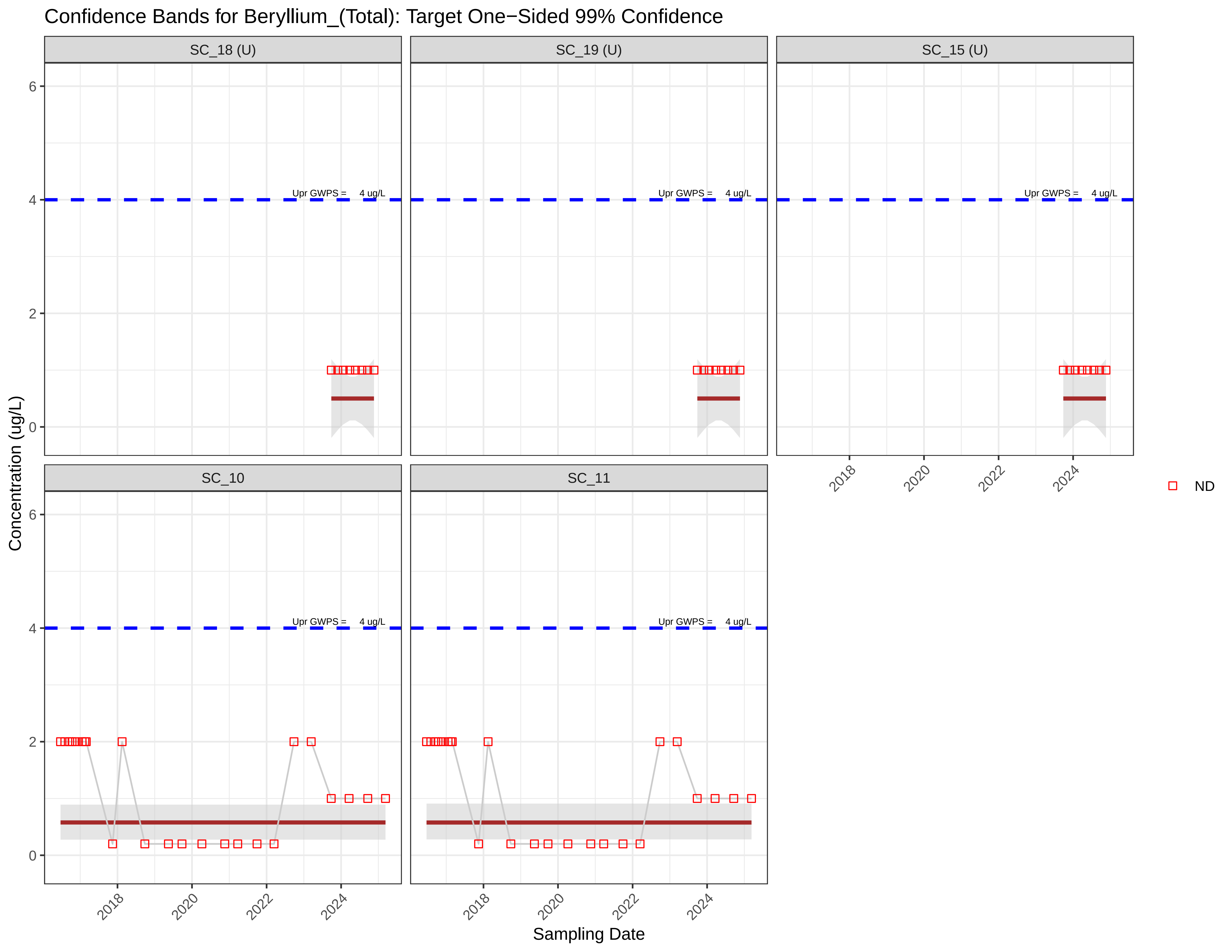


Confidence Bands for Antimony_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 6 ug/L
Concentration (ug/L)
Sampling Date
0
5
10
15
20
2018
2020
2022
2024
Detect
ND



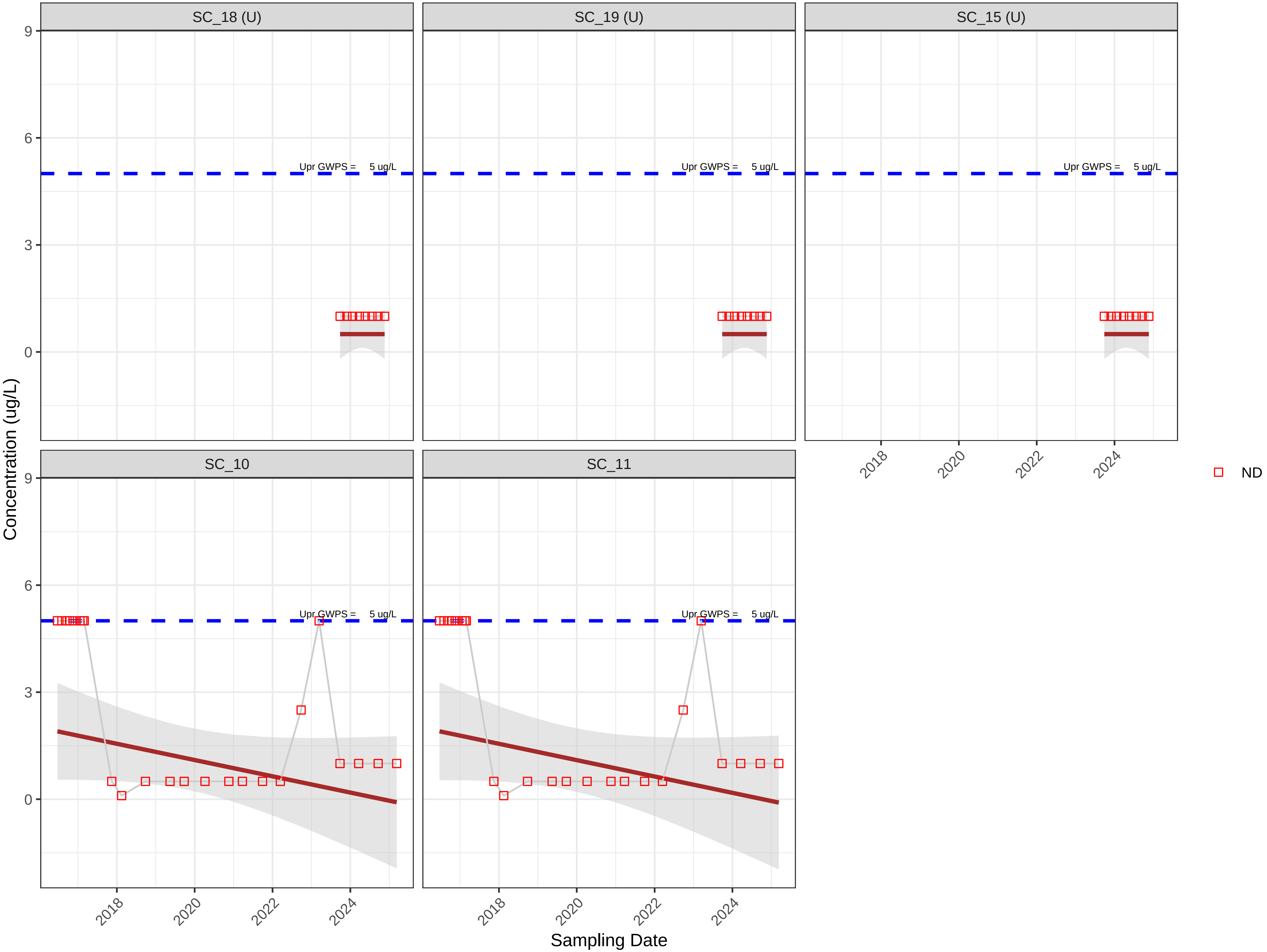
Confidence Bands for Arsenic_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 10 ug/L
Concentration (ug/L)
Sampling Date
0
10
20
2018
2020
2022
2024
Detect
ND

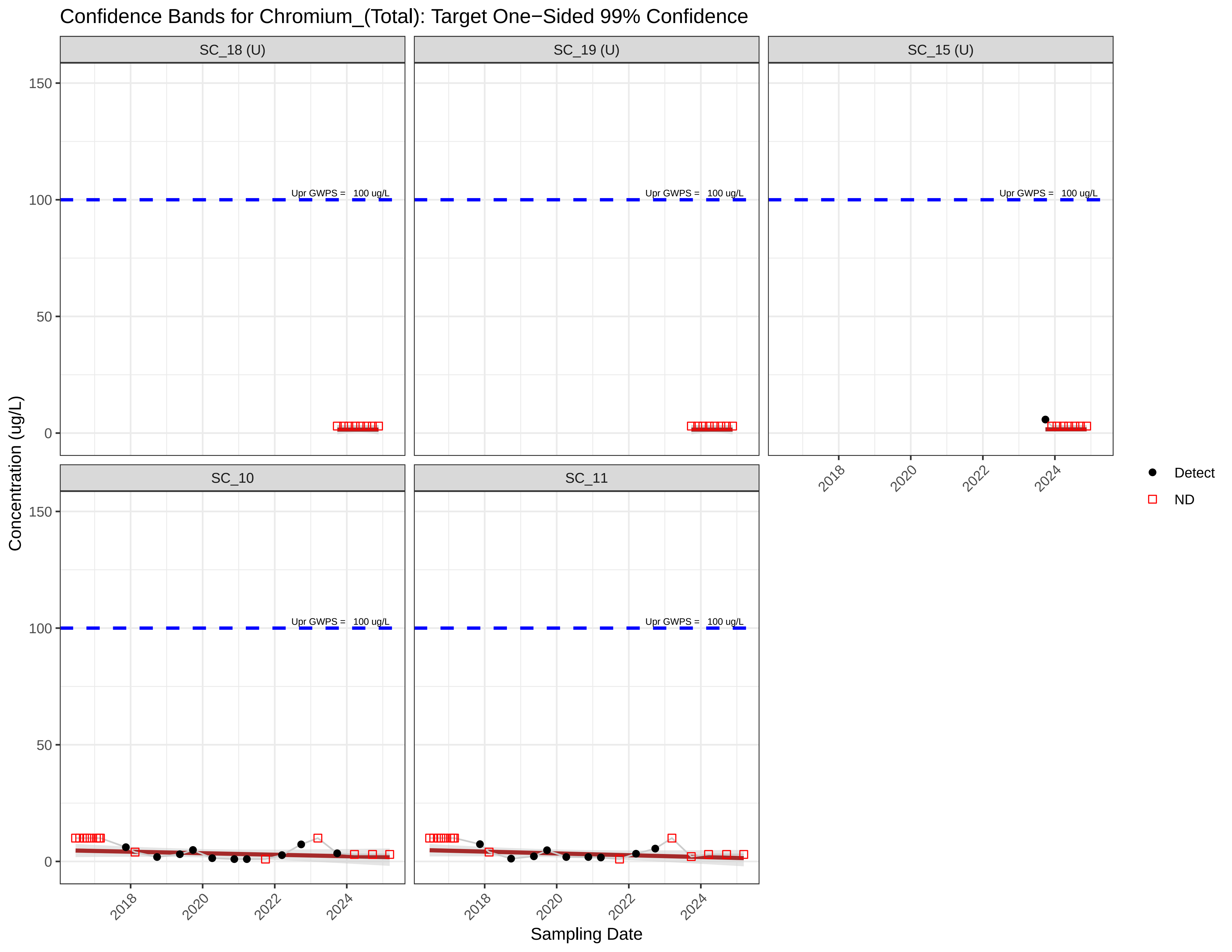

Confidence Bands for Barium_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 2000 ug/L
Concentration (ug/L)
Sampling Date
3000
2000
1000
0
2018
2020
2022
2024
Detect



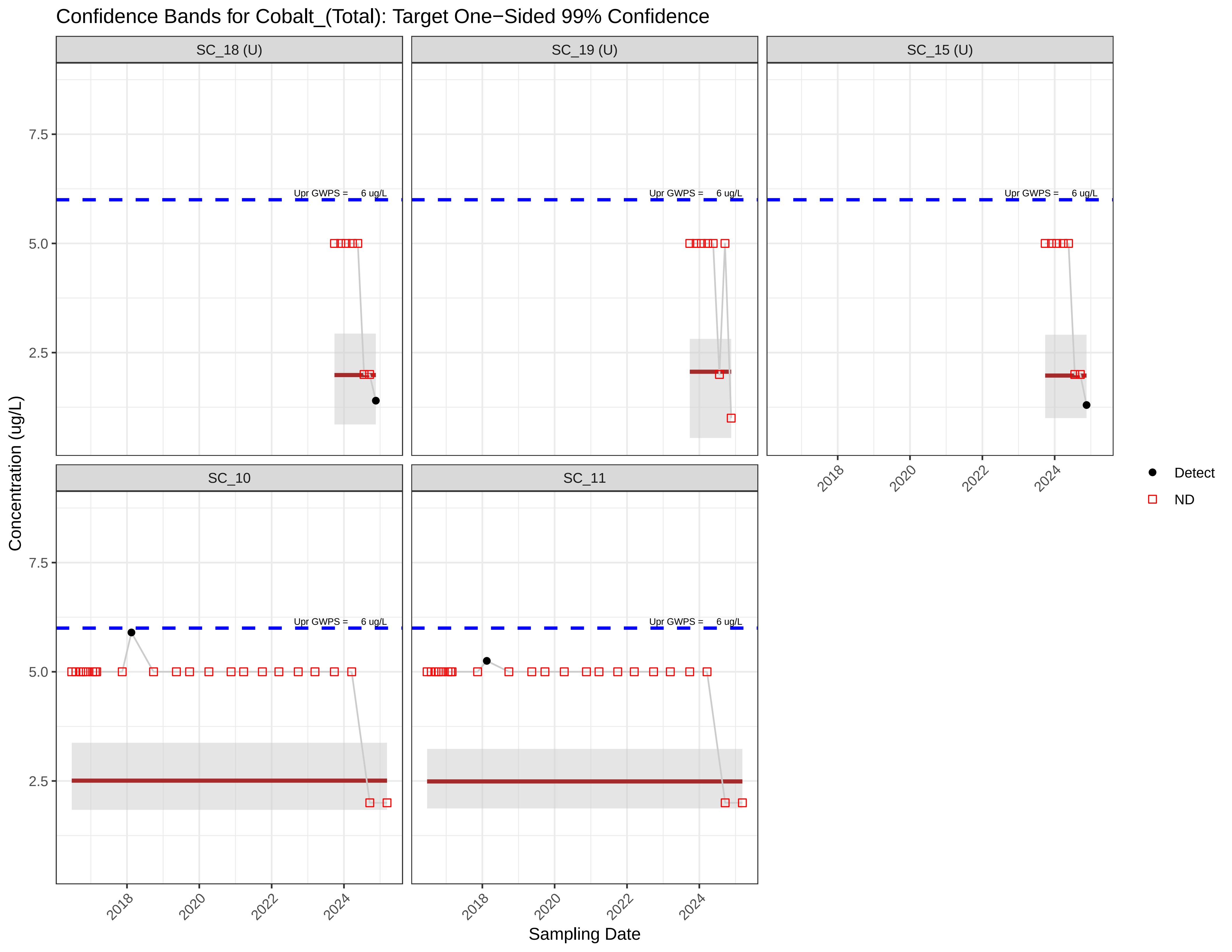
Confidence Bands for Beryllium_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 4 ug/L
Concentration (ug/L)
Sampling Date
0
2
4
6
2018
2020
2022
2024
ND

