

**FOURTH FIVE-YEAR REVIEW REPORT FOR
GEMS LANDFILL SUPERFUND SITE
GLOUCESTER TOWNSHIP, CAMDEN COUNTY, NEW JERSEY**



Prepared by

**U.S. Environmental Protection Agency
Region 2
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A handwritten signature in black ink, appearing to read "P. Evangelista", is written over a horizontal dashed line.

**Pat Evangelista, Acting Director
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7/17/19
Date

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LIST OF ABBREVIATIONS & ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
CCMUA	Camden County Municipal Utilities Authority
CEA	Classification Exception Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
EPA	United States Environmental Protection Agency
ERAGS	Ecological Risk Assessment Guidance for Superfund
FFS	Focused Feasibility Study
FYR	Five-Year Review
gpm	gallons per minute
HDPE	high density polyethylene
ICs	Institutional Controls
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NJDEP	New Jersey Department of Environmental Protection
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCE	Tetrachloroethylene
PRP	Potentially Responsible Party
RAO	Remedial Action Objectives
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
TBC	To be considered
TCE	Trichloroethylene
UU	unlimited use
UE	unrestricted exposure
VOC	Volatile Organic Compound

I. INTRODUCTION

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this FYR review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the fourth FYR for the GEMS Landfill Superfund Site. The triggering action for this policy review is the completion date of the previous FYR. The FYR has been prepared due to the fact that hazardous substances, pollutants or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Site currently consists of two operable units (OUs) which will be addressed in this FYR. OU1 includes stormwater management, a landfill cap and an active gas collection and treatment system, and OU2 includes a groundwater extraction and treatment system. EPA is considering a third operable unit to address potential offsite contamination.

The GEMS Superfund Site FYR was led by Supinderjit Kaur, Remedial Project Manager at EPA. Participants included Michael Scorca, Hydrologist at EPA, Marian Olsen, Human Health Risk Assessor at EPA, and Michael Clemetson, Ecological Risk Assessor at EPA. New Jersey Department of Environmental Protection (NJDEP) was notified of the initiation of the five-year review. The review began on 7/1/2018.

Site Background

The GEMS Landfill Superfund site is an approximately 60 acre inactive landfill located in Gloucester Township, Camden County, New Jersey (see Figure 1). The landfill is roughly triangular in shape with an estimated volume of six million cubic yards. Holly Run, an intermittent stream to the north and east of the landfill, discharges to Briar Lake. The site is bounded by New Brooklyn Road (Erial Road) to the north and east, Turnersville-Hickstown Road to the south and undeveloped land to the west.

The GEMS Landfill has been owned by Gloucester Township from at least the late 1950s to the present. The landfill was operated by various parties as a disposal site for solid, liquid, and hazardous wastes and substances. Records indicate that a variety of industrial wastes including asbestos, solvents and other materials were disposed of at the site between 1970 and 1979. In 1980, sludge from the City of Philadelphia's northeast wastewater treatment facility was disposed of at the site. Analyses of the sludge revealed the presence of pesticides. The landfill stopped accepting waste in 1980.

In 1980, NJDEP sampling confirmed that private water wells near the landfill, Holly Run and Briar Lake were contaminated by volatile organic compounds (VOCs). Residents were urged to connect to public water supply systems. NJDEP also opposed installation of new wells within the affected area. In 1983, EPA removed debris from the site and constructed a fence, two culverts and a berm. These response

actions helped prevent residents from coming in contact with wastes in the area and controlled drainage from the site.

EPA proposed to add the site to the National Priorities List (NPL) on December 30, 1982. The site was placed on the NPL on September 8, 1983.

The landfill area is zoned industrial and is used solely for purposes of remediation. Holly Run and Briar Lake are used for recreation. The area surrounding the site is predominantly rural and residential. The closest residences are approximately 300 feet from the base of the landfill.

The surficial aquifer beneath the site is the Kirkwood-Cohansey aquifer system, comprised of the Tertiary-age Cohansey formation and the underlying Miocene-age Kirkwood Formation. The Kirkwood-Cohansey aquifer system is the predominant aquifer in the area. The underlying Wenonah-Mount Laurel aquifer is separated from the Kirkwood Formation by the Manasquan-Navasink aquitard. The groundwater of the Cohansey Formation extends to about 50 feet below ground surface. The Cohansey Formation is contaminated with organic and inorganic constituents. Annual groundwater sampling conducted in the Kirkwood Formation since 2015 indicates that there may be impacts to this aquifer. The underlying Wenonah-Mount Laurel aquifer was not affected.

Groundwater flow in the Cohansey Formation is predominantly to the northwest. A secondary local component of flow is from the northeast part of the landfill towards the relocated Holly Run and associated marshy area.

Ecological resources include a federally-listed threatened plant species, swamp pink (*Helonias bullata*), which was discovered on the site in 1994. The EPA coordinates with the U.S Fish and Wildlife Service regarding this resource.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: GEMS Landfill		
EPA ID: NJD980529192		
Region: 2	State: NJ	City/County: Gloucester Township, Camden County
SITE STATUS		
NPL Status: EPA		
Multiple OUs? Yes	Has the site achieved construction completion? Yes	
REVIEW STATUS		
Lead agency: EPA		
Author name (Federal or State Project Manager): Supinderjit Kaur		
Author affiliation: Remedial Project Manager, USEPA – Region 2		

Review period: 3/1/2014 – 3/1/2019
Date of site inspection: 3/13/2019
Type of review: Policy
Review number: 4
Triggering action date: 4/13/2014
Due date (<i>five years after triggering action date</i>): 4/13/2019

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

In October 1983, the EPA began a federally funded remedial investigation/feasibility study (RI/FS) to characterize the site and evaluate clean-up alternatives. Four natural vents discharging the landfill gases were found to have significant concentrations of VOCs including benzene, chlorobenzene and tetrachloroethene. Samples of leachate seep liquid and soils at the landfill were found to contain polycyclic aromatic hydrocarbons (PAHs), including benzo-a-pyrene, as well as trace levels of the pesticides, dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyldichloroethane (DDD), and dichlorodiphenyltrichloroethane (DDT). Groundwater samples collected in the Kirkwood-Cohansey aquifer system were shown to be contaminated with organics and inorganics. Surface water samples from Holly Run were contaminated with benzene, chlorobenzene, dichloroethane, acetone and xylene. Contaminants in Holly Run surface waters were found to be volatilizing into the ambient air, which showed gross organic vapor levels ranging from 10 to 40 parts per million (ppm). In 1985, the EPA performed a focused feasibility study (FFS) to evaluate remedial action alternatives for contaminated groundwater impacting Holly Run.

In the July 1985 RI/FS report, cancer risks and noncancer health hazards were evaluated under current and future site conditions. The risk assessment concluded that the following posed unacceptable risks:

- Inhalation of VOCs in ambient air;
- Inhalation of organic compounds in landfill gases (also fire and/or explosion hazard);
- Ingestion of benzene, 1,2-dichloroethane, 1,1,1-trichloroethane, acrylonitrile, trichloroethylene, chloroform, and PCBs in groundwater;
- Ingestion, inhalation, or dermal exposure to organics in surface water, sediment, and leachate;
- Ingestion of benzene, methylene chloride, chloroform, bis(2-chloroethyl)ether, bis(2-ethylhexyl)phthalate, lead, arsenic, cadmium, and chromium from Holly Run; and
- Ingestion of contaminated aquatic receptors in Holly Run and Briar Lake.