Confidence Bands for Cadmium_(Total): Target One−Sided 99% Confidence

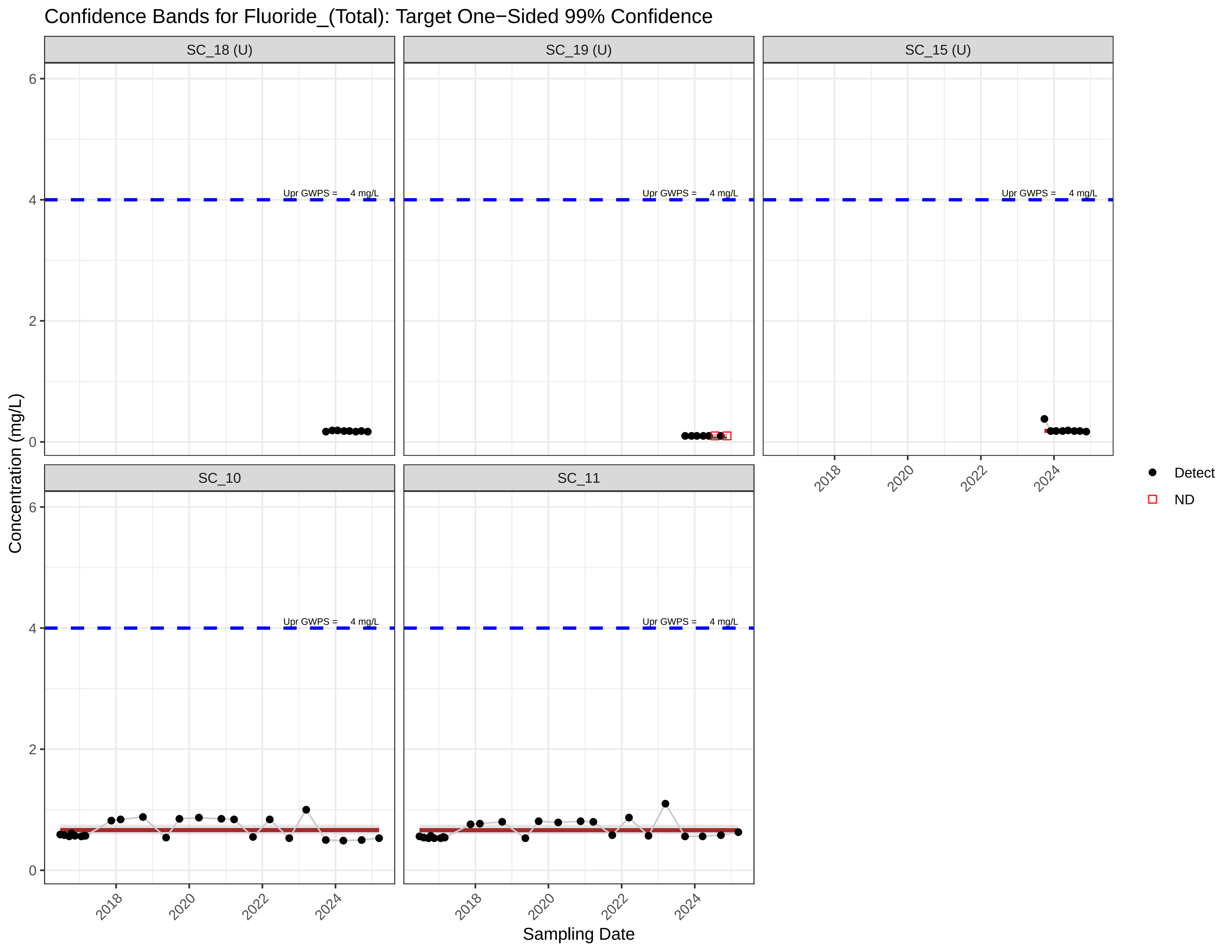




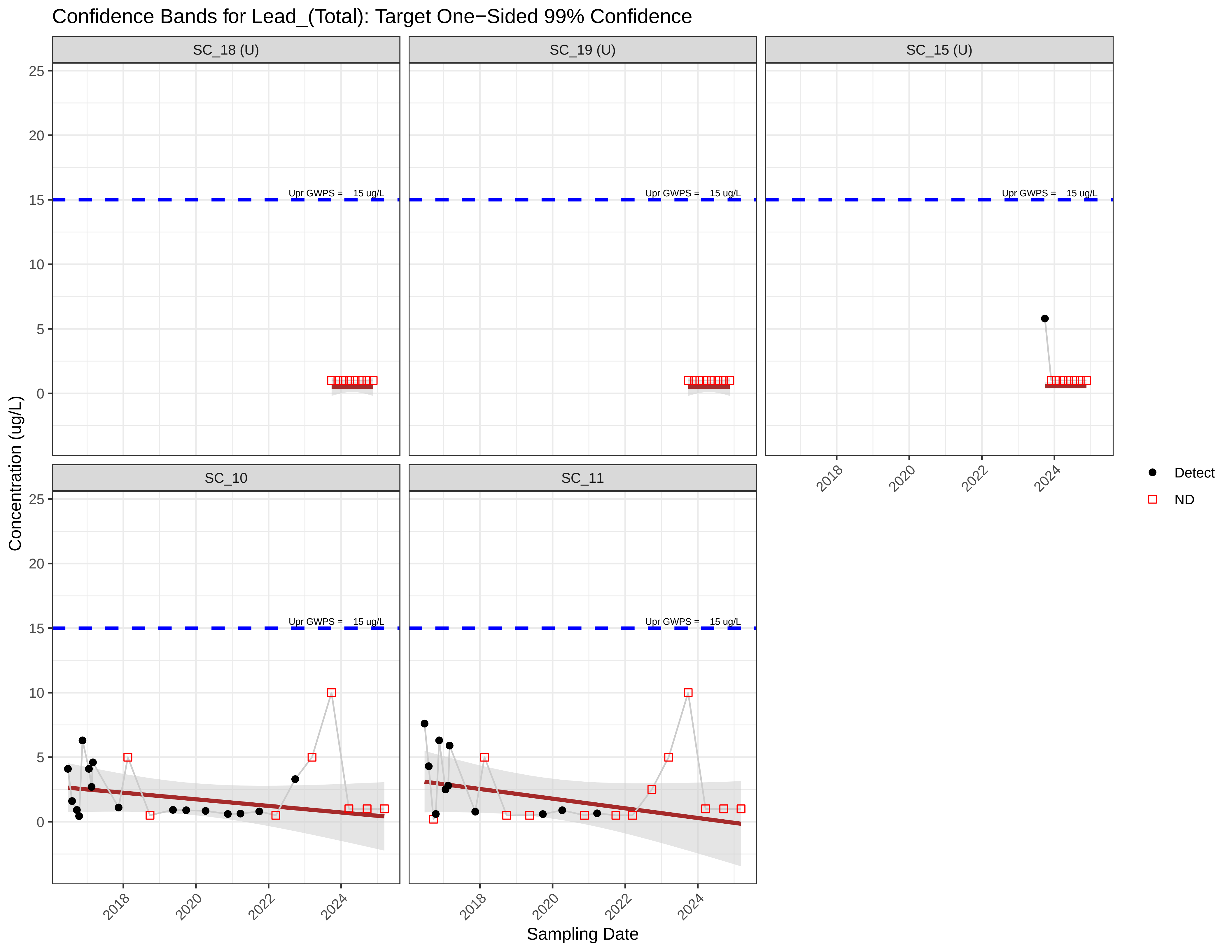
Confidence Bands for Chromium_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 100 ug/L
150
100
50
0
2018
2020
2022
2024
Concentration (ug/L)
Sampling Date
Detect
ND



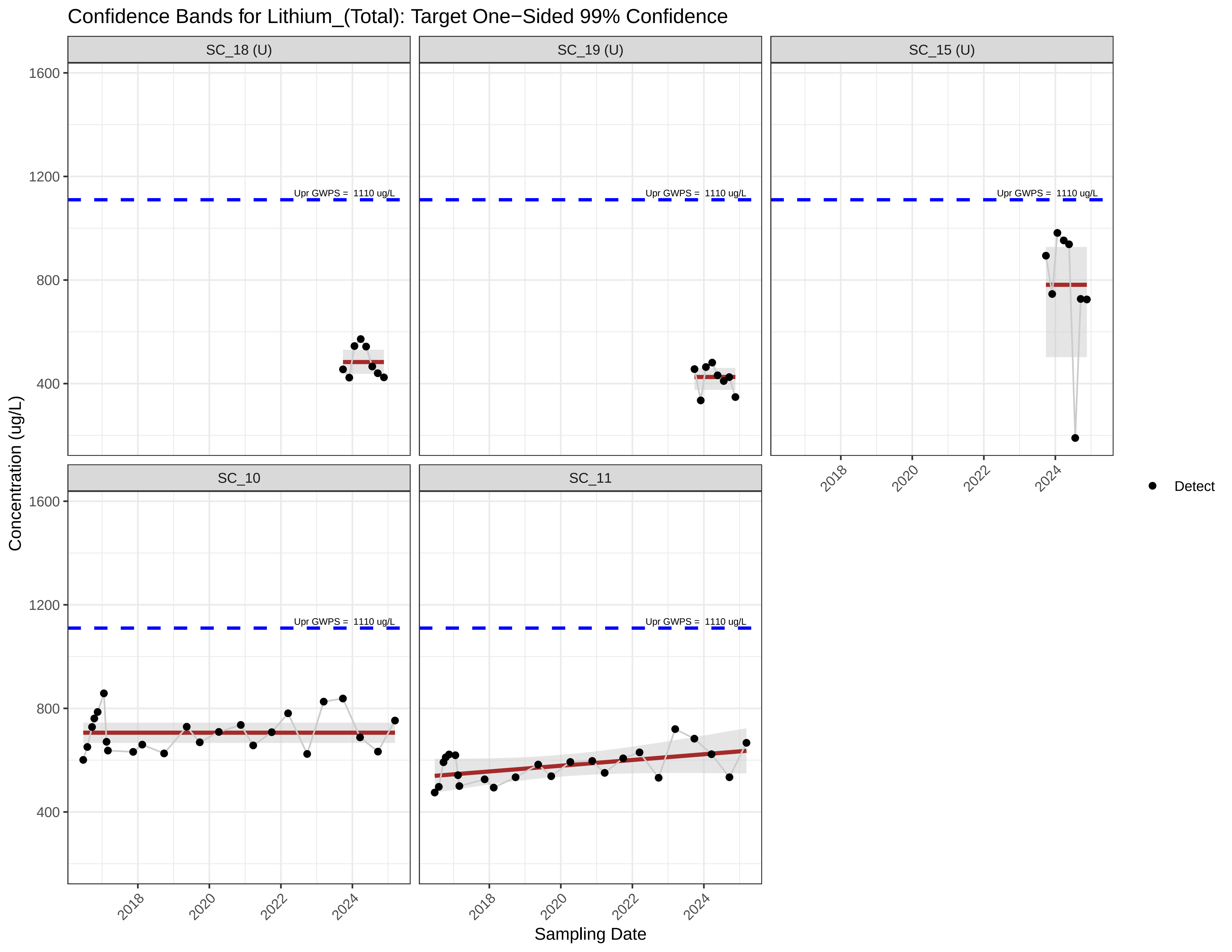
Confidence Bands for Cobalt_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 6 ug/L
7.5
5.0
2.5
2018
2020
2022
2024
Concentration (ug/L)
Sampling Date
Detect
ND



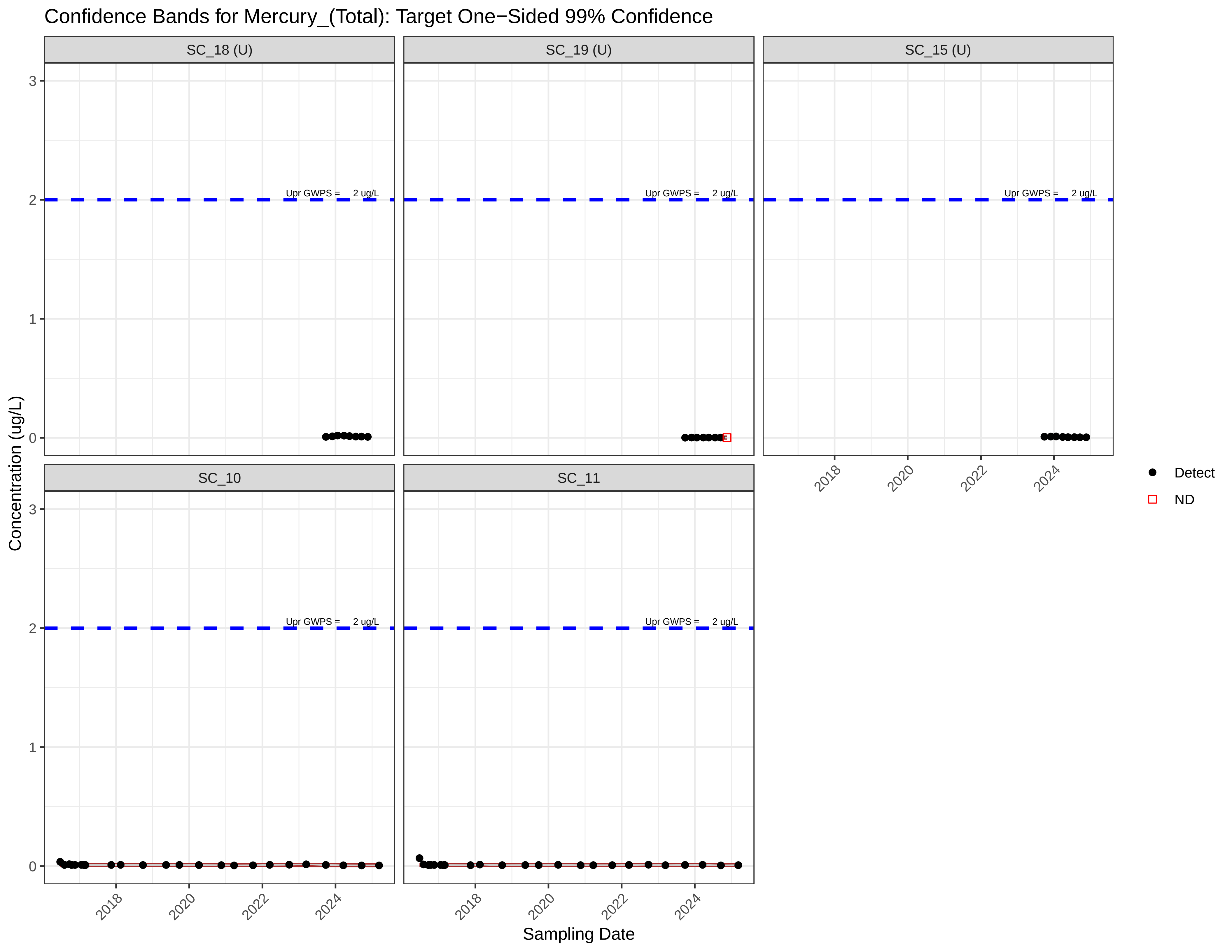
Confidence Bands for Fluoride_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 4 mg/L
Concentration (mg/L)
Sampling Date
0
2
4
6
2018
2020
2022
2024
Detect
ND



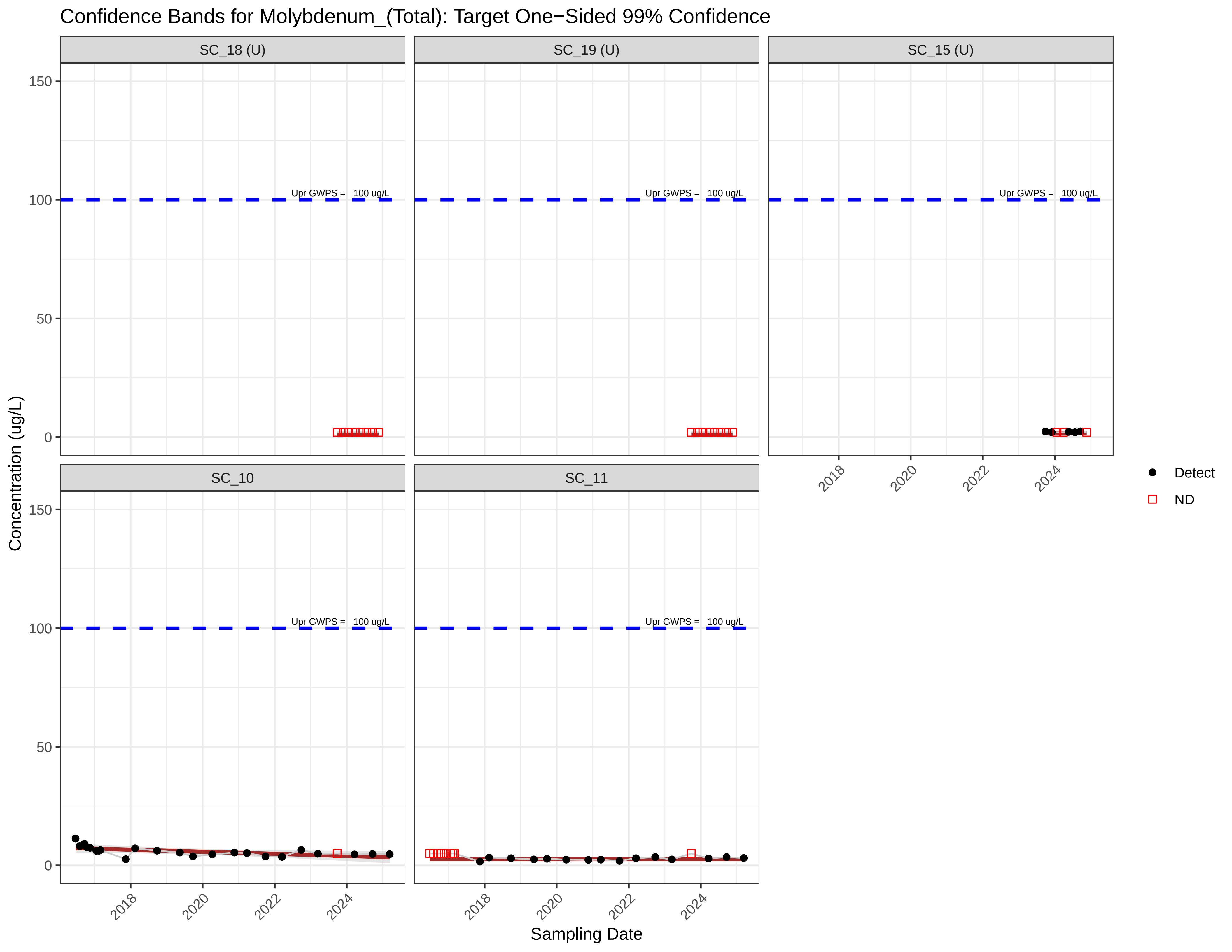
Confidence Bands for Lead_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 15 ug/L
Concentration (ug/L)
Sampling Date
0
5
10
15
20
25
2018
2020
2022
2024
Detect
ND



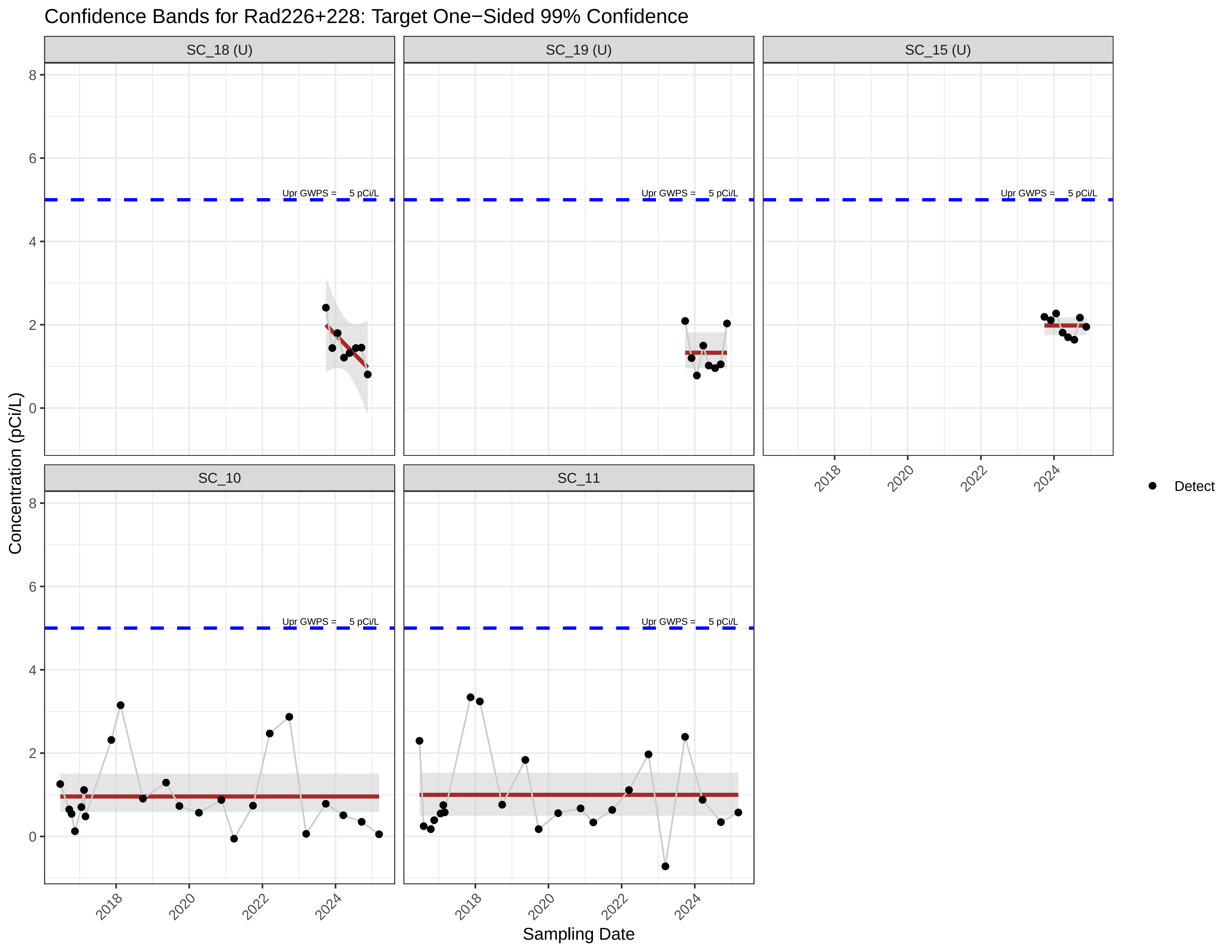
Confidence Bands for Lithium_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 1110 ug/L
1600
1200
800
400
2018
2020
2022
2024
Concentration (ug/L)
Sampling Date
Detect