Although a full ecological risk assessment was not performed, the conclusions of the RI/FS were that acute and chronic toxic effects to aquatic biota in Holly Run and Briar Lake were likely.

Response Actions

On September 27, 1985, the EPA issued a Record of Decision (ROD) that selected the following remedial action components for the site:

- a landfill cap consisting of a multimedia cover on the top of the landfill and a clay cap on the side slopes;
- an active gas collection and treatment system;
- a groundwater extraction and pretreatment system to treat the entire site including the contamination of Holly Run, with discharge to the publicly owned treatment works;
- remediation of Holly Run and Briar Lake (i.e., sediment excavation);
- surface water controls;
- a monitoring program;
- a security fence;
- relocation and isolation of Holly Run;
- connection of the potentially affected homes to the existing public water supply system; and
- operation and maintenance to ensure the effectiveness of the remedy.

Remedial action objectives (RAOs) were not listed in the 1985 ROD as is the EPA's current practice. Nonetheless, a review of the ROD identified the following remedial action goals, which are considered the RAOs for the site:

- prevent direct contact with, inhalation and ingestion of contaminants by human and ecological receptors;
- stop the generation of leachate by preventing landfill waste from contacting groundwater;
- eliminate surface water and sediment contamination in Holly Run and Briar Lake and prevent recontamination by stopping contaminated groundwater from discharging into Holly Run and Briar Lake;
- stop the migration of the contaminant plume (plume containment); and
- eliminate the uncontrolled release of VOCs to the atmosphere.

Status of Implementation

The remedial action was divided into two phases. Phase I, which is also referred to as OU1, addressed all components of the ROD except those related to the contaminated groundwater and leachate. In August 1988, the EPA issued a unilateral administrative order to a group of potentially responsible parties known as the GEMS Trustees for the remedial design/remedial action of the Phase I work. The Phase I remedial design was completed in December 1988. The Phase I work was constructed from 1989 to 1994. At the landfill, a galvanized chain-link fence with three-strand barbed wire and four locked gates was installed for security. The landfill was capped with two feet of clay, a 40-mil high density polyethylene (HDPE) liner, a one-foot drainage layer, 18 inches of soil cover and six inches of vegetated topsoil. The landfill gas collection and treatment system was installed with in-waste gas extraction wells, out-of-waste perimeter wells, HDPE collection piping, condensate removal tank and traps and an enclosed gas flare system. At Holly Run and Briar Lake, contaminated sediments were excavated from both locations and Holly Run was rerouted. The Holly Run underdrain (HRU), an 18-

inch perforated corrugated HDPE pipe approximately 4,000 feet in length along the northeastern edge of the landfill, was installed below the water table to prevent contaminated groundwater from discharging into Holly Run and Briar Lake. Upstream of Briar Lake, culverts were reconstructed to correct drainage problems. A partial fence along Holly Run and Briar Lake was installed to restrict access to the surface water bodies. The EPA approved the remedial action completion report for Phase I in 1995.

Phase II, which is also referred to as OU2, of the remedial action addressed the contaminated groundwater and leachate components of the ROD. In a Consent Decree signed with the EPA on June 30, 1997, the GEMS Trustees agreed to perform the remedial design/remedial action and pay past and future costs for cleaning up the site. The Phase II work was constructed from 1998 to 1999. The leachate collection system, comprised of a perimeter collection trench, manholes, pump stations and an underground double-walled steel storage tank, leads to the treatment system on the west side of the landfill.

Treatment consists of pH adjustment, filtration, granular activated carbon treatment and solids removal followed by discharge to the Camden County Municipal Utilities Authority (CCMUA), the local publicly owned treatment works. The system is designed to treat up to 200 gallons per minute. Groundwater extraction wells were installed at the downgradient edge of the landfill and extracted groundwater is pumped to the treatment facility.

In 1999, the EPA determined that remedy construction of Phase I and Phase II was complete and issued a Preliminary Site Close-Out Report. From 1999 to 2005, equipment for solids removal was upgraded and issues were resolved related to discharge requirements. Representatives of the EPA, U.S. Army Corps of Engineers and NJDEP conducted a precertification inspection in July 2005. Also in July 2005, the EPA determined that the remedy was operational and functional. Since July 2005, the site has been in the long-term operation and maintenance phase. The EPA approved the remedial action completion report for Phase II 2007.

Vertical groundwater extraction wells were replaced in 2014 with a horizontal extraction well due to diminishing capacity of the vertical wells. The horizontal extraction well, installed in October of 2014 by Direction Technologies, Inc (DTI), at a depth of 38 feet below ground surface. The system began operation in February 2015.

IC Summary

Summary of Planned and/or Implemented ICs

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater	No (in place)	No	Landfill property and 5 adjacent properties	Restrict installation of ground water wells and ground water use.	A Classification Exception Area (CEA) is in place for the site. In 2007, the NJDEP expanded the CEA for contaminated groundwater in the

					Kirkwood-Cohansey aquifer system beneath the site. The most recent CEA biennial certification monitoring report is dated July 2012.
Groundwater	Yes	No	Landfill property and 5 adjacent properties	Restrict installation of ground water wells and ground water use.	NJDEP is seeking to obtain deed notices for properties within the CEA (landfill and five adjacent properties). Outside the CEA, the Wenonah-Mount Laurel aquifer system is used for public water supply. Planned for completion by 12/31/2019.

Systems Operations/Operation & Maintenance

Per the 1997 Consent Decree, all Operation and Maintenance (O&M) activities for the GEMS Landfill site (Phase I and Phase II) were officially transferred to the New Jersey Department of Environmental Agency (NJDEP) on July 31, 2015. Prior to the transfer the GEMS Trustees were responsible for O&M Activities at the site.

Phase I

NJDEP is now responsible for Phase I system operations/operation and maintenance in accordance with the Phase I Operation and Maintenance (O&M) Plan.

In 2004-2005, the cap drainage system was improved with the installation of new downchutes, rehabilitation of diversion swales, construction of new berms and installation of new subsurface drains. In 2006 and again in 2009, the discharge permit requirements were updated. In 2008, a vapor intrusion evaluation was completed which indicated that the concentrations of VOCs, especially trichloroethylene (TCE) and tetrachloroethylene (PCE), were below groundwater screening levels at the time. In 2009, 15 new gas collection wells were installed in-waste to improve operation of the enclosed flare. In 2010, landfill cap repairs were conducted to remove water collecting on the top of the cap and along the mid-slope swale and to regrade the mid-slope swales that experienced localized erosion. To prevent reoccurrence of the erosion, the Phase I O&M Plan was modified to add mowing and seeding of swales. In 2011, a new enclosed flare began operating.

Inspections occur on a regular basis to ensure that the perimeter security fence is maintained and that there are no issues with the landfill cap and landfill gas collection and treatment system.

A swamp pink monitoring plan was approved in 1997 and modified most recently in 2013 in consultation with U.S. Fish and Wildlife Service. Swamp pink parameters (number of rosettes, number of leaves per rosette, leaf length) are measured in June along transects in both study and reference locations, and wetland piezometers measure depth to groundwater. The monitoring results are to be reported annually, with the most recent report submitted in June 2018.