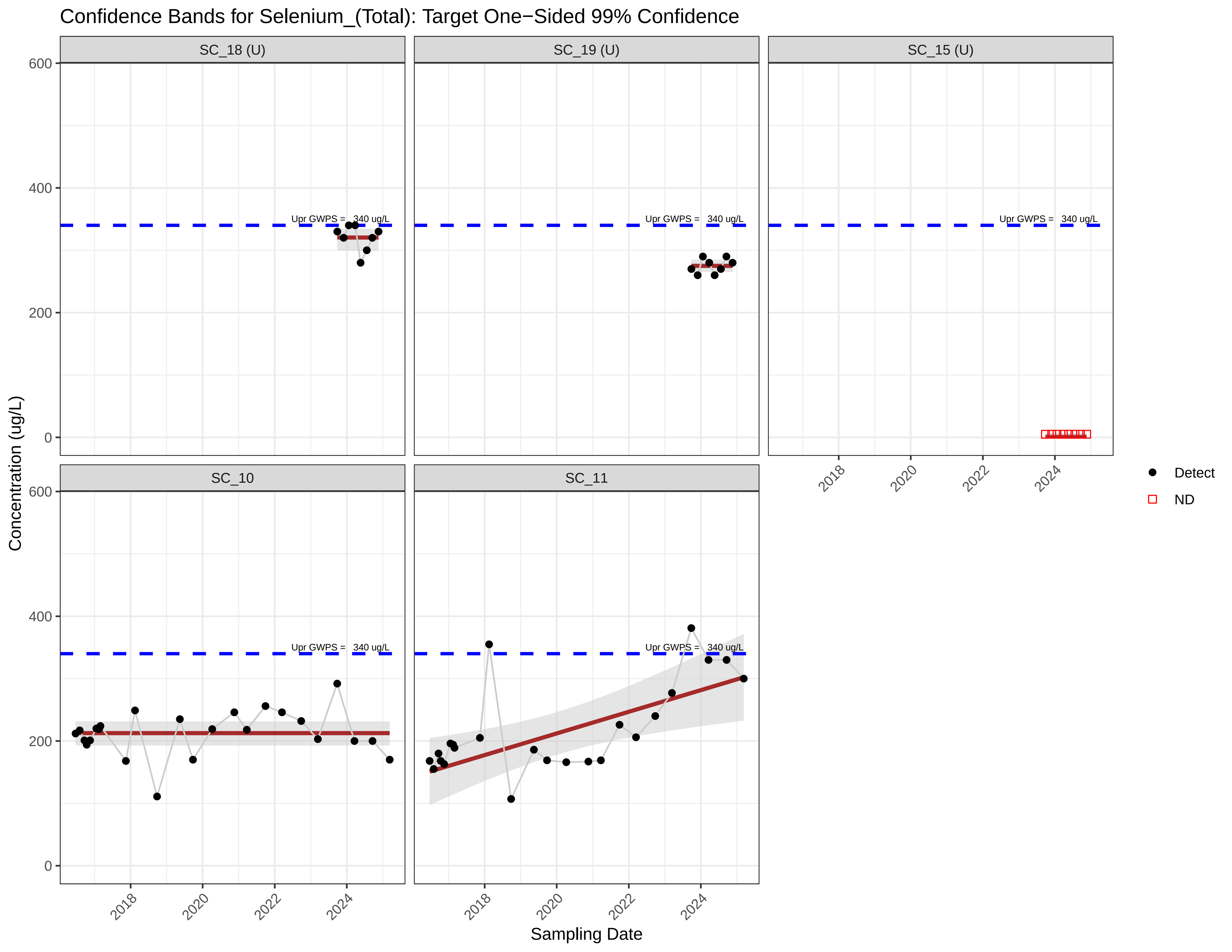
Confidence Bands for Mercury_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 2 ug/L
Concentration (ug/L)
Sampling Date
0
1
2
3
2018
2020
2022
2024
Detect
ND



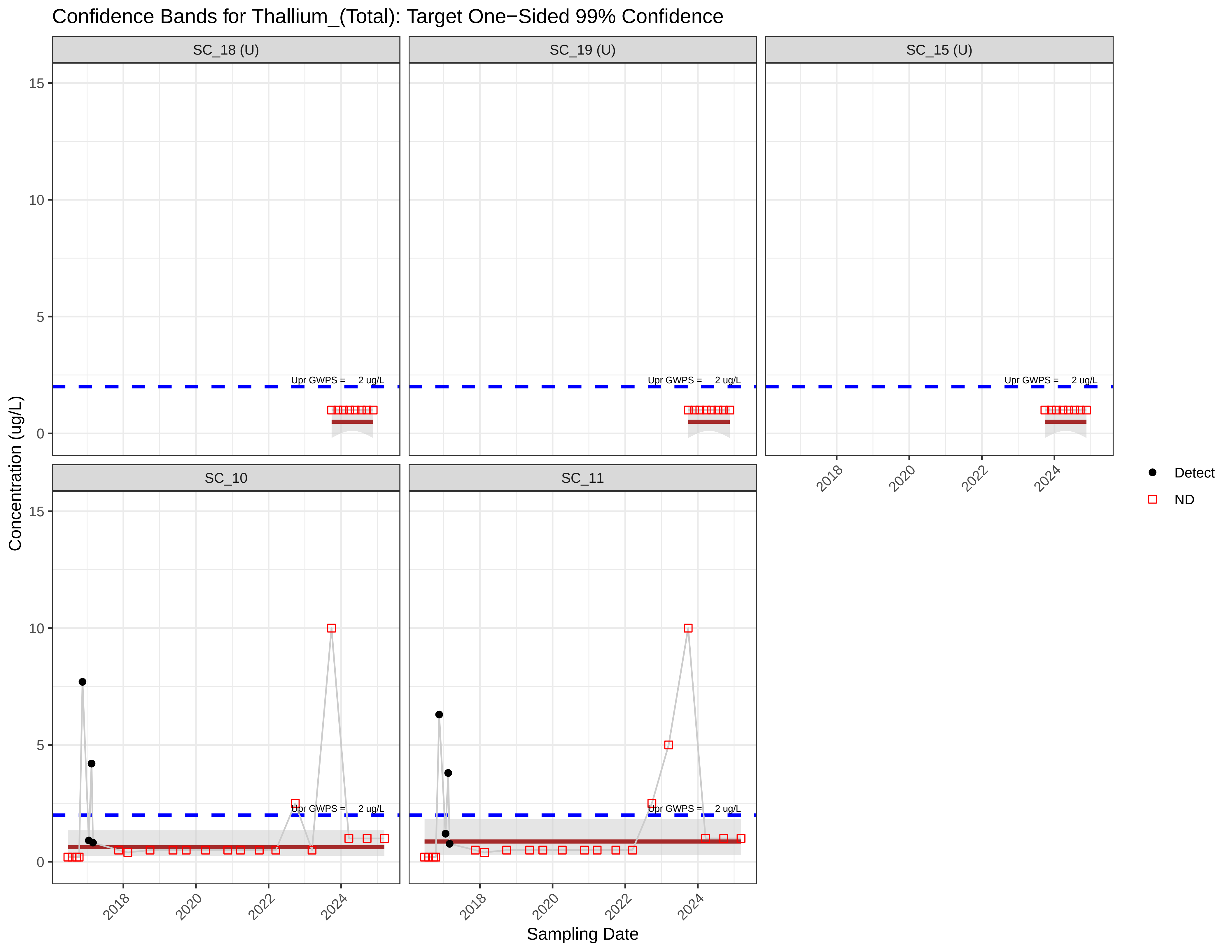
Confidence Bands for Molybdenum_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 100 ug/L
Concentration (ug/L)
Sampling Date
0
50
100
150
2018
2020
2022
2024
Detect
ND



Confidence Bands for Rad226+228: Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 5 pCi/L
Concentration (pCi/L)
Sampling Date
2018
2020
2022
2024
0
2
4
6
8
Detect



Confidence Bands for Selenium_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 340 ug/L
Concentration (ug/L)
Sampling Date
600
400
200
0
2018
2020
2022
2024
Detect
ND


Confidence Bands for Thallium_(Total): Target One−Sided 99% Confidence
SC_18 (U)
SC_19 (U)
SC_15 (U)
SC_10
SC_11
Upr GWPS = 2 ug/L
Concentration (ug/L)
Sampling Date
0
5
10
15
2018
2020
2022
2024
Detect
ND

Attachment 2 CCR Landfill Monitoring Well Completion Logs

Site ID: 383600104430301

Site Name: CC-1

Local Well Number: SC 17-65-6BCC

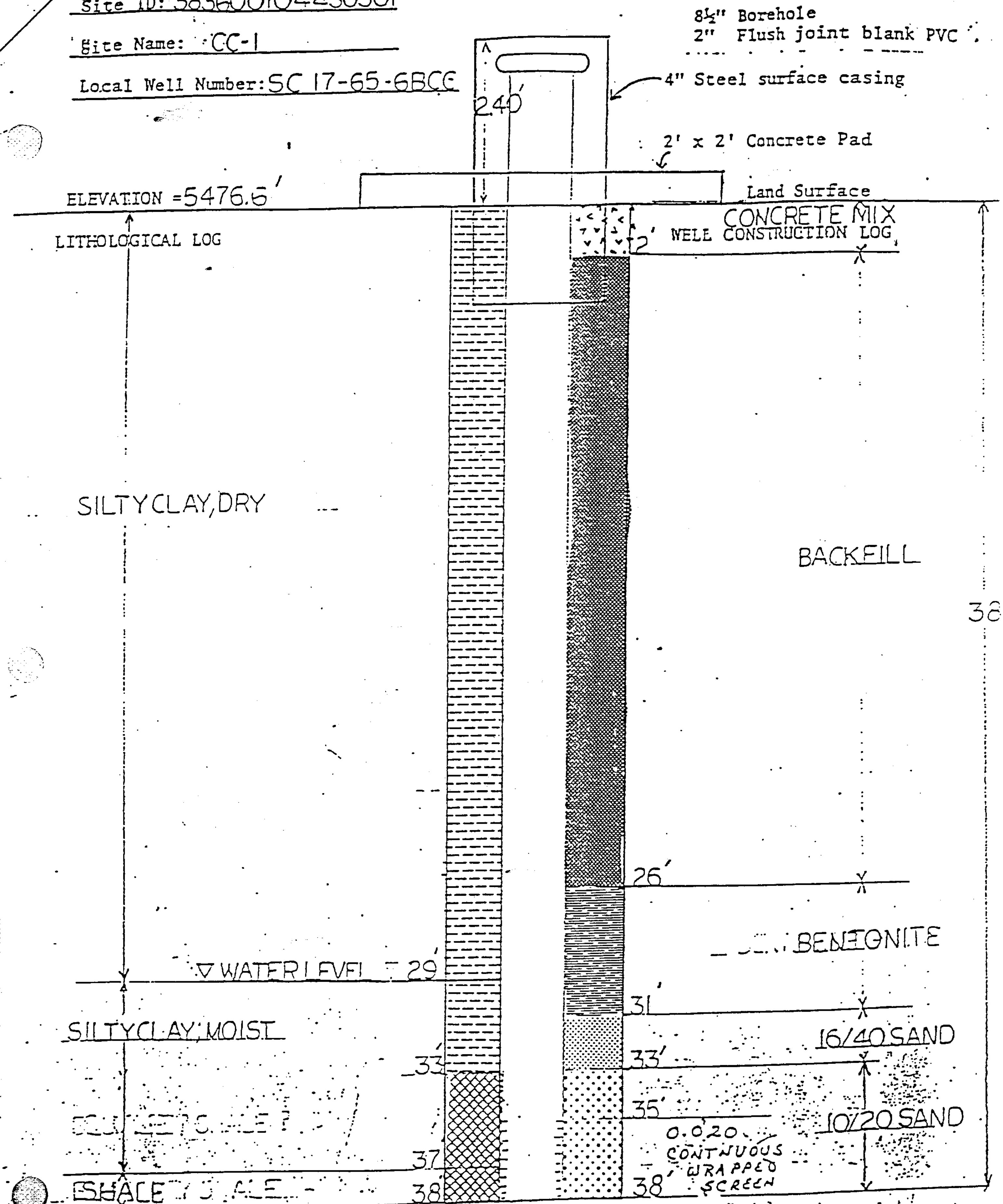


Figure 20.

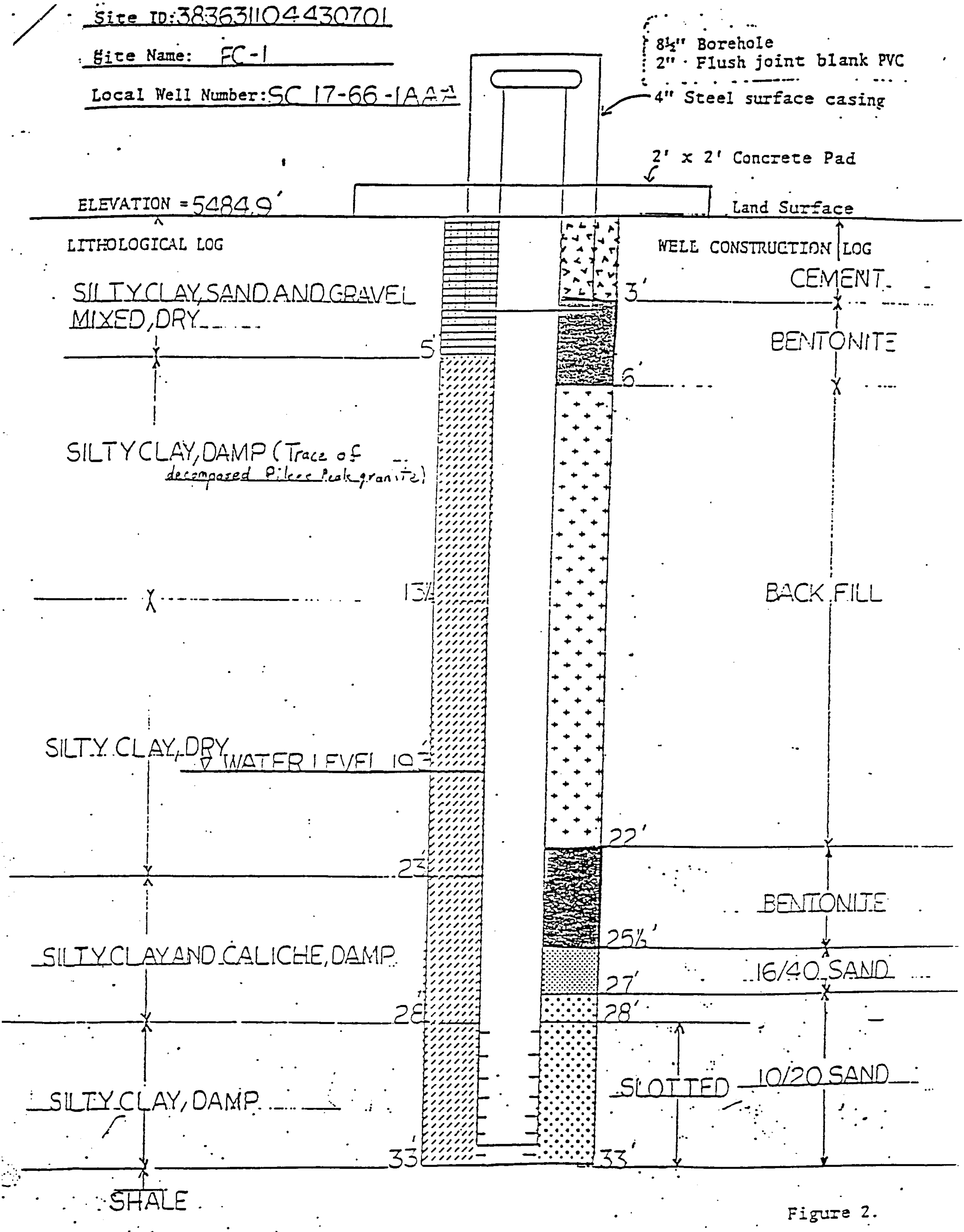

Site ID:383631104430701
Site Name: FC-1
Local Well Number: SC 17-66-1AAA
8½" Borehole
2" Flush joint blank PVC
4" Steel surface casing
2' x 2' Concrete Pad
ELEVATION = 5484.9'
Land Surface
LITHOLOGICAL LOG
WELL CONSTRUCTION LOG
SILTY CLAY, SAND AND GRAVEL MIXED, DRY
CEMENT
3'
BENTONITE
5'
6'
SILTY CLAY, DAMP (Trace of decomposed Pikes Peak granite)
13½
BACK FILL
SILTY CLAY, DRY
WATER LEVEL 19'
22'
23'
BENTONITE
25½'
SILTY CLAY AND CALICHE, DAMP
16/40 SAND
27'
28'
28'
SLOTTED
10/20 SAND
SILTY CLAY, DAMP
33'
33'
SHALE

Figure 2.

Site ID: 383621104430801

Site Name: FC-2

Local Well Number: SC16-66-36[illegible]A

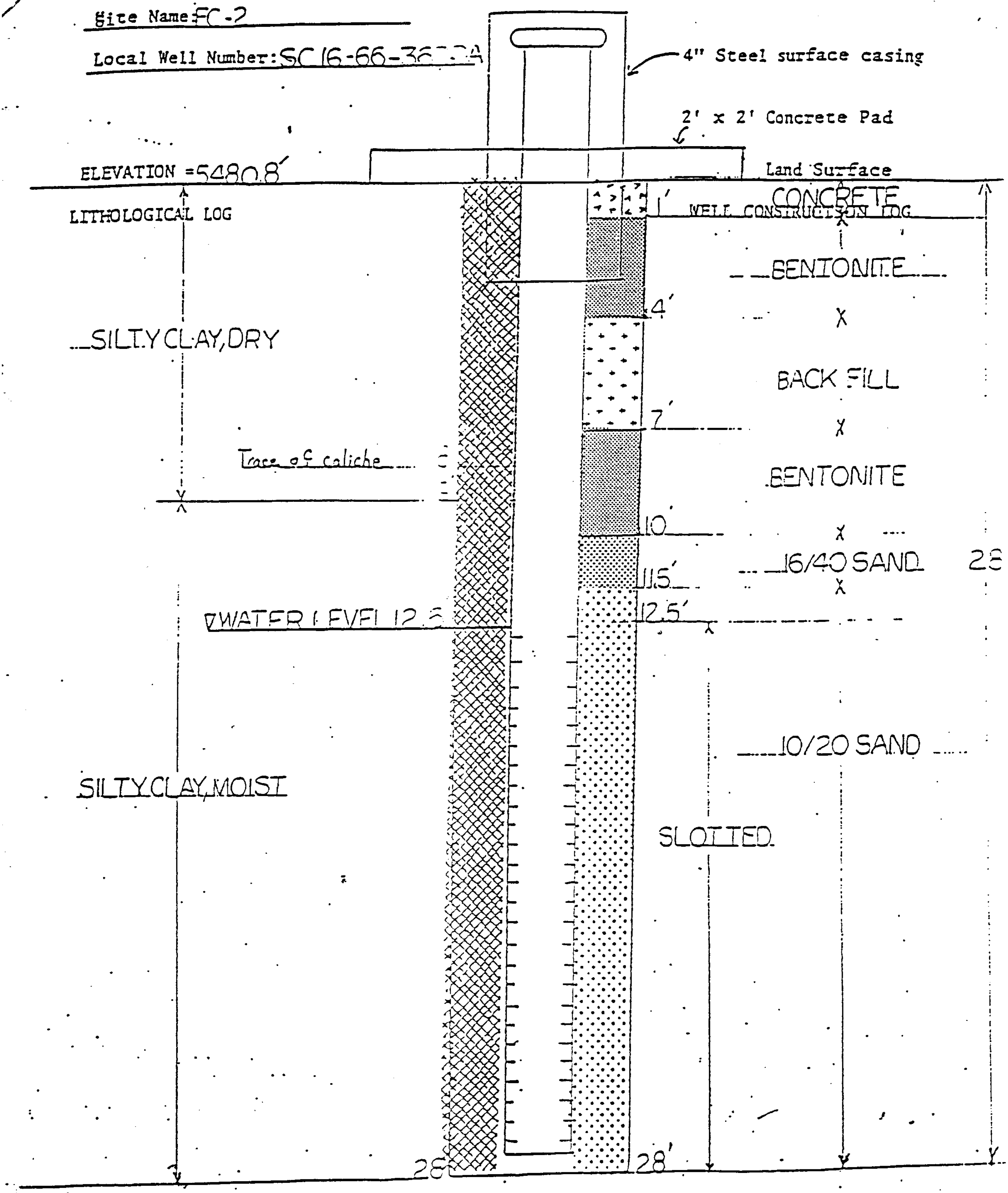


Figure 3.