Phase II

Since July 2015, NJDEP is responsible for Phase II system operations/operation and maintenance in accordance with the Phase II O&M Plan and the Industrial Discharge Permit issued by CCMUA. Over time, NJDEP has adjusted the groundwater sampling strategy as new information about the performance of the treatment system has come to light. They are currently sampling a subset of the monitoring well network on an annual basis. During the most recent sampling round, which was conducted in September 2018, NJDEP sampled approximately 45 locations for a list of analytes including VOCs, semi-volatile organic compounds (SVOCs), metals, and landfill-leachate indicator parameters. Discussions are ongoing with NJDEP on making modifications to the monitoring plan.

In 2006, the extraction well network was reduced from the initial eight wells to the four eastern extraction wells (EX-1, EX-2, EX-3, EX-4) at the request of U.S. Fish and Wildlife Service to help preserve swamp pink habitat. In 2009, EX-3 and EX-4 were replaced with new extraction wells (20 foot off-set) due to encrustation that decreased well yield.

A horizontal extraction well system was installed in October 2014. The horizontal extraction well replaced the four vertical groundwater extraction wells (EX-1 through EX-4). They needed replacement due to their diminishing capacity and decreased well yield from iron fouling, resulting in incomplete capture and treatment of contaminated groundwater at the downgradient end of the plume. The horizontal extraction well system operation began in February of 2015.

The onsite groundwater and leachate pretreatment system is operated, maintained and monitored in accordance with the discharge permit requirements of the CCMUA. Effluent monitoring water quality data (consisting of 24-hour composite samples, grab samples, and once per two week samples as well as continuous flow measurements) are submitted to CCMUA in monthly industrial discharge monitoring reports. There were a few exceedances in radium concentrations in May, August and September of 2016. The CCMUA was notified accordingly. The radium is not believed to be site-related. There have been no violations or concentrations above any of the discharge parameters since October 2016. The groundwater treatment system was out of operation in September 2016, June 2017 to July 2017, January 2018, and from June 2018 to October 2018 due to system malfunctions.

In 2014, GEMS Trustees led an off-site groundwater investigation to better delineate a plume that has migrated north of the landfill. The investigation was conducted in three phases with sampling from temporary wells and vertical profile borings. Once the extent of landfill related groundwater contamination was delineated, five off-site sentinel wells were installed around the perimeter to monitor and ensure that the contamination is not migrating further off-site. The sentinel wells are to be sampled periodically.

Sitewide groundwater monitoring has continued since NJDEP took over O&M operations in 2015. These more recent monitoring data are discussed in the Data Review section.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the last FYR as well as the recommendations from the last FYR and the current status of those recommendations.

Table 1: Protectiveness Determinations/Statements from the 2014 FYR

OU #	Protectiveness Determination	Protectiveness Statement
Sitewide	Short-term Protective	Based on the third five-year review, the remedy at the GEMS Landfill site currently protects human health and the environment because there is no completed exposure pathway. However, in order for the remedy to be protective in the long-term, the groundwater plume must be contained. Additional measures are being investigated and will be designed and implemented, as needed, to ensure long-term protectiveness.

Table 2: Status of Recommendations from the 2014 FYR

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description*	Completion Date (if applicable)
Sitewide	New information since the 2009 five-year review suggests that contaminated groundwater at the downgradient end of the plume is not being captured fully by the groundwater extraction system.	Identify and implement additional action(s) to capture and treat contaminated groundwater at the downgradient end of the plume which may include installation of a horizontal well proposed by the Potentially Responsible Parties (PRPs), to ensure the long-term effectiveness of the remedy.	Completed	This recommendation led to the installation of the horizontal extraction well in late 2014. The horizontal extraction well system started running in February 2015. The well yields about 25-30 gallons per minute (gpm).	2/1/2015
Sitewide	New information since the 2009 five-year review suggests that	Investigate groundwater in the vicinity of the Holly Run underdrain and	Completed	This recommendation led to the phased off-site investigation and installation of the five off-property sentinel wells	7/31/2015

	contaminated groundwater from the site may be flowing below the Holly Run underdrain and needs to be investigated.	identify whether any modifications are needed to ensure the long-term effectiveness of the remedy.		(conducted by GEMS Trustees).	
Sitewide	The screening level ecological risk assessment indicated the need for a baseline ecological risk assessment at Holly Run and Briar Lake; contractor selection has been completed.	Perform a baseline ecological risk assessment for Holly Run and Briar Lake.	Completed	The GEMS Trust submitted a draft Ecological Risk Assessment Guidance for Superfund (ERAGS) Step 3, the report concluded that no further ecological risk assessments are required. Comments on this report from NJDEP and EPA stated that there may be potential risk of arsenic to benthic communities in Briar Lake, and further sediment sampling is warranted. Since NJDEP took over O&M from the Trustees before the report was finalized, NJDEP secured a contractor and conducted the sediment sampling (in January 2017). Based on results of this sampling and the report it was concluded that a baseline ecological risk assessment was not required.	11/1/2017
Sitewide	There are no deed notices on the landfill property or on the five adjacent residential properties where components of the remedy are located and which are within the limits of the Classification	Finalize deed notices and engage property owners for signature and filing.	Ongoing	NJDEP has prepared the deed notices and they are with the Township and property owners for signatures.	

	Exception Area established for contaminated groundwater at the site.				
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IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

On October 1, 2018, EPA Region 2 posted a notice on its website indicating that it would be reviewing site cleanups and remedies at 42 Superfund sites in New York, New Jersey, U.S. Virgin Islands & Puerto Rico including the GEMS Landfill Superfund site. The announcement can be found at the following web address: <https://www.epa.gov/aboutepa/fiscal-year-2019-five-year-reviews>. The results of the review and the report will be made available on the website for the Site (<https://www.epa.gov/superfund/gems-landfill>), as well as at the Site information repository located at Gloucester County Municipal Building, 1261 Chews Landing Road (at Hider Lane) Laurel Springs, New Jersey 08021.

Interviews were not conducted during this FYR process.

Data Review

In 2014 and 2015, groundwater samples from a total of 37 direct-push (geoprobe) borings downgradient of the landfill indicated that VOCs and other landfill-related parameters (including chloride, sulfate, ammonia, total dissolved solids, chemical oxygen demand and total organic carbon) are present in the Lower Cohansey about 40 feet below ground surface. Groundwater at a few locations, also had high concentrations in shallower (Upper and Intermediate Cohansey) intervals. These observations helped to delineate groundwater contamination in the area downgradient of the current extraction system. A set of five sentinel wells (OSW-1 to -5) were installed at the edge of the plume.

Groundwater Monitoring

Groundwater monitoring has been conducted at the GEMS Landfill site since the 1980s. Following the transfer of operations to NJDEP in 2015, groundwater sampling has been conducted annually and groundwater levels have been measured quarterly. The well network includes about 16 wells with longer-term sampling records, 28 piezometers installed along transects to evaluate the horizontal extraction well, and 5 far-downgradient (sentinel) wells. The monitoring well locations are shown in Figure 1.

Groundwater levels are measured quarterly at about 51 wells in the monitoring network which includes the 28 piezometers in the transects around the horizontal extraction well. The significant impact of pumping of the horizontal well on the groundwater flow is illustrated on the contour map on Figure 1. The pumping draws down the natural water level by about 0.5 to 3 feet along the length of the well. The capture zone (Figure 3) also extends to the downgradient side of the well, which can draw back a portion of the contamination that had previously migrated to this area.

Groundwater Chemistry

Numerous site-related chemicals are present above New Jersey Groundwater Quality Standards (NJGWQS) in the landfill-leachate affected groundwater and the water collected from the HRU. Commonly observed chemicals include VOCs (acetone, benzene, 2-butanone, chlorobenzene, 1,2-dichloroethane, ethylbenzene, methylene chloride, tert-butyl-alcohol, tetrahydrofuran, toluene, xylenes), SVOCs (1,4-dioxane, bis(2-chloroethyl)ether, benzo(B)fluoranthene), metals (arsenic, iron, aluminum, sodium, manganese cadmium, chromium) and other inorganic landfill-leachate indicator parameters (ammonia, chloride, total dissolved solids).

Although several monitoring wells remain highly affected by landfill leachate, generally declining trends in chemical concentrations are observed for the majority of chemicals at most of the wells. The groundwater monitoring results indicate that operating the horizontal well at its design capacity of about 30 gpm is effective at capturing the bulk of the groundwater plume and is improving water quality in the Cohansey and Kirkwood aquifers. Graphs of chemical concentrations over time are presented for selected wells to demonstrate trends and patterns in Appendix C.

Three piezometer transects (designated A, B, and C) were installed across the horizontal extraction well and two transects (designated D and E) extended away from each side of the well. The crossing transects included one Lower Cohansey piezometer on the near (landfill) side of the horizontal well, one piezometer above the horizontal well (30 feet deep), a cluster with piezometers screened in the Upper Cohansey, Lower Cohansey, and top of the Kirkwood, and single Lower Cohansey piezometer at about 50 and 100 feet away on the far side of the horizontal well. Existing well PM-16 was included as the furthest downgradient well on transect C. Each of the two transects on either side of the horizontal well include a cluster of 3 piezometers (screened as described above) and one single Lower Cohansey piezometer located about 100 feet away.

The further downgradient piezometers PZ-A4, PZ-B4, and PM-16, like the closer piezometers, have shown generally improving conditions on the far side of the horizontal extraction well, with mostly declining concentrations for the majority of chemicals. Well PM-16 is along the furthest east transect (C) and has declining concentrations for all contaminants. PZ-B4 is on the center transect and has declining concentrations, except for benzene, which has increased. PZ-A4 is on the furthest west transect and although most contaminants are showing declining trends, a few (ammonia, tetrahydrofuran, 1,4-dioxane, and tert butyl alcohol) are variable and show some declines and increases. PZ-A4 is probably near the edge of the horizontal extraction well capture zone, so the effects are somewhat less pronounced than most of the other wells in the monitoring network.

Groundwater in the area just to the west and southwest of the capture zone of the horizontal well has generally shown minor impacts from the landfill leachate. Well PM-11 (42 feet deep) is screened in the Lower Cohansey and has remained generally unaffected by the landfill. Well PM-10 (65 feet deep) is screened in the Lower Cohansey and has shown some minor effects from leachate previously, but it is currently showing declining trends of all chemical constituents, except sodium and 1,4-dioxane. In the same well cluster, PM-9 (39 feet deep) is screened in the Upper Cohansey and shows no significant impacts from the landfill. The area to the west and southwest of the horizontal well capture zone will continue to be monitored and evaluated.

On the northeast side of the landfill and the far side of the HRU, direct-push samples shown limited leachate effects in the upper and intermediate Cohansey. However, groundwater samples from upper Cohansey well PM-19 have shown declining concentrations of most chemical constituents during the past five years. In the same well cluster as PM-19, monitoring well 102-AR, screened in the lower

Cohansey, has shown decreasing concentrations of chloride, ammonia, and total dissolved solids and more variable concentrations of benzene, 1,4-dioxane, tert butyl alcohol, chlorobenzene, and tetrahydrofuran. Like PZ-A4, well 102-AR is probably near the edge of the horizontal extraction well capture zone, so its effects are somewhat less pronounced than at other monitoring wells. The effectiveness of the HRU and horizontal extraction well in capturing contaminated groundwater in the Cohansey aquifer will continue to be further examined.

Although during the original remedial design the Kirkwood Formation was considered to be a lower permeability unit than the Cohansey Formation, sampling of wells screened in the Kirkwood during the last five years indicates that contamination has affected greater depths than previously expected in the area downgradient of the landfill. Wells PM-8, PM-14, and PM-20 are screened in the Kirkwood at depths of 90, 75, and 75 feet, respectively. Groundwater samples from the wells contained significantly elevated concentrations of VOCs, SVOCs, and inorganics (some leachate indicators) in 2015. Subsequent sampling has shown declining trends in concentrations, which suggests that operating the horizontal well at its design capacity of over 30 gpm is also contributing to improving water quality in the Kirkwood Formation. Wells PM-17, PM-23, PM-27, and PM-28 are screened in the Kirkwood and located on the northeast side of the landfill and have depth of 72, 75, 79, 75 feet respectively. Samples show that the Kirkwood groundwater in these areas is not affected by the landfill leachate. Additional investigations of the Kirkwood will be conducted as part of the proposed Operable Unit 3. Data related to the above discussion is included in Appendix C.

Treatment System Flow Rates

The pumping rate of the horizontal extraction well typically ranges between 28 and 30 gpm. The well is cleaned out and redeveloped several times a year to maximize pumping efficiency. The HRU is designed to intercept shallow groundwater in the upper Cohansey at the northeast Side of the landfill. The flow rate from the HRU is variable and is dependent on rainfall, with typical pumping rates ranging from 60 to 120 gallons per minute (gpm). The combined volume of water from the extraction well and the HRU that is treated by the system each month is shown in Figure 2. Due to equipment malfunctions, the entire treatment system was turned off, or operated well below capacity, during one month in 2016, three months in 2017 and ten months in 2018. Ongoing repairs are expected to bring the treatment system operation back to full capacity in 2019.

Surface Water/Sediment

No surface water or sediment monitoring is required under the O&M plans. NJDEP conducted sediment sampling in Briar Lake in January 2017 to evaluate potential impacts of arsenic to the benthic communities in Briar Lake. Based on the results there did not seem to be impacts of arsenic to the benthic communities. Additional investigations or a baseline ecological risk assessment were not further warranted.

Swamp Pink

Monitoring of swamp pink in both the Colony III and Campus locations continue to show a general decline in the health of the populations. There have been no indication that groundwater levels in the colonies are being affected by operation of the remedy, or that the impacts noted are in any way related to operation of the remedy. The decline in swamp pink population may be due to deer browsing.

Site Inspection

The inspection of the Site was conducted on 3/13/2019. In attendance were Mark Austin, Michael Scorca, and Hannah Greenberg from USEPA, and Greg Giles from NJDEP. The purpose of the inspection was to assess the integrity of the remedy.