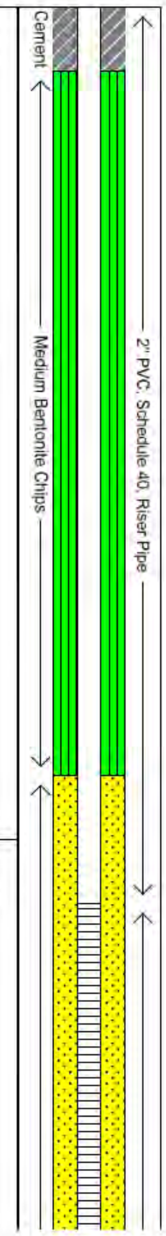
AECOM Boring and Well Construction Log

Boring #: FC-3A

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1282807.37** Easting: **3223409.73**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5481.95**
Start Date & Time: **6/6/2016 10:40 AM**	Method: **Hollow Stem Auger**	Total Depth (ft): **34.75**
Finish Date & Time: **6/6/2016 15:25 PM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	Lithology	USCS Symbol	Soil and Rock Description
	CB	NR	92	NM	0		CL	very stiff, 3.5 unconfined compressive strength (qu) tons per square foot (tsf), dark gray (10YR 4/1), LEAN CLAY, moist; non-plastic, noncohesive, with organic rootlets, no odor or staining
				NM				3.0 - AS ABOVE; no rootlets
	CB	NR	85	NM	5			5.0 - AS ABOVE; hard > 4.0 qu (tsf), brown (10YR 4/3) with little calcite deposits
				NM				
	CB	NR	92	NM	10			10.0 - AS ABOVE; very stiff 3.0 qu (tsf), medium plasticity, cohesive
				NM			CH	13.0 - very stiff 2.0 qu (tsf), dark grayish brown (10YR 4/2), FAT CLAY, moist; medium/high plasticity; cohesive, no odor or staining
	CB	NR	100	NM	15			15.0 - AS ABOVE; dark grayish brown (10YR 5/2), massive, trace calcite deposits
				NM				

Well Diagram



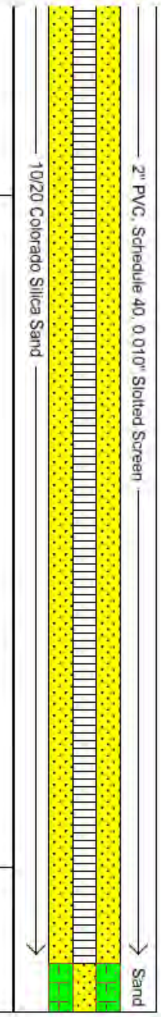
Remarks and Datum Used:	**Monitoring well was completed with above-grade well protection, SS = 2" Split Spoon**	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	**Soil samples were not collected from soil boring FC-3A**	**Depth to Water Table (ft):**
	NR = Not Recorded, CB = 5' Long, 4" Diameter Core Barrel	**19.12 TOIC 6/6/2016 15:07 PM**
	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

Boring and Well Construction Log

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**	
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1282807.37**	Easting: **3223409.73**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5481.95**	
Start Date & Time: **6/6/2016 10:40 AM**	Method: **Hollow Stem Auger**	Total Depth (ft): **34.75**	
Finish Date & Time: **6/6/2016 15:25 PM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**	

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	USCS Symbol	Soil and Rock Description
	CB	NR	72	NM	20		20.0 - AS ABOVE; soft 0.5 qu (tsf), wet, slow dilatency
				NM		CL	22.0 - stiff 2.0 qu (tsf), yellowish brown, SANDY LEAN CLAY, moist/wet, slow dilatency, non-plastic, noncohesive, very fine to fine sand, alluvial
	CB	NR	90	NM	25		25.0 - AS ABOVE: little fine sand
				NM			28.2 - AS ABOVE; gray (10YR 5/1), with gravel, slight mottled gray (10YR 5/1) and brownish yellow (10YR 6/8)
	CB	NR	80	NM	30		30.0 - AS ABOVE; very stiff, some calcite deposits
				NM		CLAY-STONE	32.5 - very stiff, dark gray (10YR 5/1) CLAYSTONE, moist, non-plastic, noncohesive, blocky, mottled brownish yellow and dark gray
	SS	50	9"	NM			34.0 - Core Barrel Refusal

Well Diagram



Remarks and Datum Used:	**Monitoring well was completed with above-grade well protection, SS = 2" Split Spoon**	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	**Soil samples were not collected from soil boring FC-3A**	**Depth to Water Table (ft):**
	NR = Not Recorded, CB = 5' Long, 4" Diameter Core Barrel	**19.12 TOIC 6/6/2016 15:07 PM**
	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

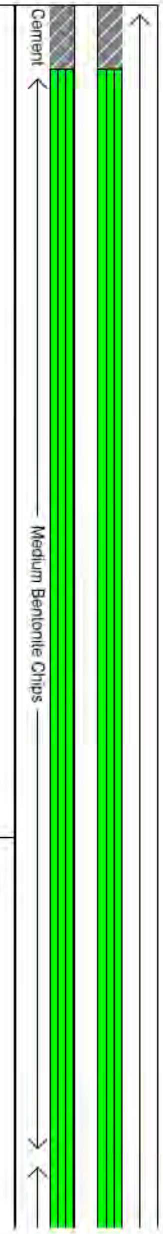
AECOM Boring and Well Construction Log

Boring #:FC-3B
Sheet 1 of 3

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1282806.09** Easting: **3223416.43**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5481.54**
Start Date & Time: **6/10/2016 06:45 AM**	Method: **Hollow Stem Auger**	Total Depth (ft): **55.1**
Finish Date & Time: **6/10/2016 09:50 AM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	Lithology	USCS Symbol	Soil and Rock Description
				NM	0		CL	very stiff 3.5 unconfined compressive strength (qu) tons per square foot (tsf), dark gray (10YR 4/1), LEAN CLAY, moist; non-plastic, noncohesive, with organic rootlets, no odor or staining
	CB	NR	92					
				NM				3.0 - AS ABOVE; no rootlets
				NM	5			5.0 - AS ABOVE; hard > 4.0 qu (tsf), brown (10YR 4/3) with little calcite deposits
	CB	NR	85					
				NM				
				NM	10			10.0 - AS ABOVE; very stiff 3.0 qu (tsf), medium plasticity, cohesive
	CB	NR	92					
				NM			CH	13.0 - very stiff 2.0 qu (tsf), dark grayish brown (10YR 4/2), FAT CLAY, moist; medium/high plasticity; cohesive, no odor or staining
				NM	15			15.0 - AS ABOVE; dark grayish brown (10YR 5/2), massive, trace calcite deposits
	CB	NR	100					
				NM				

Well Diagram



Remarks and Datum Used:	All information presented for 0 to 34.75 feet bgs was obtained from soil boring FC-3A.	
AECOM	Soil samples were not collected from soil boring FC-3B	Depth to Water Table (ft):
6200 South Quebec Street Greenwood Village, CO 80111	NR = Not Recorded, CB = 5' Long, 4" Diameter Core Barrel	39.32 TOIC 6/10/16 11:39 AM
Direct: (303) 740-3916 Office: (303) 740-2600	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1282806.09** Easting: **3223416.43**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5481.54**
Start Date & Time: **6/10/2016 06:45 AM**	Method: **Hollow Stem Auger**	Total Depth (ft): **55.1**
Finish Date & Time: **6/10/2016 09:50 AM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	Lithology	USCS Symbol	Soil and Rock Description	Well Diagram
					20			20.0 - AS ABOVE; soft 0.5 qu (tsf), wet, slow dilatency	2" PVC, Schedule 40, Riser Pipe
	CB	NR	72	NM					
				NM			CL	22.0 - stiff 2.0 qu (tsf), yellowish brown, SANDY LEAN CLAY, moist/wet, slow dilatency, non-plastic, noncohesive, very fine to fine sand, alluvial	
					25			25.0 - AS ABOVE: little fine sand	
	CB	NR	90	NM					
				NM				28.2 - AS ABOVE; gray (10YR 5/1), with gravel, slight mottled gray (10YR 5/1) and brownish yellow (10YR 6/8)	Time Release Bentonite Chips
					30			30.0 - AS ABOVE; very stiff, some calcite deposits	
	CB	NR	80	NM					
				NM			CLAY-STONE	(34.0-34.75') very stiff, dark gray (10YR 5/1) CLAYSTONE, moist, non-plastic, noncohesive, blocky, mottled brownish yellow and dark gray	
	SS	50	9"	NM				34.0 - Core Barrel Refusal	
					35			(34.75-40.0') "blind"drilled, no sampling	

Remarks and Datum Used:	**All information presented for 0 to 34.75 feet bgs was obtained from soil boring FC-3A.**	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	**Soil samples were not collected from soil boring FC-3B** **NR = Not Recorded, CB = 5' Long, 4" Diameter Core Barrel** **NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing**	**Depth to Water Table (ft):** **39.32 TOIC 6/10/16 11:39 AM**

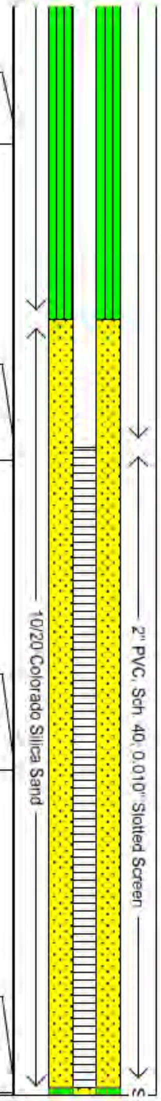
Boring and Well Construction Log

AECOM

Boring #:FC-3B
Sheet 3 of 3

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1282806.09** Easting: **3223416.43**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5481.54**
Start Date & Time: **6/10/2016 06:45 AM**	Method: **Hollow Stem Auger**	Total Depth (ft): **55.1**
Finish Date & Time: **6/10/2016 09:50 AM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	Lithology	USCS Symbol	Soil and Rock Description
	SS	50	3"	NM	40		SHALE	40.0 - hard, bluish gray (GLEY2 5/10B), SHALE, dry, non-plastic, platy, bedded to thinly bedded.
								(40.26-45.0') "blind" drilled, no sampling
	SS	50	2"	NM	45		SHALE	45.0 - hard, bluish gray (GLEY2 5/10B), WEATHERED SHALE, dry, non-plastc, platy, thinly bedded, with moist, dark gray, clay
								(45.2-50.0') "blind" drilled, no sampling
	SS	50	0.5"	NM	50		SHALE	50.0 - hard, bluish gray (GLEY2 5/10B), WEATHERED SHALE, dry, non-plastc, platy, thinly bedded, with moist, dark gray, clay
								(50.4-55.0') "blind" drilled, no sampling
	SS	50	1.5"	NM	55		SHALE	55.0 - hard, bluish gray (GLEY2 5/10B), WEATHERED SHALE, dry, non-plastc, platy, thinly bedded, with moist, dark gray, clay



Remarks and Datum Used:	**All information presented for 0 to 34.75 feet bgs was obtained from soil boring FC-3A.**	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	**Soil samples were not collected from soil boring FC-3B**	**Depth to Water Table (ft):**
	NR = Not Recorded, CB = 5' Long, 4" Diameter Core Barrel	**39.32 TOIC 6/10/16 11:39 AM**
	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

AECOM

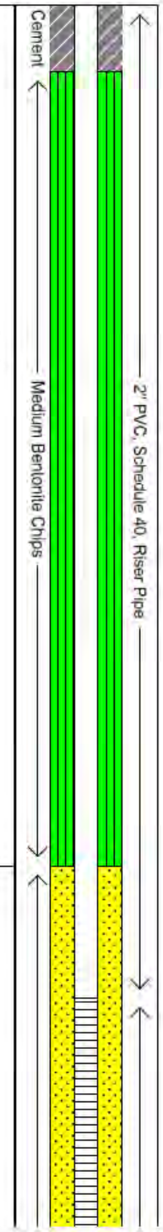
Boring and Well Construction Log

Boring #:SC-10
Sheet 1 of 2

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1283428.94** Easting: **3226344.60**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5445.18**
Start Date & Time: **6/9/2016 12:00 PM**	Method: **Hollow Stem Auger**	Total Depth (ft): **35.25**
Finish Date & Time: **6/9/2016 17:00 PM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Sampling and Field Data					Depth (ft.)	Lithology	USCS Symbol	Soil and Rock Description
Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)				
	CB	NR	85	NM	0		CL	very soft,brown (10YR 4/3), LEAN CLAY WITH GRAVEL, moist, non-plastic, noncohesive, organic rootlets 0.3 - AS ABOVE; very stiff >4.0 unconfined compressive strength (qu) tons per square foot (tsf), dark grayish brown (10YR 4/3)
				NM				2.5 - AS ABOVE; no rootlets
	CB	NR	100	NM	5			5.0 - AS ABOVE; stiff 1.0 qu (tsf), medium/high plasticity, cohesive, massive
				NM				
	CB	NR	87	NM	10			10.0 - AS ABOVE; very stiff 3.0 qu (tsf)
				NM			CH	13.0 - soft, dark grayish brown, FAT CLAY, wet, slow dilatency, medium/high plasticity, coshesive, no odor or staining
	CB	NR	100	NM	15			15.0 - AS ABOVE; stiff 2.0 unconfined compressive strength (qu) tons per square foot (tsf), very dark gray (10YR 3/1)
								17.5 - AS ABOVE; very stiff 2.5 qu (tsf), dark grayish brown (10YR 4/2), moist, medium plasticity, cohesive,

Well Diagram



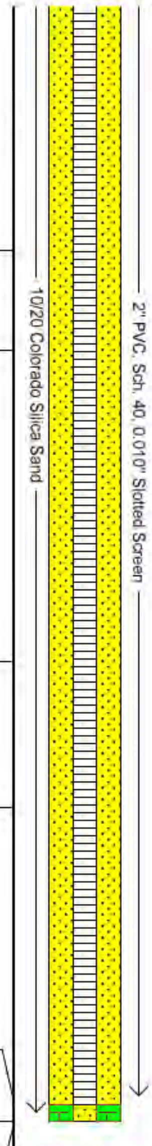
Remarks and Datum Used:	**Monitoring well SC-10 was constructed with above-grade well protection; SS= Split-Spoon sampler**	
AECOM **6200 South Quebec Street** **Greenwood Village, CO 80111** **Direct: (303) 740-3916** **Office: (303) 740-2600**	**Soil samples were not collected from soil boring SC-10** **NR = Not Recorded, CB = 5' long, 4" Diameter Core Barrel** **NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing**	**Depth to Water Table (ft):** **9.73 TOIC 6/10/2016 11:23 AM**

AECOM Boring and Well Construction Log

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1283428.94** Easting: **3226344.60**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5445.18**
Start Date & Time: **6/9/2016 12:00 PM**	Method: **Hollow Stem Auger**	Total Depth (ft): **35.25**
Finish Date & Time: **6/9/2016 17:00 PM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	USCS Symbol	Soil and Rock Description
				NM			~15% calcite deposit
					20		19.75 - AS ABOVE; very soft 0.25 quf (tsf), high plasticity
				NM			
	CB	NR	98			CL	22.1 - very soft, dark grayish brown (10YR 4/2), LEAN CLAY WITH SAND AND GRAVEL, wet, non-plastic, noncohesive, subangular gravel, fine to coarse sand, no odor or staining
				NM		GP	23.6 - loose, dark grayish brown (10YR 4/2), POORLY GRADED GRAVEL, wet, fine to coarse sand, subangular gravel, no odor or staining
					25		25.0 - AS ABOVE; with sand and clay
				NM			
	CB	NR	90				
				NM		CLAY-STONE	28.3 - loose, dark grayish brown (10YR 4/2), WEATHERED CLAYSTONE, moist, blocky, with moist non-plastic clay and gravel,
	SS	50	6"	NM	30		30.0 - Core Barrel Refusal
							(30.5-35.0') "blind" drilled, no sampling
					35		35.0 - hard >4.0 qu (tsf), gray, WEATHERED SHALE, dry, thinly bedded, massive
	SS	50	3"	NM		SHALE	35.25 Feet BGS - End of Boring

Well Diagram



Remarks and Datum Used:	Monitoring well SC-10 was constructed with above-grade well protection; SS= Split-Spoon sampler	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	Soil samples were not collected from soil boring SC-10	Depth to Water Table (ft):
	NR = Not Recorded, CB = 5' long, 4" Diameter Core Barrel	9.73 TOIC 6/10/2016 11:23 AM
	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

AECOM Boring and Well Construction Log

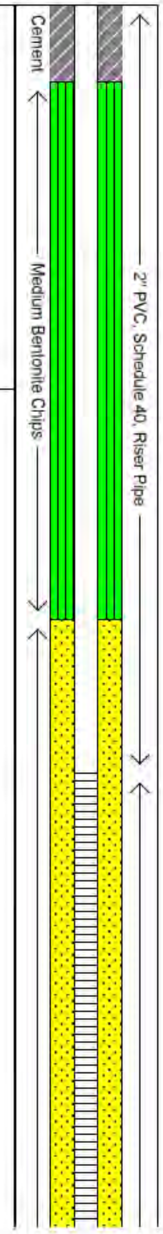
Boring #: SC-11
Sheet 1 of 2

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1283151.69** Easting: **3226374.64**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5441.94**
Start Date & Time: **6/6/2016 16:00 PM**	Method: **Hollow Stem Auger**	Total Depth (ft): **30.66**
Finish Date & Time: **6/7/2016 10:30 AM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Sampling and Field Data

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	USCS Symbol	Soil and Rock Description
				NM	0	CL	hard >4.0 unconfined compressive strength (qu) tons per square foot (tsf), brown (10YR 4/3), LEAN CLAY, moist, non-plastic, noncohesive, massive, little sand with organic rootlets, no odor or staining
							1.0 - AS ABOVE; no rootlets
	CB	NR	71				2.0 - AS ABOVE; white calcite deposit
				NM			4.5 - AS ABOVE; stiff 1.5 qu (tsf), medium plasticity, cohesive
SC-11 (5'4"-6'0") 6/6/2016 16:30 PM, SEE COC	SS	3 5	6" 6"	NM	5	CH	5.0 - stiff 1.5 qu (tsf), brown (10YR 4/3), FAT CLAY, moist, high plasticity, cohesive, massive, trace calcite, no mottling, odor, or staining.
				NM			
	CB	NR	100				
				NM			
				NM	10		10.0 - AS ABOVE; dark grayish brown (10YR 4/2), no calcite deposits
	CB	NR	100				
				NM			
					15		15.0 - AS ABOVE; very soft <0.25 qu (tsf), brown (10YR 4/3), wet, slow dilatency, medium/high plasticity