At the time of the Site inspection, the groundwater treatment plant was in operation manually. There were systematic problems with the computer system due to incompatibility issues. NJDEP continues manual operations, but is working on getting the system running optimally. The equalization tanks had leaks, therefore most of the groundwater was going through temporary holding tanks. The leaks from the tanks have been repaired since the time of the site inspection. NJDEP's contractor also notified EPA that when the treatment system was shut down completely, the HRU was overflowing through a nearby manhole. It was noted during the inspection that the manhole was completely rusted. Rusting was also noticed at a nearby culvert.

At the time of the Site inspection, there were no significant issues identified with the landfill cap, site fence, or the gas collection system.

V. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

Question A Summary:

Most components of the remedy are either completed or are being operated, maintained and monitored as intended by the Record of Decision, including repairs to the landfill cap as needed. The GEMS Trustees constructed a horizontal extraction well and treatment system operations were transferred to NJDEP in 2015. The onsite groundwater and leachate pretreatment system is operated, maintained and monitored in accordance with the discharge permit requirements. However, due to equipment malfunctions, the entire treatment system was turned off, or operated well below capacity, during ten months in 2018. The security fence is intact.

The groundwater monitoring well data indicates that during the operation of the horizontal extraction well at the design rate of 30 gpm, the bulk of the groundwater plume within the extraction well capture zone is being captured and groundwater quality has improved. Continued operation of the system will be required for the remedy to remain protective. Groundwater outside the extraction well capture zone and in the Kirkwood aquifer will be investigated further as part of the proposed OU-3.

There is no known direct human exposure to contaminated groundwater. All groundwater users are on public water supply and groundwater use is restricted by a classification exception area at the site. NJDEP is placing deed restrictions on properties that contain components of the remedy (e.g., the HRU).

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Question B Summary:

The exposure assumptions, toxicity data, cleanup levels and remedial action objectives used at the time of the remedy are still valid and protective. In 2014, EPA updated the standard default exposure

assumptions (OSWER Directive 9200.1-120 – February 4, 2014 titled “Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors”. Changes include updates to the groundwater ingestion rates for the child and adult; resident exposure duration, resident skin surface area for adult and child; and adult bodyweight. The changes in exposures do not affect the protectiveness of the remedy.

Exposure Pathway Specific Evaluation:

Soil: The land use considerations and potential exposure pathways in the 1985 ROD are consistent with the current and anticipated future land uses of the landfill. The remedy included the capping of the landfill and ongoing maintenance to prevent potential direct contact with the landfill waste and soils. In addition, the site is surrounded by a fence, two culverts and a berm to prevent and restrict potential exposures through direct contact with the landfill in the event of trespassing. Therefore, direct exposures are not expected to occur. There are no significant changes in site use expected over the next five years. The area surrounding the site is predominantly rural and residential. Additional residential development is occurring in the area and is expected to continue in the future. These development activities do not impact the protectiveness of the remedy at the site.

Sediments/Surface Water: For potential risks to human health, the exposure assumptions, toxicity data, cleanup levels and remedial action objectives are still valid, as discussed above.

Potential risks to ecological receptors were evaluated in an Ecological Risk Assessment Step 3 Report (March 2015). There are no apparent ecological impacts related to sediment or surface water COC metal concentrations in the background areas or within Holly Run. Five organic contaminants (2,4-dinitrophenol, 4-nitrophenol, hexachlorocyclopentadiene, 2-methylphenol and carbon disulfide) had detection limits greater than their corresponding sediment screening values. Based on the evaluation, it is unlikely that any of the potential ecological risks would be underestimated by excluding these five contaminants from the evaluation for the following reasons: (1) the standard method detection limits were used and adjusted for sample-specific conditions, such as moisture content, which is consistent with standard EPA protocols; (2) the elevated detection limits were below alternate screening benchmarks and/or benchmarks adjusted for site-specific sediment TOC results; and (3) none of these five chemicals have been reported in any of the historical sampled media at the landfill. There were exceedances of sediment benchmarks for arsenic, iron and zinc in Briar Lake. Of these, only arsenic may be of potential concern at some of the locations. However, it is unclear whether the arsenic in Briar Lake sediments is site-related (based upon review of the available groundwater and HRU data) or from other sources. Sediment toxicity testing was conducted on samples from Briar Lake in June 2017 by the NJDEP. The conclusion of this testing indicated that there does not appear to be any sediment toxicity associated with the contaminants in Briar Lake.

Groundwater: The exposure assumptions, toxicity data, cleanup levels and remedial action objectives used at the time of the remedy are still valid. For this FYR, an evaluation of the direct contact pathway with site groundwater showed that this is not a completed pathway given all nearby residents are connected to a public water supply. In addition, a CEA is in place to prevent new water supply wells from being drilled. The planned deed notices will ensure an additional layer of protection when filed. EPA will continue to assist NJDEP and the GEMS Trustees in this effort.

Vapor Intrusion: As discussed in the previous FYR, a vapor intrusion investigation was conducted in 2008 and concentrations in the groundwater were not found to be of concern for vapor intrusion. Site

conditions have not changed, and all of the assumptions used for the previous vapor intrusion assessment, including land use, remain valid. Groundwater contamination associated with a potential OU3 is deep and thus not of concern for vapor intrusion.

Toxicity Values: The toxicity values for DDD, DDE and benzo(a)pyrene were updated in 2017 and the toxicity of lead is being revaluted by EPA. These changes in toxicity values do not change the overall conclusions regarding the protectiveness of the remedy since exposure pathways were interrupted by the landfill cap and provision of drinking water from a public supply. Several chemicals such as polychlorinated biphenyls and chromium are identified for further evaluation under the Integrated Risk Information System, EPA's source of toxicity data for inclusion in risk assessments. Any changes in the toxicity values will be evaluated in the next FYR.

Based on the results of the recent Ecological Risk Assessment it appears that any potential ecological risk is insignificant. Consequently, the exposure assumptions are appropriate and thus the remedy remains protective of ecological resources.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No information has come to light that could call into question the protectiveness of the remedy.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): OU2	Issue Category: Monitoring			
	Issue: Due to changed site conditions (e.g., installation of the horizontal extraction well, installation of extensive monitoring network, etc.) , groundwater and swamp pink monitoring plans for the Site need to be evaluated, and revised appropriately.			
	Recommendation: Finalize and memorialize groundwater and swamp pink O&M monitoring plans with NJDEP.			
Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	No	EPA/State	EPA	12/31/2019
OU(s): OU2	Issue Category: Remedy Performance			
	Issue: New information since the 2014 five year review suggests that further delineation of the extents of the contaminated groundwater plume are needed. Data indicated that deeper Kirkwood aquifer has landfill related impacts.			

	Recommendation: Conduct additional investigation to delineate potential offsite groundwater contamination (horizontally and vertically) through the proposed new OU.			
Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	Yes	EPA	EPA	6/30/2020
OU(s): OU2	Issue Category: Operations and Maintenance			
	Issue: The groundwater treatment system was down for several months in 2018 and is currently being operated manually. During the time that the treatment system was not in operation the HRU overflowed, and there is rusting in a nearby manhole. When the groundwater extraction and treatment system is in operation, the system adequately captures and treats contaminated groundwater.			
	Recommendation: Optimize and upgrade the groundwater treatment plant to ensure that groundwater extraction treatment system remains operating.			
Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	Yes	State	EPA	12/31/2019
OU(s): OU1	Issue Category: Institutional Controls			
	Issue: The deed notices are not finalized on the landfill property or on the five adjacent residential properties where components of the remedy are located and which are within the limits of the Classification Exception Area established for contaminated groundwater at the site			
	Recommendation: Obtain signed deed notices from the property owners and finalize them.			
Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	Yes	State	State	12/31/2019

VII. PROTECTIVENESS STATEMENT

OU1 Protectiveness Statement	
<i>Protectiveness Determination:</i> Short-term Protective	<i>Planned Addendum Completion Date:</i> Click here to enter a date
<i>Protectiveness Statement:</i> Based on this fourth five-year review, the remedy at the GEMS Landfill site currently protects human health and the environment in the short-term since there are no completed exposure pathways. However, in order for the remedy to be protective in the long-term, deed restrictions need to be put in place.	
OU2 Protectiveness Statement	
<i>Protectiveness Determination:</i> Short-term Protective	<i>Planned Addendum Completion Date:</i> Click here to enter a date
<i>Protectiveness Statement:</i> Based on this fourth five-year review, the remedy at the GEMS Landfill site currently protects human health and the environment in the short-term since there are no completed exposure pathways. However, in order for the remedy to be protective in the long-term, the groundwater plume must be fully delineated and contained, the monitoring program needs to be updated and the groundwater treatment system needs to be optimized to function continuously.	

VIII. NEXT REVIEW

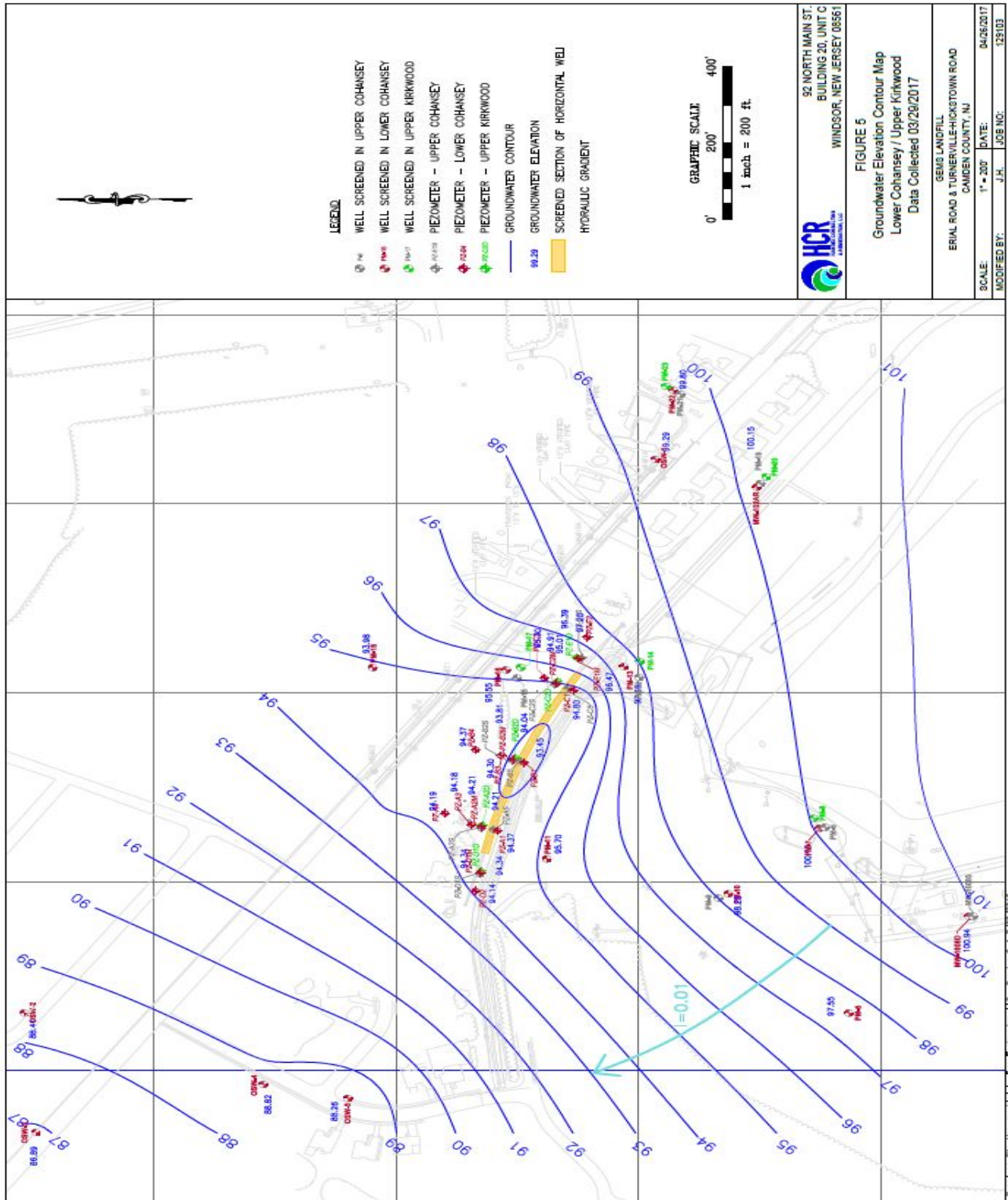
The next FYR report for the GEMS Landfill Superfund Site is required five years from the completion date of this review.

APPENDIX A – REFERENCE LIST

Table 1: Documents, Data and Information Reviewed in Completing the Five-Year Review	
Document Title, Author	Date
Remedial Investigation/Feasibility Study, EPA	July 1985
Record of Decision, EPA	September 1985
Unilateral Administrative Order, EPA	August 1988
Consent Decree, USDOJ	June 1997
Third Five-Year Review, EPA	April 2014
First Quarterly Report Horizontal Extraction Well Operation, GEMS Trust	June 2015
Results of Phase 3 Offsite Investigation, GEMS Trust	June 2015
Remedial Investigation Report for Ecological Risk Assessment Sampling of Briar Lake, NJDEP	June 2017
Annual Swamp Pink Monitoring Report, NJDEP	June 2018
Groundwater Annual Progress Report, NJDEP	December 2018

APPENDIX B – Figures

Figure 1 – Map showing well locations and water level contours in the Lower Cohansey and Upper Kirkwood aquifers, March 2017