Well Diagram



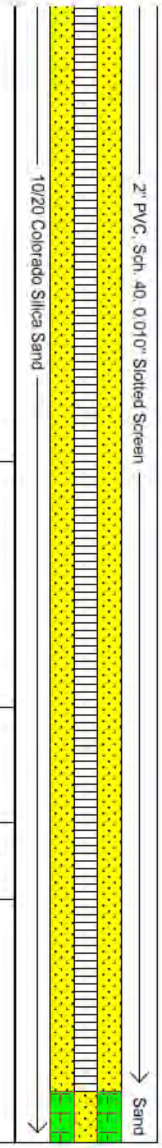
Remarks and Datum Used:	**Monitoring well SC-11 was constructed with above-grade well protection; SS= Split-Spoon sampler**	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	**California sampler was collected from SC-11 from 5'4" to 6'0"**	**Depth to Water Table (ft):**
	NR = Not Recorded, CB = 5' long, 4" Diameter Core Barrel	**7.63 TOIC 6/7/16 12:52 PM**
	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

AECOM	# Boring and Well Construction Log	Boring #:SC-11 Sheet 2 of 2

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1283151.69** Easting: **3226374.64**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5441.94**
Start Date & Time: **6/6/2016 16:00 PM**	Method: **Hollow Stem Auger**	Total Depth (ft): **30.66**
Finish Date & Time: **6/7/2016 10:30 AM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	Lithology	USCS Symbol	Soil and Rock Description
				NM				15.25 - medium 1.0 qu (tsf), brown (10YR 4/3), moist
	CB	NR	100					
				NM				19.0 - AS ABOVE; very stiff 2.75 qu (tsf), mottled brown (10YR 4/3) and yellowish brown (10YR 5/8)
					20			
				NM				
	CB	NR	68				SP	21.8 - very loose, brown (10YR 4/3), POORLY GRADED SAND WITH CLAY AND GRAVEL, wet, fine to coarse sand
				NM				
					25		CL	25.0 - stiff 1.5 qu (tsf), brown (10YR 4/3), SANDY LEAN CLAY WITH GRAVEL, wet, non-plastic, noncohesive, angular gravel
				NM			CH	26.5 - soft, brown (10YR 4/3), FAT CLAY, wet, high plasticity, cohesive, non mottling or staining
	CB	NR	80				CLAY-STONE	27.5 - stiff, dark gray (10YR 4/1), WEATHERED CLAYSTONE, moist, massive, blocky
				NM				
	SS	50	8"	NM	30			30.0 - Core Barrel Refusal

Well Diagram



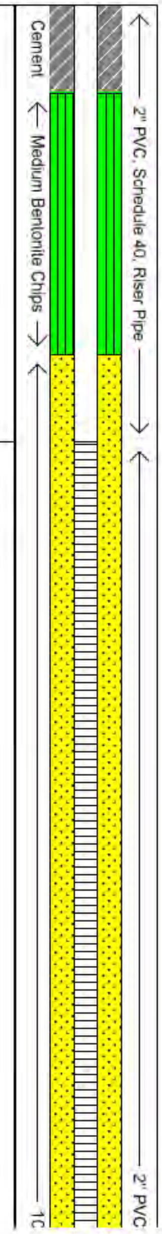
Remarks and Datum Used:	Monitoring well SC-11 was constructed with above-grade well protection; SS= Split-Spoon sampler	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	California sampler was collected from SC-11 from 5'4" to 6'0"	Depth to Water Table (ft):
	NR = Not Recorded, CB = 5' long, 4" Diameter Core Barrel	7.63 TOIC 6/7/16 12:52 PM
	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

AECOM

Boring and Well Construction Log

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1282807.25** Easting: **3226399.78**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5442.07**
Start Date & Time: **6/7/2016 11:00 AM**	Method: **Hollow Stem Auger**	Total Depth (ft): **25.83**
Finish Date & Time: **6/7/2016 15:10 PM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Sampling and Field Data									
Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	Lithology	USCS Symbol	Soil and Rock Description	Well Diagram
	CB	NR	73	NM	0		CL	very stiff, brown (10YR 4/3), LEAN CLAY, moist, non-plastic, noncohesive, massive, with rootlets	
				NM				2.5 - AS ABOVE; no rootlets, little calcite deposits	
	CB	NR	72	NM	5		CH	5.0 - very soft <0.25 unconfined compressive strength (qu) tons per square foot (tsf), dark yellowish brown (10YR 4/4), FAT CLAY, moist, high plasticity, cohesive, massive, with fine sand	
				NM				7.5 - AS ABOVE; wet (7.5' to 7.7' bgs)	
	CB	NR	53	NM	10			10.0 - AS ABOVE; no mottling or calcite deposits	
				NM					



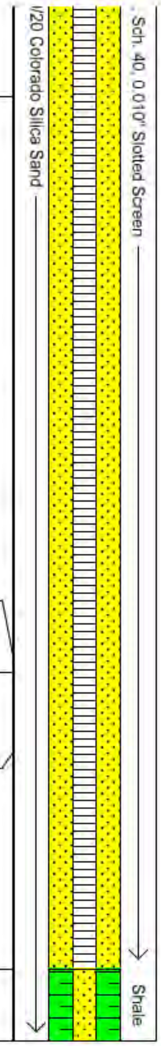
Remarks and Datum Used:	**Monitoring well SC-12 was constructed with above-grade well protection; SS= Split-Spoon sampler**	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	**Soil samples were not collected at soil boring SC-12**	**Depth to Water Table (ft):**
	NR = Not Recorded, CB = 5' long, 4" Diameter Core Barrel	**7.55 TOIC 6/7/16 15:17 PM**
	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

Boring and Well Construction Log

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1282807.25** Easting: **3226399.78**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5442.07**
Start Date & Time: **6/7/2016 11:00 AM**	Method: **Hollow Stem Auger**	Total Depth (ft): **25.83**
Finish Date & Time: **6/7/2016 15:10 PM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	USCS Symbol	Soil and Rock Description
					15	CL	15.0 - very soft <0.25 qu (tsf), brown (10YR 5/3), LEAN CLAY, wet, slow dilatency, medium plasticity, cohesive, massive
	CB	NR	90	NM			
				NM			17.8 - AS ABOVE; sandy lean clay, non-plastic, noncohesive, mottled brown and brownish yellow (10YR 6/8)
							18.2 - AS ABOVE; no sand
					20		20.0 - AS ABOVE; with calcite deposit, massive, mottled brown (10YR 5/3) and gray (10YR 5/1)
	CB	NR	83	NM		SP	21.5 - medium dense, brown, POORLY GRADED SAND WITH CLAY AND GRAVEL, wet, coarse gravel
						CL	21.6 - hard >4.0 qu (tsf), brown (10YR 4/3), LEAN CLAY WITH GRAVEL, moist, non-plastic, noncohesive, massive, mottled
				NM		CLAY-STONE	22.5 - hard, dark gray, CLAYSTONE, moist, non-plastic, blocky, with trace sand
	SS	50	10"	NM	25	SHALE	25.0 - hard, blue, SHALE, dry, platy, non-plastic, Core Barrel Refusal at 25 feet bgs

Well Diagram



Remarks and Datum Used:	**Monitoring well SC-12 was constructed with above-grade well protection; SS= Split-Spoon sampler**	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	**Soil samples were not collected at soil boring SC-12**	**Depth to Water Table (ft):**
	NR = Not Recorded, CB = 5' long, 4" Diameter Core Barrel	**7.55 TOIC 6/7/16 15:17 PM**
	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

Boring and Well Construction Log

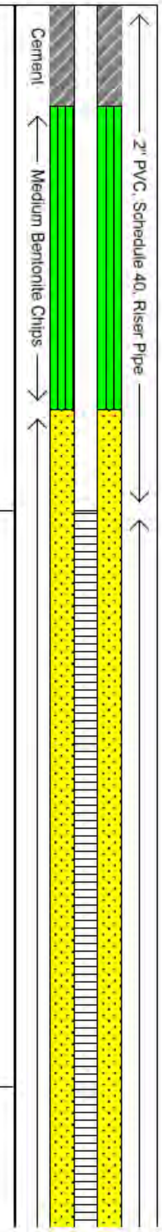
AECOM

Boring #:SC-13
Sheet 1 of 2

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1282422.79** Easting: **3226375.83**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5443.74**
Start Date & Time: **6/7/2016 15:45 PM**	Method: **Hollow Stem Auger**	Total Depth (ft): **23.16**
Finish Date & Time: **6/8/2016 11:00 AM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	Lithology	USCS Symbol	Soil and Rock Description
					0		CL	hard >4.0 unconfined compressive strength (qu) tons per square foot (tsf), brown (10YR 4/3), LEAN CLAY, moist, non-plastic, noncohesive, with organic rootlets
				NM				1.5 - AS ABOVE; no organic rootlets
	CB	NR	83					
				NM				
					5		CH	5.0 - very soft 1.0 qu (tsf), brown (10YR 4/3), FAT CLAY, moist, high plasticity, cohesive, massive, trace calcite deposits
				NM				
	CB	NR	75					7.5 - AS ABOVE; very soft < 0.25 qu (tsf)
				NM				
					10			
							CL	10.7 - stiff 1.0 qu (tsf), brown (10YR 4/3), LEAN CLAY, wet, medium plasticity, cohesive, massive, mottled gray and brown, trace sand, alluvial deposition
				NM				

Well Diagram



Remarks and Datum Used:	**Monitoring well SC-13 was constructed with above-grade well protection; SS= Split-Spoon sampler**	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	**Soil samples were not collected at soil boring SC-13**	**Depth to Water Table (ft):**
	NR = Not Recorded, CB = 5' long, 4" Diameter Core Barrel	**8.57 TOIC 6/8/16 11:25 AM**
	NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing	

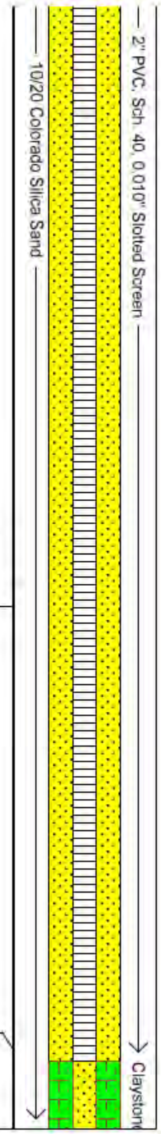
AECOM

Boring and Well Construction Log

Project: **CSU Well Installation**	Contractor: **GDI Drilling Inc.**	Location: **Clear Springs Ranch, Fountain, CO**
Project #: **60506434.3**	Operator: **Dean & Eric Stedman**	Northing: **1282422.79** Easting: **3226375.83**
Client: **Colorado Springs Utilities**	Drill Rig Type: **Diedrich D-90 Truck Mount**	Surface Elevation (ft AMSL): **5443.74**
Start Date & Time: **6/7/2016 15:45 PM**	Method: **Hollow Stem Auger**	Total Depth (ft): **23.16**
Finish Date & Time: **6/8/2016 11:00 AM**	Boring ID: **8.5 inches**	Logged By: **Chris Ahrendt**

Analytical Samples	Sample Type	Blows/ 6 inch	% Rec	PID (ppm)	Depth (ft.)	Lithology	USCS Symbol	Soil and Rock Description
	CB	NR	100	NM				14.0 - AS ABOVE; soft 0.50 qu (tsf), non-plastic, noncohesive
				NM	15			15.5 - AS ABOVE; medium 1.0 qu (tsf)
	CB	NR	95					17.0 - AS ABOVE; SANDY LEAN CLAY WITH GRAVEL,
								17.8 - stiff, wet, slow dilatency, mottled brown (10YR 5/3) and yellowish brown (10YR 5/8), trace angular gravel
				NM			GP	18.0 - loose, brown POORLY GRADED GRAVEL WITH CLAY, wet, angular gravel, little fine to coarse sand
	CB	NR	50	NM	20			
	SS	50	8"	NM			CLAY-STONE	22.4 - hard >4.0 qu (tsf), brown and gray, WEATHERED CLAYSTONE, moist, bedded, blocky, no odor or staining Core Barrel Refusal at 22.5 feet bgs.

Well Diagram



Remarks and Datum Used:	**Monitoring well SC-13 was constructed with above-grade well protection; SS= Split-Spoon sampler**	
AECOM 6200 South Quebec Street Greenwood Village, CO 80111 Direct: (303) 740-3916 Office: (303) 740-2600	**Soil samples were not collected at soil boring SC-13** **NR = Not Recorded, CB = 5' long, 4" Diameter Core Barrel** **NM = Not Measured, ft. TOIC = Feet from Top of Inner PVC Casing**	**Depth to Water Table (ft):** **8.57 TOIC 6/8/16 11:25 AM**

PROJECT NAME: CSU Clear Springs Ranch	**DATES DRILLED:** 11/21/22 - 11/21/22
PROJECT NO: 60696724	**SURFACE ELEVATION (ft):** 5480.75
LOCATION: Clear Springs Ranch, Fountain, CO	**TOTAL DEPTH (ft):** 35.3

LOG NO: SC-15

AECOM

DRILLING COMPANY: GDI Drilling	**INCLINATION (deg):** N/A	**LOGGED BY:** J. Hurshman
DRILLER: Dean Stedman	**AZIMUTH (deg):** N/A	**CHECKED BY:** M. Levorsen
DRILL EQUIP: CME	**CASING DEPTH (ft bgs):** N/A	**HOLE LOCATION:** South of FSL, near WW-3A
DRILL METHOD: Hollow Stem Auger	**GROUNDWATER (ft bgs):** 25.98	**LATITUDE (deg) or NORTHING (ft):** 1284890.11(ft)
BIT SIZE/TYPE: 8" HSA	**COMPLETION:** Monitoring Well	**LONGITUDE (deg) or EASTING (ft):** 3225042.01(ft)

ELEVATION (ft)	DEPTH (ft)	SOIL SAMPLES: SAMPLING TYPE AND NUMBER	BLOW COUNTS (N VALUE)	RECOVERY (%)	MATERIAL DESCRIPTION AND REMARKS	LITHOLOGY	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	GRAVEL (%)	SAND (%)	FINES - Passing No. 200 Sieve (%)	CLAY - Passing 2 microns (%)
5480	0	CC 1		30	LEAN CLAY with SILT (CL), compact to hard, dry, light tan, with silt, few gravel, and organics/roots, driller indicate some gravel at 2-3ft bgs.									
5475	5	CC 2		70	LEAN CLAY (CL), moist, medium brown, low plasticity, no gravel, few roots, rolls formed (1 cm), softer drilling at 5-10ft, Silt in top 1 foot of recovery, decrease Silt with depth.									
5470	10	CC 3		50	SILTY CLAY (CL), stiff, moist, low plasticity, slight increase in Silt.									
5465	15	CC 4		100	CLAY (CL), soft, moist, brown, medium plasticity, little silt, no gravel, homogeneous, rolls with clay formed (0.5cm).									
5460	20	CC 5		100	CLAY (CL), soft to very soft, mottled brown to dark brown, medium to high plasticity, 1 cm thick seam of white gypsum crystals at 23 ft, few orange oxide color 24-25 ft. Small interbedded nodules of white gypsum 22-24 ft.									
5455	25	CC 6		70	CLAY (CL), soft, moist, mottled brown to orange and dark brown, medium to high plasticity, increased moisture Lense of gravel at 29.7 ft for 2-3 inches in clay, moist to wet, subrounded to subangular, 1cm gravel - granitic.									
5450	30	CC 7		50	CLAY (CL), soft, moist, mottled brown to orange and dark brown, medium to high plasticity, bottom foot is chunky weathered shale, oxidized, water from above, white fractures in shale									
	35	SS		100	Split spoon. 50/4"- to confirm shale bedrock									

Bottom of hole at 35.3 feet.

AECOM
Boring Log

Project Name:	CSU CCR Landfill Well Installation	**Boring ID:**	**SC-18**
Client:	Colorado Springs Utilities		
Project Number:			

Date(s) Drilled	13-Sep-23	Logged By	Jeremy Hurshman	Checked By		Total Depth of Borehole (ft)	30'
						Depth to Water (bgs)	10.37
Drilling Method	Hollow Stem Auger	Diameter of Borehole (in)	8 1/4"			Ground Surface Elevation (ft-msl)	5465.86
Drill Rig Type	CME	Drilling Company	GDI			Groundwater Elevation (ft-msl)	5457.82
Driller's Name	Dean Stedman	Sampler Type	Continuous Core Barrel			Measuring Point Elevation (ft-msl)	5468.19
Description of Sample Location						Northing	1284057.5
						Easting	3224403.7

Depth (ft-bgs)	Run Number	Recovery (%)	Sample ID	USCS Symbol	PID (ppm)	MATERIAL DESCRIPTION	Well Construction
0-5	1	100%		CL		0-5: Clay with minor silt, no sand, no gravel, brown, moist, soft, moderate plasticity	
4-5						4-5: interbedded mottled white, almost fibrous, similar to paper debris.	
5-10	2	100%				5-9: Clay with minor silt, no sand, brown, stiff, moist, moderate plasticity	
9-10						9-10: mottled clay of light tan, brown, and orange oxidation. Minor sand in this interval.	
10-15	3					Stiff clay to 12 ft. becomes softer from 12-15 feet. Clay to 15 ft. becomes more wet 14-15	
14-15				SC		14-15: Medium sand with clay, brown/oxidized mottled color. Wet ~ 14.5 Shoe of drill flight has sandy clay at 15 ft.	
15-16	4					15-16: Sandy clay to 16 ft. wet, poorly sorted, silt	
16-19				CL/CH		16-19: Clay, stiff, moderate to high plasticity, brown, moist to wet, minor interbedded sand increased water with depth	
19-20				CL		Silty clay, moist to wet, soft, brown, 50% silt, minor interbedded medium sand	

AECOM

Boring Log

Project Name:	**CSU CCR Landfill Well Installation**	**Boring ID:**	**SC-18**
Client:	**Colorado Springs Utilities**		
Project Number:			

Date(s) Drilled	13-Sep-23	**Logged By**	**Checked By**	**Total Depth of Borehole (ft)** 30'	**Depth to Water (bgs)** 10.37
Drilling Method	Hollow Stem Auger	**Diameter of Borehole (in)**	8 1/4"	**Ground Surface Elevation (ft-msl)**	5465.86
Drill Rig Type	CME	**Drilling Company**	GDI	**Groundwater Elevation (ft-msl)**	5457.82
Driller's Name Dean	**Sampler Type**	Continuous Core Barrel		**Measuring Point Elevation (ft-msl)**	5468.19
Description of Sample Location				**Northing** / **Easting**	1284057.5 / 3224403.7

Depth (ft-bgs)	SAMPLES: Run Number	Recovery (%)	Sample ID	USCS Symbol	PID (ppm)	MATERIAL DESCRIPTION	Well Construction
20-23	5	75%		SC		little to no recovery to 23 ft. (appears to be sand). Wet	
23-24				GC		23-24: sandy gravel with minor clay, wet, subrounded to rounded grains, fractured rock fragments, poorly sorted	
24-25				Bedrock		24-25: Clay stone (shale) light gray, mottled brown with oxidation, highly weathered, mostly crubles	
25-29	6	30%		Bedrock		25-30: poor recovery	
29-30						29-30: Harder shale/clay stone, dry on shoe of core, stiff, doesn't break easily	
30-40							

AECOM Boring Log	Project Name:	CSU CCR Landfill Well Installation	Boring ID:	SC-19
	Client:	Colorado Springs Utilities		
	Project Number:			

Date(s) Drilled	13-Sep-23	Logged By	Jeremy Hurshman	Checked By	
Total Depth of Borehole (ft)	25'	Depth to Water (bgs)	10.93		
Drilling Method	Hollow Stem Auger	Diameter of Borehole (in)	8 1/4"	Ground Surface Elevation (ft-msl)	5467.36'
Drill Rig Type	CME	Drilling Company	GDI	Groundwater Elevation (ft-msl)	N/A
Driller's Name		Sampler Type	Continuous Core Barrel	Measuring Point Elevation (ft-msl)	5469.68'
Description of Sample Location				Northing	1284195.79
				Easting	3224353.14

Depth (ft-bgs)	SAMPLES: Run Number	Recovery (%)	Sample ID	USCS Symbol	PID (ppm)	MATERIAL DESCRIPTION	Well Construction
0-1	1	100%		OL		0-1: Topsoil, dark brown, most, rootlets	
1-5	1	100%		CL		1-5: Clay, brown, moist, stiff, low to moderate plasticity	
4				CL		4:5: Minor white interbedded streaks of granular mudstone	
5-7	2	100%		CL		5-7: Clay as above, medium brown color to 7 ft.	
7-8	2	100%		CL		7-8: Clay as above, dark brown	
8-10	2	100%		CL		8-10: Mottled light tan color with oxidation streaks, moist, stiff, moderate plasticity, gypsum crystals, moist - dry around 8 ft. bgs. (1 cm in size)	
10	3	80%		CL		Clay, moist, very thin wet zone. Around 10 ft. bgs. minor sand in this zone.	
13-15	3	80%		CL		13-15: softer clay, increased moisture, dark zones of interbedded organic material. Increased silt content in soft areas.	
14-15	3	80%		CL		14-15: mottled brown to tan color, moderate to high plasticity	
15-18	4	80%		CL		15-18: Clay as above to around 18 ft. very moist and soft, wet, in areas, thin 2 inch thick sandy/gravelly clay zone at 18 ft. bgs., top foot has increased silt content	
18-20	4	80%		CL		18-20: mottled gray to tan clay, appears to be weathered shale, crubles, moist	

AECOM
Boring Log

Project Name:	CSU CCR Landfill Well Installation	**Boring ID:**	**SC-19**
Client:	Colorado Springs Utilities		
Project Number:			

Date(s) Drilled	13-Sep-23	**Logged By**	Jeremy Hurshman	**Checked By**		**Total Depth of Borehole (ft)**	25' — **Depth to Water (bgs)** 10.93
Drilling Method	Hollow Stem Auger	**Diameter of Borehole (in)**	8 1/4"			**Ground Surface Elevation (ft-msl)**	5467.36'
Drill Rig Type	CME	**Drilling Company**	GDI			**Groundwater Elevation (ft-msl)**	N/A
Driller's Name		**Sampler Type**	Continuous Core Barrel			**Measuring Point Elevation (ft-msl)**	5469.68'
Description of Sample Location						**Northing** / **Easting**	1284195.79 / 3224353.14

Depth (ft-bgs)	Run Number	Recovery (%)	Sample ID	USCS Symbol	PID (ppm)	MATERIAL DESCRIPTION	Well Construction
20–25	5	50%		Bedrock		Harder, slower drilling 20-25 ft., tan to gray blocky weathered bedrock shale, crumbles, moist in zone. Dry in zone. Highly weathered.	
25						Dry at 25 ft. bgs. in shoe of auger.	
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

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RECEIVED
JUL 20 2016
WATER RESOURCES
STATE ENGINEER COLO.

1. WELL PERMIT NUMBER: mH-55392 302141

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Colorado Springs Utilities

MAILING ADDRESS: 121 South Tejon Street, P.O. Box 1103, Mail Code 940

CITY: Colorado Springs STATE: Colorado ZIP CODE: 80947

TELEPHONE NUMBER w/area code: (719) 668-4171

3. WELL LOCATION AS DRILLED: SW 1/4, SW 1/4, Sec., 31 Twp. 16 ☐ N or S, ☒ Range 65 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 330 ft. from ☐ N or ☒ S section line and 60 ft. from ☐ E or ☒ W section line.

SUBDIVISION: ______, LOT ____, BLOCK ____, FILING (UNIT) ____

Owner's Well Designation: FC-3A

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Easting: ______

Northing: ______

STREET ADDRESS AT WELL LOCATION: 6598 Ray Nixon Road, Fountain, Colorado

4. GROUND SURFACE ELEVATION ______ feet

DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 06/06/2016 TOTAL DEPTH 34 feet DEPTH COMPLETED 34 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0	CLAY		DARK GRAY	20-30
32.5	WEATHERED CLAYSTONE		DARK GRAY	

Remarks: ______

6. HOLE DIAM (in.)

HOLE DIAM (in.)	From (ft)	To (ft)
8.5	0	34

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	2.049	0	14

PERFORATED CASING: Screen Slot Size (in): 0.010

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC14	2.049	14	34

8. FILTER PACK:

Material Silica Sand
Size 10/20
Interval 12-34

9. PACKER PLACEMENT:

Type ______
Depth ______

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Cement			0-1	Poured
Medium			1-12	Poured

11. DISINFECTION: Type None Amt. Used None

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD ______

Static Level ____ ft. Date/Time measured: ______, Production Rate ______ gpm.

Pumping Level ____ ft. Date/Time measured ______, Test Length (hrs) ______.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name: GDI Drilling, Inc.

Phone w/area code: 719-574-4121

License Number:

Mailing Address: 1355 Valley Street, Colorado Springs, CO 80915

Sign (or enter name if filing online)

Print Name and Title: Dean Stedman - President

Date: 7-15-16

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

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RECEIVED
JUL 20 2016
WATER RESOURCES
STATE ENGINEER COLO.

1. WELL PERMIT NUMBER: MH-55590 302138

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Colorado Springs Utilities

MAILING ADDRESS: 121 South Tejon Street, P.O. Box 1103, Mail Code 940

CITY: Colorado Springs STATE: Colorado ZIP CODE: 80947

TELEPHONE NUMBER w/area code: (719) 668-4171

3. WELL LOCATION AS DRILLED: SW 1/4, SW 1/4, Sec., 31 Twp 16 ☐ N or S, ☒ Range 65 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 330 ft. from ☐ N or ☒ S section line and 65 ft. from ☐ E or ☒ W section line.

SUBDIVISION: ____, LOT ____, BLOCK ____, FILING (UNIT) ____

Owner's Well Designation: FC-3B

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Easting: ____

Northing: ____

STREET ADDRESS AT WELL LOCATION: 6598 Ray Nixon Road, Fountain, Colorado

4. GROUND SURFACE ELEVATION ____ feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 06/10/2016 TOTAL DEPTH 55 feet DEPTH COMPLETED 55 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0	CLAY		DARK GRAY	20-30
32.5	WEATHERED CLAYSTONE		DARK GRAY	
40	PIERRE SHALE		BLUISH GRAY	

Remarks: ____

6. HOLE DIAM (in.)

HOLE DIAM (in.)	From (ft)	To (ft)
8.5	0	55

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	2.049	0	45

PERFORATED CASING: Screen Slot Size (in): 0.010

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC14	2.049	45	55

8. FILTER PACK:

Material Colorado Silica
Size 10/20
Interval 43-55

9. PACKER PLACEMENT:

Type ____
Depth ____

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Cement			0-1	Poured
Medium			1-18	Poured
Time Re			18-43	Poured

11. DISINFECTION: Type None Amt. Used None

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD ____

Static Level ____ ft. Date/Time measured: ____, Production Rate ____ gpm.

Pumping Level ____ ft. Date/Time measured ____, Test Length (hrs) ____.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name: GDI Drilling, Inc.

Phone w/area code: 719-574-4121

License Number:

Mailing Address: 1355 Valley St. Colorado Springs, CO 80915

Sign (or enter name if filing online)

Print Name and Title: Dean Stedman - President

Date: 7-15-16

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

RECEIVED JUL 20 2016 WATER RESOURCES STATE ENGINEER COLO

1. WELL PERMIT NUMBER: MH-56389 302131

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Colorado Springs Utilities

MAILING ADDRESS: 121 South Tejon Street, P.O. Box 1103, Mail Code 940

CITY: Colorado Springs STATE: Colorado ZIP CODE: 80947

TELEPHONE NUMBER w/area code: (719) 668-4171

3. WELL LOCATION AS DRILLED: SW 1/4, SE 1/4, Sec., 31 Twp 16 ☐ N or S ☒ Range 65 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 890 ft. from ☐ N or ☒ S section line and 2,073 ft. from ☒ E or ☐ W section line.

SUBDIVISION: ______, LOT ____, BLOCK ____, FILING (UNIT) ____

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: SC-10

Easting: ______

Northing: ______

STREET ADDRESS AT WELL LOCATION: 6598 Ray Nixon Road, Fountain, Colorado

4. GROUND SURFACE ELEVATION ______ feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 06/09/2016 TOTAL DEPTH 35 feet DEPTH COMPLETED 35 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0	Clay		Brown	
13	Fat Clay		Dk Gray Brown	13-28.3
22	Clay		Dk Gray Brown	
23.6	Gravel w/ sand	f-c sand	Dk Gray Brown	
28.3	Weathered Claystone		Dk Gray Brown	
35	Weathered Shale		Gray	

Remarks: ______

6. HOLE DIAM (in.)

HOLE DIAM (in.)	From (ft)	To (ft)
8.5	0	35

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	2.049	0	15

PERFORATED CASING: Screen Slot Size (in): 0.010

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC14	2.049	15	35

8. FILTER PACK:

Material Colorado S
Size 10/20
Interval 13-35

9. PACKER PLACEMENT:

Type ______
Depth ______

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Cement			0-1	Poured
Medium			1-13	Poured

11. DISINFECTION: Type None Amt. Used None

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD ______

Static Level ____ ft. Date/Time measured: ______, Production Rate ______ gpm.

Pumping Level ____ ft. Date/Time measured ______, Test Length (hrs) ______.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name: GDI Drilling, Inc. Phone w/area code: 719-574-4121 License Number:

Mailing Address: 1355 Valley St. Colorado Springs CO 80915

Sign (or enter name if filing online) Print Name and Title Dean Stedman - President Date 7-15-16

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

RECEIVED JUL 20 2016 WATER RESOURCES STATE ENGINEER COLO.

1. WELL PERMIT NUMBER: ~~MH-55389~~ 302135

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Colorado Springs Utilities

MAILING ADDRESS: 121 South Tejon Street, P.O. Box 1103, Mail Code 940

CITY: Colorado Springs STATE: Colorado ZIP CODE: 80947

TELEPHONE NUMBER w/area code: (719) 668-4171

3. WELL LOCATION AS DRILLED: SW 1/4, SE 1/4, Sec., 31 Twp 16 ☐ N or S ☒ Range 65 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 280 ft. from ☐ N or ☒ S section line and 2,051 ft. from ☒ E or ☒ W section line.

SUBDIVISION: ____, LOT ____, BLOCK ____, FILING (UNIT) ____

Owner's Well Designation: SC-12

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13 Easting: ____ Northing: ____

STREET ADDRESS AT WELL LOCATION: 6598 Ray Nixon Road, Fountain, Colorado

4. GROUND SURFACE ELEVATION ____ feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 06/07/2016 TOTAL DEPTH 25 feet DEPTH COMPLETED 25 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0	Clay		Brown	
5	Fat Clay		Dk Yellow Brown	
15	Clay		Brown	15-21.6
21	Sand w/Clay&Gravel	c. gravel	Brown	
21.6	Clay with Gravel		Brown	
22.5	Claystone		Dk Gray	
25	Shale		Blue	

Remarks: ____

6. HOLE DIAM (in.)

HOLE DIAM (in.)	From (ft)	To (ft)
8.5	0	25

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	2.049	0	5

PERFORATED CASING: Screen Slot Size (in): 0.010

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC14	2.049	5	25

8. FILTER PACK: Material Colorado S; Size 10/20; Interval 4-25

9. PACKER PLACEMENT: Type ____ Depth ____

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Cement			0-1	Poured
Medium			1-4	Poured

11. DISINFECTION: Type None Amt. Used None

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD ____

Static Level ____ ft. Date/Time measured: ____, Production Rate ____ gpm.

Pumping Level ____ ft. Date/Time measured ____, Test Length (hrs) ____.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name: GDI Drilling, Inc. Phone w/area code: 719-574-4121 License Number:

Mailing Address: 1355 Valley St. Colorado Springs, CO 80915

Sign (or enter name if filing online) Print Name and Title Dean Stedman - President Date 7-15-16

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

RECEIVED JUL 20 2016 WATER RESOURCES STATE ENGINEER COLO.

1. WELL PERMIT NUMBER: 302134

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Colorado Springs Utilities

MAILING ADDRESS: 121 South Tejon Street, P.O. Box 1103, Mail Code 940

CITY: Colorado Springs STATE: Colorado ZIP CODE: 80947

TELEPHONE NUMBER w/area code: (719) 668-4171

3. WELL LOCATION AS DRILLED: NW 1/4, NE 1/4, Sec., 6 Twp 17 ☐ N or S ☒ Range 65 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 100 ft. from ☒ N or ☐ S section line and 2,063 ft. from ☒ E or ☐ W section line.

SUBDIVISION: ______, LOT ____, BLOCK ____, FILING (UNIT) ____

Owner's Well Designation: SC-13

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13 Easting: ______ Northing: ______

STREET ADDRESS AT WELL LOCATION: 6598 Ray Nixon Road, Fountain, Colorado

4. GROUND SURFACE ELEVATION ______ feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 06/07/2016 TOTAL DEPTH 22.5 feet DEPTH COMPLETED 22.5 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0	Clay		Brown	
5	Fat Clay		Brown	
10.7	Clay		Brown	10.7-22.4
18	Gravel w/Clay&Sand	f-c sand	Brown	
22.4	Weathered Claystone		Dk Brown	

Remarks: ______

6. HOLE DIAM (in.)

HOLE DIAM (in.)	From (ft)	To (ft)
8.5	0	22.5

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	2.049	0	5

PERFORATED CASING: Screen Slot Size (in): 0.010

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC14	2.049	5	22.5

8. FILTER PACK:
Material Colorado 8
Size 10/20
Interval 4-22.5

9. PACKER PLACEMENT:
Type ______
Depth ______

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Cement			0-1	Poured
Medium			1-4	Poured

11. DISINFECTION: Type None Amt. Used None

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD ______

Static Level ____ ft. Date/Time measured: ______, Production Rate ____ gpm.

Pumping Level ____ ft. Date/Time measured ______, Test Length (hrs) ____.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name: GDT Drilling, Inc Phone w/area code: 719-574-4121 License Number:

Mailing Address: 1355 Valley St. Colorado Springs, Co 80915

Sign (or enter name if filing online) Print Name and Title Dean Stedman - President Date 7-15-16

Form No. GWS-31 02/2017	**WELL CONSTRUCTION AND YIELD ESTIMATE REPORT** State of Colorado, Office of the State Engineer 1313 Sherman St., Room 821, Denver, CO 80203 303.866.3581 www.water.state.co.us and dwrpermitsonline@state.co.us	For Office Use Only

1. Well Permit Number: ~~MH-63892~~ - 329915 **Receipt Number:** 10026912

2. Owner's Well Designation: SC-15

3. Well Owner Name: Colorado Springs Utilities - Env. Services; Mail Code 0940

4. Well Location Street Address: 6598 Ray Nixon Road, Fountain, CO 80817

5. As Built GPS Well Location (required): ☐ Zone 12 ☒ Zone 13 Easting: 525003.6 Northing: 4273848.79

6. Legal Well Location: NE 1/4, SW 1/4, Sec., 31 Twp. 16 ☐ N or S ☒, Range 65 ☐ E or W ☒, 6 P.M.

County: El Paso

Subdivision: ____, Lot ____, Block ____, Filing (Unit) ____

7. Ground Surface Elevation: 5480.75 feet **Date Completed:** 11/21/2022 **Drilling Method:** Hollow Stem Auger

8. Completed Aquifer Name : Alluvial **Total Depth:** 35.3 feet **Depth Completed:** 35.3 feet

9. Advance Notification: Was Notification Required Prior to Construction? ☒ Yes ☐ No, Date Notification Given: 11/17/2022

10. Aquifer Type: (Check one) ☐ Type I (One Confining Layer) ☐ Type I (Multiple Confining Layers) ☐ Laramie-Fox Hills ☐ Type II (Not overlain by Type III) ☐ Type II (Overlain by Type III) ☒ Type III (alluvial/colluvial)

11. Geologic Log:

Depth	Type	Grain Size	Color	Water Loc.
0 - 5	lean clay	clay	light tan	dry
5 - 10	lean clay	clay	med. brown	moist
10 - 15	silty clay	clay	med. brown	moist
15 - 20	clay	clay	brown	moist
20 - 25	clay	clay	dark brown	moist
25 - 30	clay	clay	brown	moist
30 - 35	clay, shale	clay	brown	moist
35 - 35.3	shale	clay	brown	moist

Remarks:

12. Hole Diameter (in.)

Hole Diameter (in.)	From (ft)	To (ft)
8"	0	35.3

13. Plain Casing

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	0	20

Perforated Casing Screen Slot Size (in): 0.010

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2	PVC	0.154	20	35

14. Filter Pack:

Material Washed Silica Sand

Size 10/20

Interval 18-35

15. Packer Placement:

Type ____

Depth ____

16. Grouting Record

Material	Amount	Density	Interval	Method
Concrete			0 - 2	
Bentonite			2 - 18	

17. Disinfection: Type Amt. Used

18. Well Yield Estimate Data: ☐ Check box if Test Data is submitted on Form Number GWS-39, Well Yield Test Report

Well Yield Estimate Method: ____

Static Level: 25.98 Estimated Yield (gpm) ____

Date/Time measured: ____ Estimate Length (hrs) ____

Remarks:

19. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402 2. The filing of a document that contains false statements is a violation of section 37 91 108(1)(e), C.R.S., and is punishable by fines up to $1,000 and/or revocation of the contracting license. If filing online the State Engineer considers the entry of the licensed contractor's name to be compliance with Rule 17.4.