Gallons of Water Treated Per Month - GEMS Landfill

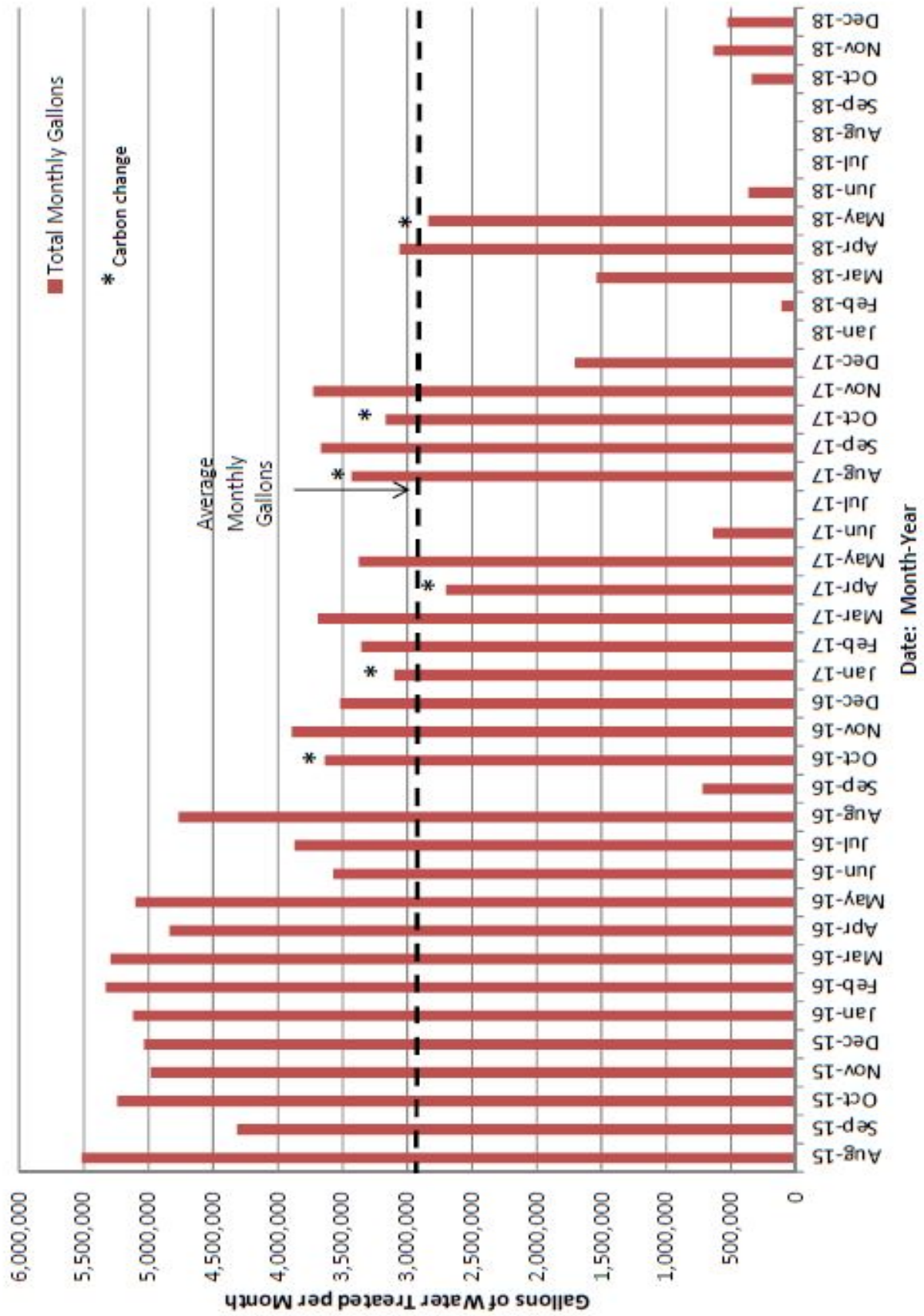
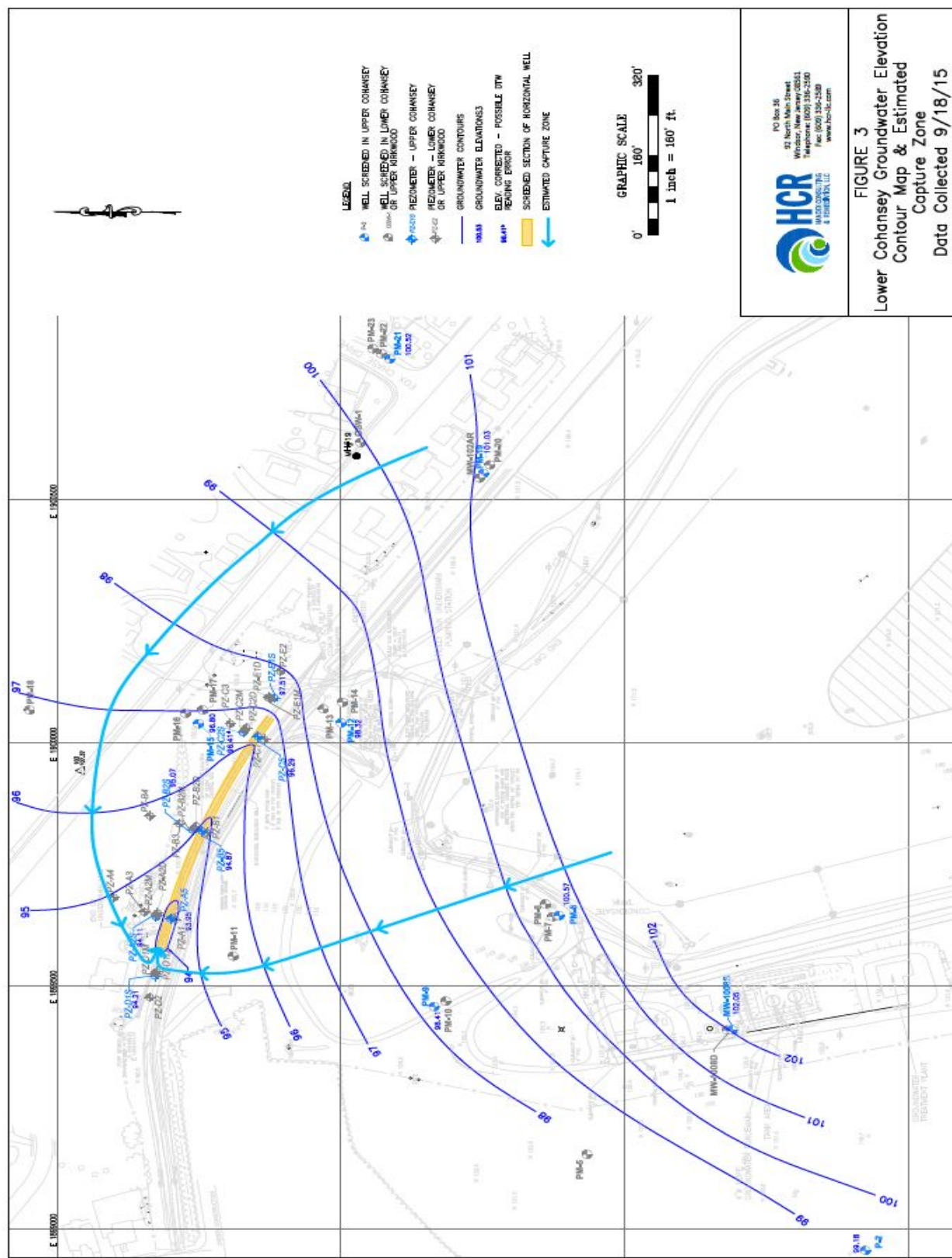
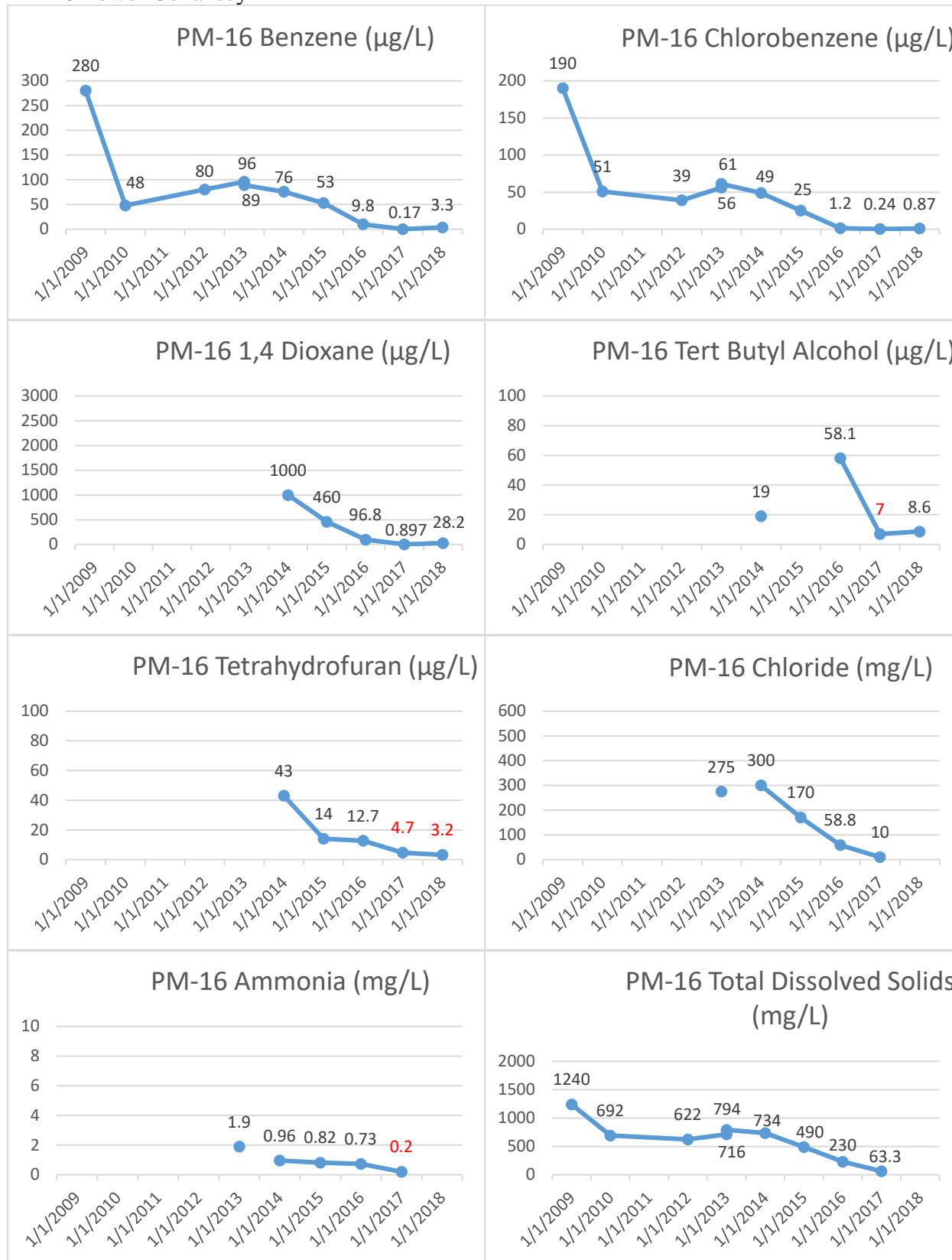