Company Name:	Email:	Phone w/area code:	License Number:
GDI Drilling Inc	bstedmangdi@Gmail.com	719-440-3375	

Mailing Address:

Sign (or enter name if filing online)	Print Name and Title	Date:
[signature]	Dean Stedman President	3-26-23

Form No. GWS-31 02/2017	**WELL CONSTRUCTION AND YIELD ESTIMATE REPORT** State of Colorado, Office of the State Engineer 1313 Sherman St., Room 821, Denver, CO 80203 303.866.3581 dwr.colorado.gov and dwrpermitsonline@state.co.us	For Office Use Only

1. Well Permit Number: 333132 Receipt Number: ~~04000296~~ 10033056
2. Owner's Well Designation: SC-18
3. Well Owner Name: Colorado Springs Utilities - Env. Services; Mail Code 0940
4. Well Location Street Address: 6598 Ray Nixon Road, Fountain, CO 80817
5. As Built GPS Well Location (required): ☐ Zone 12 ☒ Zone 13 Easting: 524841.7 Northing: 4273607.4
6. Legal Well Location: NW 1/4, SW 1/4, Sec., 31 Twp. 16.0 ☐ N or S ☒, Range 65 ☐ E or W ☒, Sixth P.M.
County: El Paso
Subdivision: ______, Lot ____, Block ______, Filing (Unit) ______
7. Ground Surface Elevation: 5465.86 feet Date Completed: 09/14/2023 Drilling Method: Hollow Stem Auger
8. Completed Aquifer Name: Unnamed Alluvial Total Depth: 30.4 feet Depth Completed: 30.4 feet
9. Advance Notification: Was Notification Required Prior to Construction? ☒ Yes ☐ No, Date Notification Given: ______
10. Aquifer Type: (Check one) ☐ Type I (One Confining Layer) ☐ Type I (Multiple Confining Layers) ☐ Laramie-Fox Hills ☐ Type II (Not overlain by Type III) ☐ Type II (Overlain by Type III) ☒ Type III (alluvial/colluvial)

11. Geologic Log:

Depth	Type	Grain Size	Color	Water Loc.
0-4	clay & silt	clay - silt	brown	N/A
4-5	clay & silt	clay - silt	white	N/A
5-9	clay & silt	clay - silt	brown	N/A
9-10	clay, silt, sand	clay - sand	tan, brown	N/A
10-15	clay	clay	brown	14.5
15-16	sandy clay	clay -sand	brown	N/A
16-19	clay	clay	brown	N/A
19-20	silty clay	clay - silt	brown	N/A
20-23	sand	sand	brown	N/A
23-24	sandy gravel	clay - gravel	brown	N/A
25-30	shale/claystone	clay	brown	N/A

Remarks:

12. Hole Diameter (in.)

Hole Diameter (in.)	From (ft)	To (ft)
8.25	0	30.4

13. Plain Casing

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	0	15

Perforated Casing Screen Slot Size (in): 0.010

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	15	30

14. Filter Pack:
Material Washed Silica Sand
Size 10/20
Interval 13-30

15. Packer Placement:
Type ______
Depth ______

16. Grouting Record

Material	Amount	Density	Interval	Method
Portland			0-1	
Bentonite			1-13	

17. Disinfection: Type Amt. Used
18. Well Yield Estimate Data: ☐ Check box if Test Data is submitted on Form Number GWS-39, Well Yield Test Report
Well Yield Estimate Method: ______
Static Level: 10.37 Estimated Yield (gpm) ______
Date/Time measured: ______ Estimate Length (hrs) ______
Remarks:

19. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402 2. The filing of a document that contains false statements is a violation of section 37 91 108(1)(e), C.R.S., and is punishable by fines up to $1,000 and/or revocation of the contracting license. If filing online the State Engineer considers the entry of the licensed contractor's name to be compliance with Rule 17.4.

Company Name: GDI Drilling	Email: DasStedman@Gmail.com	Phone w/area code: 1-719-574-4121	License Number:

Mailing Address: 1355 Valley St Colorado Springs, CO 80915

Sign (or enter name if filing online)	Print Name and Title	Date:
[signature]	Dean Stedman	11-7-23

Form No. GWS-31 02/2017	**WELL CONSTRUCTION AND YIELD ESTIMATE REPORT** State of Colorado, Office of the State Engineer 1313 Sherman St., Room 821, Denver, CO 80203 303.866.3581 dwr.colorado.gov and dwrpermitsonline@state.co.us	For Office Use Only

1. Well Permit Number: 333133 **Receipt Number:** ~~04000296~~ 10033057

2. Owner's Well Designation: SC-19

3. Well Owner Name: Colorado Springs Utilities - Env. Services; Mail Code 0940

4. Well Location Street Address: 6598 Ray Nixon Road, Fountain, CO 80817

5. As Built GPS Well Location (required): ☐ Zone 12 ☒ Zone 13 Easting: 524826.5 Northing: 4273649.6

6. Legal Well Location: NW 1/4, SW 1/4, Sec., 31 Twp. 16.0 ☐ N or S ☒, Range 65 ☐ E or W ☒, Sixth P.M.

County: El Paso

Subdivision: ______, Lot ____, Block ____, Filing (Unit) ____

7. Ground Surface Elevation: 5465.86 feet **Date Completed:** 09/13/2023 **Drilling Method:** Hollow Stem Auger

8. Completed Aquifer Name : Unnamed Alluvial **Total Depth:** 27.4 feet **Depth Completed:** 27.4 feet

9. Advance Notification: Was Notification Required Prior to Construction? ☒ Yes ☐ No, Date Notification Given: ______

10. Aquifer Type: (Check one) ☐ Type I (One Confining Layer) ☐ Type I (Multiple Confining Layers) ☐ Laramie-Fox Hills ☐ Type II (Not overlain by Type III) ☐ Type II (Overlain by Type III) ☒ Type III (alluvial/colluvial)

11. Geologic Log:

Depth	Type	Grain Size	Color	Water Loc.
0-1	topsoil	clay - sand	brown	N/A
1-5	clay	clay	brown	N/A
5-10	clay	clay	brown, tan	N/A
10-13	clay	clay - sand	brown	N/A
13-18	clay	clay	brown	N/A
18	sandy gravel	clay -gravel	brown	N/A
18-20	clay	clay	gray, tan	N/A
20-25	shale	clay	tan, gray	N/A

Remarks:

12. Hole Diameter (in.)

Hole Diameter (in.)	From (ft)	To (ft)
8.25	0	27.4

13. Plain Casing

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	0	10

Perforated Casing Screen Slot Size (in): 0.010

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	10	25

14. Filter Pack:
Material Washed Silica Sand
Size 10/20
Interval 8-25

15. Packer Placement:
Type ______
Depth ______

16. Grouting Record

Material	Amount	Density	Interval	Method
Portland			0-1	
Bentonite			1-8	

17. Disinfection: Type Amt. Used

18. Well Yield Estimate Data: ☐ Check box if Test Data is submitted on Form Number GWS-39, Well Yield Test Report

Well Yield Estimate Method: ______

Static Level: 10.93 Estimated Yield (gpm) ______

Date/Time measured: ______ Estimate Length (hrs) ______

Remarks:

19. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402 2. The filing of a document that contains false statements is a violation of section 37 91 108(1)(e), C.R.S., and is punishable by fines up to $1,000 and/or revocation of the contracting license. If filing online the State Engineer considers the entry of the licensed contractor's name to be compliance with Rule 17.4.

Company Name:	Email:	Phone w/area code:	License Number:
GDT Drilling	D255tedman@Gmail.com	719-574-4121	

Mailing Address: 1355 Valley St Colorado Springs, CO 80915

Sign (or enter name if filing online)	Print Name and Title	Date:
[signature]	Dean Stedman	11-7-23

Attachment 3 Standard Operating Procedures

TABLE OF CONTENTS

1.0 PURPOSE

Colorado Springs Utilities (Utilities) has developed this Standard Operating Procedure (SOP) for the aid and guidance of the collection of physical and chemical data associated with groundwater monitoring. This plan serves as a guide for personnel who are involved in groundwater monitoring and sampling activities. This SOP provides details to procedures and Quality Assurance/Quality Control (QA/QC) practices associated with field measurements, sample collection, handling, and processing.

2.0 SAFETY AND HEALTH CONSIDERATIONS

The collection of water-quality data in the field can potentially be hazardous at times, the safety of field personnel is the primary concern while sampling. Field personnel often work in remote areas and under harsh environmental conditions. While sampling, field personnel may also encounter waterborne and airborne chemicals and pathogens when sampling or processing samples; and must practice safe sampling. Preparation and forethought should be used by field personnel when planning sampling activities. At a minimum, field personnel should include considerations for the following hazards:

- Potential Surficial Soil, Groundwater, and Surface Water Contaminants of Concern
- Poisonous / Dangerous Animals and Insects– Rattlesnakes, Black Widow Spiders, Ticks
- Driving Hazards (Varied & Densely Vegetated Terrain, Mud and Slick Conditions, Winter Driving)
- Lifting Hazards
- Slip / Trip / Fall Hazards
- Heat / Cold Stress
- High Wildfire Potential
- Lightning
- Poor Cell Reception
- Rapid Change in Weather

3.0 FILE DOCUMENTATION

Site and project-specific sampling procedures should be documented in a separate written Sampling Plan as outlined below. This SOP will apply to Utilities' written Sampling Plans for groundwater monitoring. Where in conflict, site specific Sampling Plans take precedence to this SOP.

Sampling personnel should take accurate notes and ensure sample bottles are labeled and handled appropriately for the intended analysis. Field personnel are responsible for ensuring that sampling documentation requirements are implemented, and written documentation remains legible.

3.1 FIELD SHEETS

Field Sheets contain the following as appropriate:

- Well identification and date of visit
- Sampling party
- Sampling time
- Purging times
- Volumes purged
- Sampling equipment used
- Flow rate
- Field measurements
- Sample appearance (e.g. color, odor)
- Site inspection notes
- QA/QC notes (Duplicate/Blank collection at site)
- Calculations
- Sample preservation notes
- Weather and site conditions
- Sample/well related observations

View Appendix A for example of a field sheet typically used by Utilities. Field Sheets should be completed before leaving each well, along with documenting sampling circumstances and deviation from this SOP or the sampling plan. Good documentation practices of legibility and transparency should be followed. Well identification and dates should be written on supplemental documentation needed related to the field sheet. Project personnel are responsible for accuracy and completeness of field data on the field sheets. To avoid recording or calculation errors, field data is checked upon sample completion. Handwritten documentation on a field sheet should be performed in pen or pencil, markers and felt-tipped pens should not be used.

3.2 CHAIN-OF-CUSTODY (COC) DOCUMENTS

A COC is used to provide necessary documentation to trace sample possession from time of collection to laboratory analysis. A sample is in custody if it is in physical possession of a person or in a secured area that is restricted to authorized personnel. Each exchange of a sample between people or places that involves a transfer of custody should be recorded on appropriate forms that document the release and acceptance of the sample. A COC accompanies samples collected by Utilities.

Should corrections be made to the COC, the original writing must be crossed out with a single line then initialed and dated. Ensure handwritten language is legible and not easily misinterpreted. Handwriting should be done in pen. Samples are kept in secured locations and accessible only to authorized personnel. Field personnel ensure the COC is completed in full prior to signing the samples for release. When using Utilities' analytical laboratory, field values are reported on the COC. The final/last set of purge values collected should be reported on Utilities COC. (i.e. the values considered to be the most representative of the samples collected).

3.3 SAMPLING PLAN

The Sampling Plan consists of one or more separate documents that detail site-specific protocols for sampling and analysis procedures unique to each program or project. The Sampling Plan provides additional details and instructions for field personnel to perform procedures and techniques and operate equipment that will produce quality data that is representative of each site. Each Sampling Plan generally has site/project-specific protocols developed to document specific project sampling and analysis procedures and requirements, such as sampling frequency, parameter selection, and hydrologic conditions specific to each site. The procedures in the Sampling Plan are intended to complement this SOP for groundwater monitoring and sampling activities but take precedence to the SOP for details specific to the program or project needs.

4.0 SAMPLING AND PURGING EQUIPMENT

There is no single sampling method that will work best for all wells. Factors that must be considered to determine the best method include but are not limited to: the portability of equipment, depth to water, well diameter, well volume, ease of cleaning equipment, reliability of the sampling equipment, method by which sample devices bring water to the surface, and the response and recovery time of the well itself. Specifics of equipment and protocols should be outlined in the project-specific Sampling Plan.

4.1 FIELD MEASUREMENTS

Field measurements should represent, as closely as possible, the existing conditions at the time of sampling. To ensure accuracy of the measurements, calibration or calibration verifications within the range of expected field conditions for each site should be completed daily prior to sampling. Instruments used by field personnel for measurements should be properly operated, maintained, and calibrated. For proper operation of field equipment, the manufacturer ‘s operating guidelines should be followed. The field instruments should be calibrated prior to making sample measurements. A multi parameter meter (e.g. YSI ProDSS or similar) and a portable turbidity meter is used for most field-collected parameters. See Sampling Plan for program specifications on field measurements required.

Indicator parameters: Indicate well stabilization during purging and will provide general water quality chemistry. Indicator parameters in groundwater can additionally help determine water irregularities. Indicator parameters include specific conductance, pH, dissolved oxygen, and others.

Operational parameters: Indicate the physical properties of groundwater and can describe environmental variability or physical processes during sampling that can compromise the integrity of the sample. Physical properties can be a point of indication that groundwater samples and implemented strategies are impacting sample integrity (e.g. flow rate too high, pump heating up the water temperature, well construction material still present, etc). Alteration of physical properties can impact the chemical properties.

Good operating conditions should be maintained for meters: routinely cleaned and repaired, and dirty or corroded connections, cells, probes, or sensors should be replaced. The meters should be stored and transported carefully in their designated cases to minimize damage and ensure storage in a controlled environment overnight.

The following parameters can be measured in the field to evaluate well stabilization during purging and provide information on general groundwater monitoring and sampling.

4.1.1 Water Temperature - Operational Parameter – physical property - Temperature is important for the determination of pH, dissolved oxygen (DO), and the interpretation of various other parameters, as these parameters are temperature dependent. Stabilized temperature readings (reference *Stabilization Criteria* table in section 5.5 for parameter specific stabilization used) that are representative of typical groundwater conditions help demonstrate that the sample was collected in a manner that minimized exposure to large temperature variations, such as heating from the electric motor of a submersible pump. Raising the temperature of a sample can result in loss of Volatile

Organic Compounds (VOCs) or the progression of chemical reactions that may alter the sample quality in an adverse manner.

4.1.2 Specific Conductance - Indicator Parameter – chemical property – Specific Conductance measures the ability of water to conduct an electric current. This value is relative to the collective concentration of ions in solution. For most circumstances, a stable specific conductance reading has been demonstrated to be a reliable indicator of the chemical stabilization of purge water.

4.1.3 pH - Indicator Parameter – chemical property- pH is often dependent on local geology. While pH has commonly been used as a purge water stabilization indicator, it is less sensitive than specific conductance or oxidation-reduction potential (ORP) in distinguishing stagnant casing water from formation water. pH measurements are important for the interpretation of groundwater quality, as pH indicates the relative solubility of metals.

4.1.4 Oxidation-Reduction Potential (ORP) - Indicator Parameter – chemical property – ORP measures the oxidizing or reducing potential of a water sample. A high ORP identifies higher level of oxygen present in the water.

4.1.5 Dissolved Oxygen (DO) - Indicator Parameter – chemical property - DO has been demonstrated to be a reliable indicator of the chemical stabilization of purge water under most groundwater purging and sampling circumstances. To account for local barometric pressure and elevations, DO should be calibrated on site just prior to sampling, rather than in a controlled environment, such as the laboratory. On-site calibration ensures the barometric pressure at the time and at the site is being used for calibration, as this can change drastically between times and locations.

4.1.6 Turbidity - Operational Parameter – physical property – Turbidity is the visible presence of suspended mineral and organic particles in a groundwater sample. Uncharacteristically high or erratic measurements may indicate inadequate well development, construction, or improper sampling procedures, such as purging at an excessive rate that exceeds the well yield or redox reactions occurring/changing oxidation state. Calibration and calibration checks are performed in a controlled environment, such as the laboratory, whenever possible.

Purging and sampling in a manner that does not artificially increase turbidity is specifically important when analyzing for total metals, which may exhibit artificially elevated concentrations in high-turbidity samples. When able, stabilization of turbidity readings is at or below 10 nephelometric turbidity units (NTUs). It is recognized that some groundwater zones may have natural turbidity higher than 10 NTUs. When turbidity is being used as a stabilization parameter, it is necessary to evaluate the stabilization criteria on a site-by-site basis, which is specified in the project Sampling Plan as necessary. Field personnel should monitor for conditions that may cause artifactual turbidity – artificial aeration, significant disturbance of the water column, or excessive stress placed on the formation by over-pumping.

4.1.7 Water Level - Operational Parameter – physical property – A groundwater electric water level tape should be used in the field for water level data collection. Water levels are collected at the start of each sample set, prior to purging or sample collection. The collection of a water level is needed to calculate the volume of water contained within the well to determine purging volumes, in addition to providing continuous hydrogeologic information with each set of purge values.

When collecting a water level, care should be taken to prevent complete submersion of the tape and disturbance of the water surface in the casing should be minimal. Total depth for sampling calculations is known prior to sampling but can additionally be verified after sampling efforts are complete to minimize resuspension of settled solids within the formation. To ensure sample integrity and prevent cross-contamination, the water level tape should be properly decontaminated after use in each well.

4.2 PUMPS

Bladder pumps and suction lift pumps are the types primarily used for sample collection by Utilities. Most sampling efforts are performed using pumps capable of performing low-flow sampling methods.

4.2.1 Bladder Pump - Bladder pumps are recommended for low-flow purging and sampling. Whenever possible, the pump is dedicated to the well. Use of a dedicated pump eliminates the need to transport and decontaminate a pump, thereby reducing the potential for cross-contamination as well as saving time and reducing project cost. Low-flow rates can be readily controlled with use of a bladder pump.

4.2.2 Suction Lift - Peristaltic is the most common suction lift pump Utilities uses. Flow rates are typically easily controlled, providing adequate rates for sampling. Visual signs of significant bubble formation in the sample tubing help determine whether off-gassing is occurring due to the use of the peristaltic pump. Off-gassing (methane, carbon dioxide, etc.) can cause VOCs to move out of solution and into the entrained bubbles, causing unrepresentative low results. Dissolved VOCs exposed to lower atmospheric pressure of peristaltic pumps can also degas, biasing results low. When VOC collection is necessary, care should be taken to prevent degassing of the samples. Off-gassing of carbon dioxide or other dissolved gasses can additionally alter the geochemical conditions (such as pH) of the water in the tubing, potentially chemically altering metals or other redox-sensitive parameters in the sample. If bubble formation in tubing is significant, sampling should be stopped, and field personnel should return with an alternative sampling method.

If no significant bubble formation is observed in the sample tubing, use of the peristaltic pumps is appropriate. Use of a peristaltic pump is restricted to shallow applications and generally not used in wells with a water depth or screened interval greater than 25 feet (ft).

4.2.3 Dedicated Tubing - Use of new or dedicated tubing at each sampling location should be practiced to prevents cross-contamination that could occur from reuse. Routine observation of tubing integrity should be made. If a well does not have dedicated tubing, new tubing should be used for each sample.

4.3 BAILERS

Bailers are not commonly used for sampling but are available for field personnel if necessary. Bailers are considered a ‘grab’ type sampler which is ill-suited for low-flow sampling. Field personnel should be aware that use of a bailer tends to introduce bias due to operator variability. Rapid addition or withdrawal of a bailer can cause surging within the well that may cause increased turbidity, loss of volatiles, aeration, degassing of samples, and affects the level of development of the well.

Personnel sampling with bailers should be experienced in the sampling method since the results are highly dependent on the skill, care, and consistency of the operator. A bailer should be lowered and raised slowly within the casing and water column to minimize sample agitation associated with degassing, aeration, and turbidity, and to the extent possible, avoid hitting the sides of the well.

Section *5.4.2 Bailer Purging* and the Sampling Plan will further describe use of a bailer for purging a well.

5.0 SAMPLE COLLECTION AND PROCEDURE

Various procedures should be followed to maintain quality and integrity of the data and samples collected in the field.

5.1 FIELD PROCEDURES

Disposable powderless nitrile gloves are used when processing and collecting samples by field personnel. Gloves are changed often with each change in activity, or in the event of potential glove contamination. If preferred, field personnel can use the glove layering technique (wearing multiple layers of gloves and stripping off the outer glove if it gets contaminated) when needing to utilize quick glove changes between tasks to maintain quality and integrity of the samples.

Field personnel and sampling programs consider the following as expected field procedures:

- An appropriately clean sample collection surface
- Inclusion of QA/QC samples described in the Sampling Plan
- Use of a calibrated field meter for field measurements
- Field sheet completion while on site, at the well
- Detailed purge log containing entries of volumes purged, times, and flow rates
- Observations concerning water quality, weather conditions or other observations that may be of importance to note

Clean and ready-to-use equipment and bottles are on hand for sampling events. Utilities Analytical Laboratory provides clean, ready-to-use bottles for sampling. Translucent or nearly translucent tubing is used during sampling for bubble entrapment observations and troubleshooting. Sample discharge tubing is kept at as short of a length as field conditions allow, to minimize exposure to ambient air temperatures.

5.2 FIELD CONDITIONS

Weather and site-specific conditions that could influence sample representativeness are documented on the field sheet. The approximate ambient air temperature, precipitation, wind and other field conditions are additionally noted on the field sheet. Site-specific conditions or situations that could potentially alter the groundwater samples or water level measurements are recorded. Notes can include but should not be limited to excavation or construction activities occurring near sampling activities, spills, noticeable presence of smoke, vapors, dust, or air contaminants from anthropogenic activities. Field personnel should be responsive to site conditions and park vehicles where sample contamination from vehicle emissions will not be an issue. Additional considerations and preparations should be made for possible rapid weather changes. For example, an umbrella, large bags, or tarps to protect equipment from the elements should be readily available if needed.

5.2.1 Well Inspection - Upon arrival, field personnel should check well identification number and compare with the Sampling Plan. Field personnel then should inspect the well's protective casing, cap, and lock carefully, and document whether damaged or if tampering has occurred. Cracks in the casing and/or surface concrete seal should be noted, as well as soil washouts and depressions around the casing.

The well inspection may include the assessment of vegetation and growth or accumulation of debris (tumble weeds or branches) in the area. Growth or debris observed that may interfere with the sampling should be removed or cut down before measurements are collected or the well is opened, and plug /cap is removed. Additional clearing may be necessary to avoid potential cross-contamination and to ensure equipment staged is not impacted by surrounding vegetation or debris that could come in contact with sample water or equipment. Tarps or large bags should be used to create a quick clean surface to store or stage equipment on where necessary.

5.3 WATER LEVEL COLLECTION AND CALCULATIONS

Static water level in the well should be measured prior to purging or sampling. Field personnel should ensure the water level tape has been properly decontaminated before use in each well to maintain sample integrity.

5.3.1 Water Levels - Water Levels should be collected at the start of each sample set, prior to, during, and following purging or sample collection. If a post-sample water level is needed it will be stated in the sample plan. Water level elevation is measured from the marked measuring point (MP) or north most point of the well's inner casing if no mark is present. Water levels are reported below measuring point and are reported to the nearest 0.01 ft. The water level measurement is repeated until accuracy between each reading is within 0.02 ft.

A well that has a water column of less than 1.00 ft will not be sampled due to insufficient water volumes. Wells that do not have enough water for sample collection will still have a water level recorded. Currently, if the well is dry, a total depth is collected with a comment to indicate the well was dry.

5.3.1.1 When water level cannot be obtained – Occasionally, the water level in a well cannot be obtained when the top of the pump is encountered before the water surface – i.e. the water level is below the top of the dedicated pump. Most well casings (2-inch diameter) do not allow enough room for both a pump and an electric water level tape probe to fit side-by-side.

When this occurs, to prevent disturbance of the water column, the pump should ***not*** be pulled prior to sampling. A note should be made on the field sheet that a water level could not be collected due to water level being below the top of pump. A separate field visit may be necessary following the sampling event to collect a water level where necessary. Project Sampling Plans have program-specific guidance. If this is a recurring issue and not due to seasonal hydrology, a remedy may need to be sought. If the water column and well casing allow, the pump can be lowered. If there is not sufficient room, a replacement pump can be considered.

5.3.2 Well Total Depth - Total depth measurements should be taken periodically. Total depth measurements in wells with dedicated pumps should not be collected prior to sampling events but rather whenever the pump is removed for maintenance or at the end of sample collection. This is to prevent disturbances to the water column and stirring up of sediments that could result in biased sampling results. If siltation is suspected to be a problem (e.g., noted increase in sample turbidity, or decrease in pump efficiency), additional maintenance can be planned, and the pump should be removed and the total well depth then checked. Depth measurements to the nearest 0.01 ft should be collected.

When collecting total depth values, care should be taken to avoid disturbing accumulated sediments, thus increasing turbidity of the water column. The water level tape is lowered into the water column smoothly and at a controlled rate.

5.3.3 Volume of Water Calculation

Calculating the volume of water in a well is important to ensure accurate water quality analysis.

$$V(gal) = 0.0408\, HD^2$$

Where:
V = Volume of water in well in gallons
H= height of water column in feet
D= inside diameter of well in inches

For wells that have a ***2 inch inside diameter***, calculation can be further simplified to:

$$\boldsymbol{V = 0.163\, H}$$

5.4 PURGING PROCEDURES

Well samples should only be collected after one of the following conditions are met:

- stagnant water in the well casing has been sufficiently removed (predetermined number of well volumes)
- groundwater monitoring and sampling parameter stabilization has been obtained through low-flow/low stress sampling
- stabilization of Sampling Plan indicated water quality field parameters has been achieved

Low-flow/low stress and parameter stabilization is utilized most frequently for Utilities' groundwater sampling activities. Well purging for stabilization under low-flow conditions is preferably completed with minimal drawdown and mixing of formation water with the stagnant water above the screened interval. Flow should be constant and uninterrupted while purging and sampling, do not halt or suddenly change the flow rate during the final phase of purging or while sampling.

5.4.1 Low-flow Purging - Low-flow purging refers to water that enters a pump intake with a low velocity. The intention of a low-flow purging method is to minimize the drawdown of the water column within the well while drawing fresh water through the screened interval, and avoiding disturbance of the stagnant water that remains above the well screened zone. Low-flow purging rates should be dependent on the well's rate of recovery; purging should cause little to no change in water level once stable. This method is based on the principle of low impact, low-stress purging, where the water within the screened zone passes through continuously and does not mix with water above the screened interval. When drawdown and indicator parameters have stabilized, water in the screened zone can be considered representative of water within the formation. When this objective is met, purging of multiple well volumes is not necessary. Flow rates for low-flow purging target a range of (0.1-0.5 L/min) 100-500 mL/min or 0.026-0.132 gal/min. Utilities has a focused target zone 100-200 mL/min or 0.026-0.053 gal/min. Pumping rates can be used to minimize changes to ambient flow conditions while preserving the quality of formation water entering the well.

Low-flow purging key elements:

- Use a flow rate of <500 mL/Min (<0.132 gal/min)
- Maintain minimal drawdown in well
- Minimize water column disturbance during water level measurement and device positioning when dedicated pump is not available
- Make adjustments to stabilize flow rate as soon as possible
- Monitor water quality parameters during purging

5.4.2 Bailer Purging - A single check valve bailer is used at a depth that collects water just below the water surface. When low-flow sampling is not performed and the standard 3 well casing purge volume is required, a bailer can be used. Care should still be taken when lowering and raising the bailer to disturb the water column as little as possible.

When calculating 3 well casing purge volumes, use *Volume of Water Calculation in section 5.3.3* and multiple it by 3. This will calculate the total amount of water that needs to be purged prior to sampling under the standard 3 well casing volume method (not a low-flow method).

For example, three well casing volumes for a well with a 2-inch diameter can be calculated as follows:

$$V = (0.0408\, H\, (2)^2) \times 3$$
$$\boldsymbol{V = (0.163\, H) \times 3}$$

Low recovery wells, or wells that go dry during purging activities, may require alternative sampling procedures. Purging a low recovery well with a bailer can be done when proper care is taken and there are no other feasible options for field personnel to purge and collect a sample. When purging a low recovery well with a bailer, field values are typically limited by the quantity of field values collected. It may be necessary to use the first bailed column of water for field values, such that all remaining amounts of water can be collected for the analytical laboratory sample. The Sampling Plan should indicate further purging requirements for the program or well-specific procedures.

5.4.3 Purging to Dryness – In some circumstances, for slow recovery, low yield wells may purge to dryness. When purging to dryness is unavoidable, then samples should be taken when there is a sufficient amount of water to collect a sample that best represents the groundwater quality. A water column that is greater than a foot and has enough volume to fill sample bottles may be considered sufficient for sample collection. In the case of a well with very slow recovery, sample collection may occur 24 hours after initial purge if sufficient water is present (i.e. water column greater than a foot and volume enough to fill sample bottles), if well recovery does not occur within this time frame a sample may not be collected from the well. As per program-specific Sampling Plans, additional trips to a well can occur after 24 hours to monitor conditions for adequate sample volumes on a site-by-site basis. The intervening time should generally be consistent from event to event. Field values are collected during purging, if a well goes dry and recovers in less than 24 hours of sample collection, additional field reading are not necessary. If recovery time exceeds 24 hours an additional field reading may be collected prior to sample collection.

5.4.4 Disposal of Purge Water – Reference Sampling Plan for specifics of purge water disposal.

5.5 STABILIZATION CRITERIA

An operational and indicator parameter can be considered stable when at least three successive readings are within the stabilization criteria range. Stabilization is additionally based on water-level draw down and pumping rates. Having parameters stabilized according to the table below, prior to sample collection is ideal, but variation may be acceptable depending on the circumstance. When considering stabilization, project objectives should be considered on a site-by-site basis. Low yielding wells or wells with specific conditions may necessitate the need to collect a sample prior to parameter stabilization. In these cases, documentation will be added to field records and sampling may proceed. Additional consideration is made if a well is purged to dryness, as detailed in section *5.4.3 Purging to Dryness.*

STABILIZATION CRITERIA

Water Level (ft)	pH	Temperature (C°)	Conductance (ųS/cm)	* ORP (mV)	* DO (mg/L)	Turbidity (NTU)
± 0.1	± 0.2	± 3%	± 3%	± 10% ***or*** ± 10mV	± 10% ***or*** ± 0.2 mg/L	± 10% ***or*** < 10 NTU

Recommended Stabilization Criteria of Field Parameters over 3 successive measurements
** Whichever is greater*

5.6 SAMPLE PROCESSING

Once operational and indicator parameters have stabilized, sampling should begin. During sampling, the flow rate should not be changed. If utilizing an in-line flow-through cell, it should be disconnected or bypassed during sampling, ensuring no sample water sent for laboratory analysis passes through the cell.

Certain analyses, like volatile organics and radon, require vials that are to be filled leaving no head space, which keeps these analytes dissolved in the water, preventing them from escaping into the air. Other constituent analyses require samples to be collected in amber-colored bottles. Amber-colored bottles prevent the breaking down of light-sensitive analytes while in transit for analysis. Glass bottles generally should not receive any form of field rinse, as they often contain sample preservatives, or are baked/rinsed with preservatives during their preparation. Bottle types for each program should be outlined in the Sampling Plan.

Care should be taken to not over-fill sample bottles. Samples can often be biased high if a bottle is overfilled. Sample water should not be poured out to correct an over-filled bottle. If a sample bottle that had been pre-preserved was overfilled, the entire sample should be discarded and a new clean bottle used for sample collection. For bottles without preservative already added, the sample water could be discarded completely and then recollected if a spare bottle is not available.

5.6.1 Filtration - Each project-specific Sampling Plan determines if filtration is necessary. Filtration is required for a sample when it is needed to separate particulates and constituents from the water in solution. For Utilities' groundwater samples, in-line field filtration should be used to minimize the sample exposure to the atmosphere. Water for sample collection is generally pumped directly from the well through a 0.45 micron pore size disposable capsule filter. In the event field filtration cannot be completed, field personnel may request the analytical laboratory to filter sample water after arrival at the lab.

5.6.1.1 Bottle fill order - Field personnel should reference the site specific Sampling Plan for bottle fill order as it applies to program requirements and objectives. Some sampling plans have additional priority bottle orders when low yield is expected, or if the well is expected to go dry. Generally, the order of bottles filled should start with the most volatile to least volatile.

A general groundwater bottle fill order starts with samples for field parameters and then to light gases, such as volatile organics or methane, ethane and propane. Next, samples that do not require filtration or preservatives like metals, some inorganics and semi-volatile organics, followed by filtered samples such as dissolved metals. Finally, bacteria can be sampled. Before sampling for bacteria, ensure the spigot or discharge sample tubing has been disinfected.

5.6.2 Sample Preservation - Sample preservation is required for some constituent groups to prevent reduction or loss of target analytes and to stabilize analyte concentrations for a limited time. The following are typical sample preservation methods that may be utilized for Utilities groundwater monitoring and sampling activities.

5.6.2.1 Temperature - The most common type of preservation is temperature. Appropriate samples are chilled immediately after collection to 4 ± 2°C (without freezing), to minimize microbiological decomposition of solids. Low temperatures reduce the activity of microorganisms present in the sample, thereby reducing microbial transformations. Nutrients are especially prone to physicochemical effects such as calcium concentration, salinity, biological uptake, and various matrix considerations. Blue ice should be generally avoided due to its ability to maintain lower temperatures than standard ice. Use of blue ice increases the potential of freezing the sample water.

Freezing of a sample should be avoided for Utilities-required sampling. Freezing a sample can alter the composition of the water as ice crystals form, damaging biological structures and precipitating out dissolved substances resulting in inaccurate analysis of the sample. Additional consideration and preparation should be implemented if sampling in ambient temperatures over 90° F (32.3°C) to adequately chill samples in the field.

5.6.2.2 Bottle Preservation- Some bottles are preserved in the field, at the time of sampling. If the bottle contains a preservative, or the bottle is prefilled with an acid preservative by the lab, the bottle should not be rinsed or overfilled. Note, if the sample water in a pre-preserved bottle over-tops the bottle, that same bottle can no longer be used, and a new pre-preserved bottle should be used. It is recommended to bring and have available extra pre-preserved bottles in the field.

6.0 QUALITY CONTROL AND QUALITY ASSURANCE

Quality objectives are identified and integrated into all levels of groundwater monitoring and sampling activities. Consistency in data quality, traceability and transparency through documentation, and through application of appropriate techniques should be utilized.

6.1 FIELD QUALITY CONTROL

Field personnel should ensure the complete and timely completion of laboratory analytical samples. Field personnel are responsible for recording the necessary information and determining if analysis requirements are missing, then take corrective action(s) when needed. Field notes and field measurements should be reviewed for completeness and accuracy and scanned into their appropriate files by field personnel as soon as reasonably possible after returning from a field sampling event. This timely entry should generally not exceed seven days past the conclusion of the final sampling day.

Field personnel should obtain samples that are representative of the groundwater, ensuring purging and sampling equipment materials and manner of use will not alter the analysis. Field personnel should take steps to avoid cross-contamination, while observing proper preservation and handling of samples.

The Sampling Plan for each project provides program-specific field quality control procedures, such as the program- or project-required duplicate and blank samples to be collected. Blank samples collected in the field and duplicate samples collected should be processed in the same manner and under the same environmental conditions as the parent samples.

6.2 DECONTAMINATION

Care should be taken to avoid contamination during sampling and processing. Field personnel should recognize the two biggest contributors to sample contamination are (a) improperly cleaned equipment, and (b) atmospheric inputs, such as dirt and dust.

Field Decontamination
Field decontamination detergent solutions should be present during sampling events. Reusable equipment that comes in contact with sample water or other contaminants should be cleaned. The water level tape is decontaminated between each well with a premixed Liquinox® spray solution of approximately 0.1-2% (not to exceed 2% for field use). Other field equipment such as the flow through cell and tubing/fittings that are reused should follow field decontamination procedures as well. Decontamination practices should be performed while wearing clean, disposable gloves.

- Wash water level tape/equipment with 0.1-2% laboratory detergent solution (Liquinox®) spray, use of soft cloth or brush may be necessary.
- (Optional) rinse with tap water to remove detergent solution.
- Final rinse of the tape/equipment should be completed with deionized (DI) water to remove detergent solution or tap water residuals.

For wells that do not have dedicated pumps or if an issue arises with a dedicated pump and an alternative form of sampling is required, such as use of a spare pump, the following procedure should be followed.

Decontamination of submersible pumps - with tubing

- Use a pre-cleaned standpipe
- Place pump in cleaned standpipe (pre-clean/rinse pump with soft brush or cloth of excessive sediments prior if needed) and add detergent solution (0.1-2%) not to exceed 2%. Detergent solution level must remain above the pump intake while pump is on; standpipe should be full when starting the cleaning process.
- Pump detergent solution through pump and tubing, if sediments are not present, place discharge tube in standpipe to circulate detergent solution to increase cleaning efficiency for at least 3 full cycles (attached tubing to be cleaned included in the cycle).

- Pump detergent solution out of standpipe and equipment then rinse standpipe and pump with tap water. Do not recycle rinse water. Pump tap water through the pump and tubing until sudsing has stopped.
- Final rinse is with DI water. Pump DI through pump and tubing, ensuring tap water has been cycled out, up to 3 cycles may be necessary. To check, collect DI rinse water in small bottles and shake the bottles – if sudsing is observed in the rinse water, continue the rinse procedure until no suds appear.
- Place pump in clean storage bag and seal shut.

Decontamination of submersible bladder pumps - without tubing

- Disassemble main components of the pump to access bladder. Remove and discard bladder from pump.
- Clean components of the disassembled pump, with detergent solution spray and brush, removing sediments that may be present. Soak individual pieces as necessary in small bottle of solution.
- Rinse pump of detergent solution well with DI water. No suds should be remaining.
- Reassemble the pump with a new clean bladder – a final DI rinse may be necessary.
- Place pump in a clean storage bag and seal shut.

7.0 POST-SAMPLING

Ensure field equipment is decontaminated and stored properly according to manufacturing guidelines. Field documentation should be processed and appropriately handled as per program Sampling Plan. Analytical data, when available from the lab, should be verified against field sheets.

8.0 REFERENCES

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APPENDIX A

Field Sheet Example

Well ID: ____________ Well Key: ____________

Project: ____________ Bladder Pump Make: ____________

Sampler: ____________ Top of Pump below TOC (ft): ____________

Date: ____________ Pump Inlet below TOC (ft): ____________

Purge Start Time: ____________

Total Well Depth below TOC (ft.): ____________

Purge Stop Time: ____________

Was a DUP Collected: ____________

Depth to Water below TOC (ft.): ____________

Was a Blank Collected: ____________

Height of Water Column (ft): ____________

Field Filtered: ____________

Blank Location: ____________

1 Well Volume (gal)*: ____________

Purge Method: ____________

Blank Sample Time: ____________

*0.163 x HWC

Flow Rate (gpm): ____________

Level Drawdown (ft): ____________

rec. stabilization criteria		± 0.1	± 0.2	± 3%	± 3%	± 10% **or** ± 10 mV Whichever is greater	± 10% **or** ± 0.2 mg/L Whichever is greater	± 10% **or** < 10 NTU	
Time	Cumul. Vol. Purged (gal)	Water Level (ft)	pH	Temp (deg C)	Cond. (umhos/cm)	ORP (mV)	DO (mg/L)	Turb (NTU)	Comments (color, clarity, odor, well observations)

Sample Time: ____________ Temp (°F): ____________ Wind: ____________ Cloud Cover: ____________ Precip: ____________

Other Remarks: ____

____