Figure 3 – Map showing water level contours and estimated extraction well capture zone in the Lower Cohansey and Upper Kirkwood aquifers, September 2015



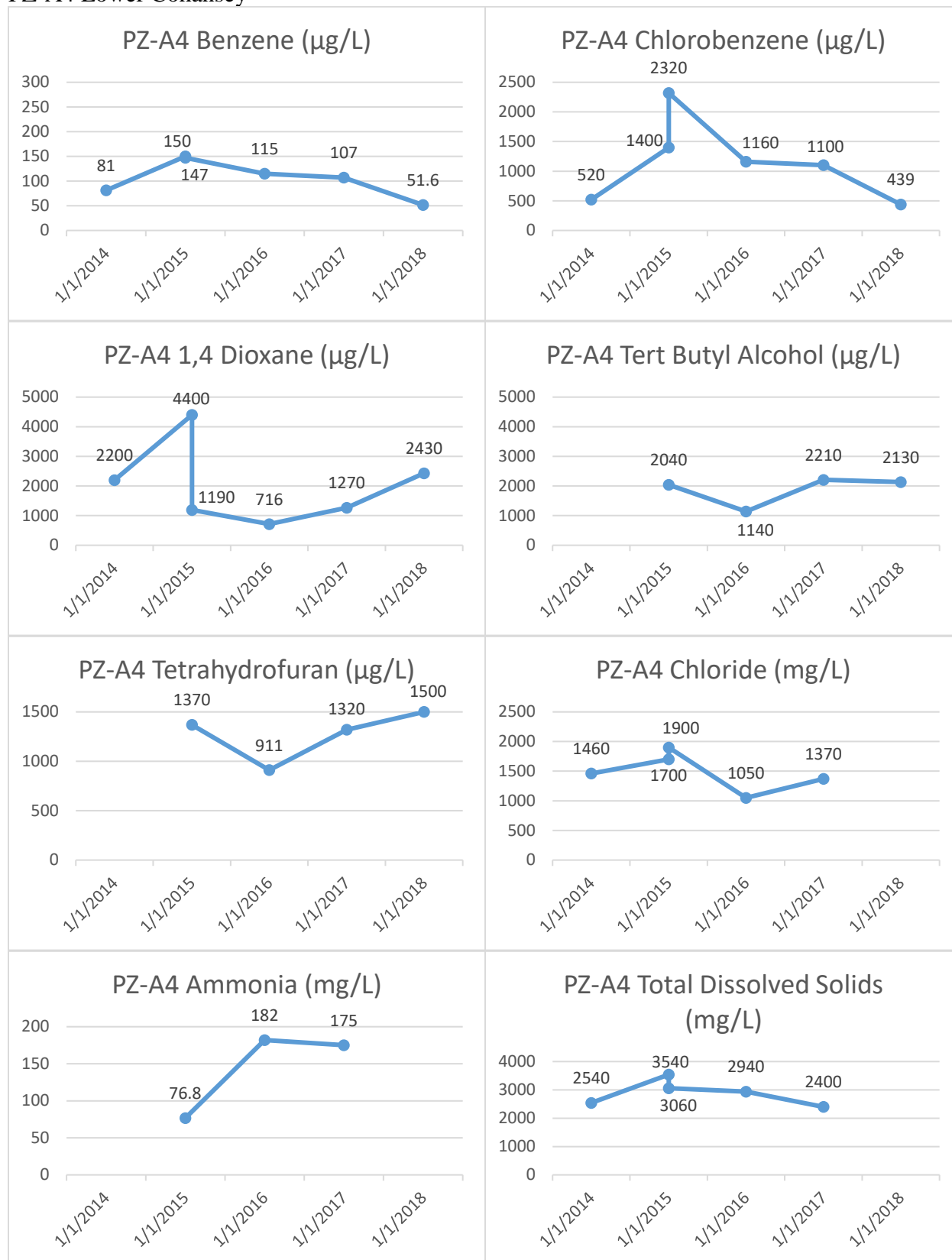
APPENDIX C – Groundwater Data

PM-16 Lower Cohansey

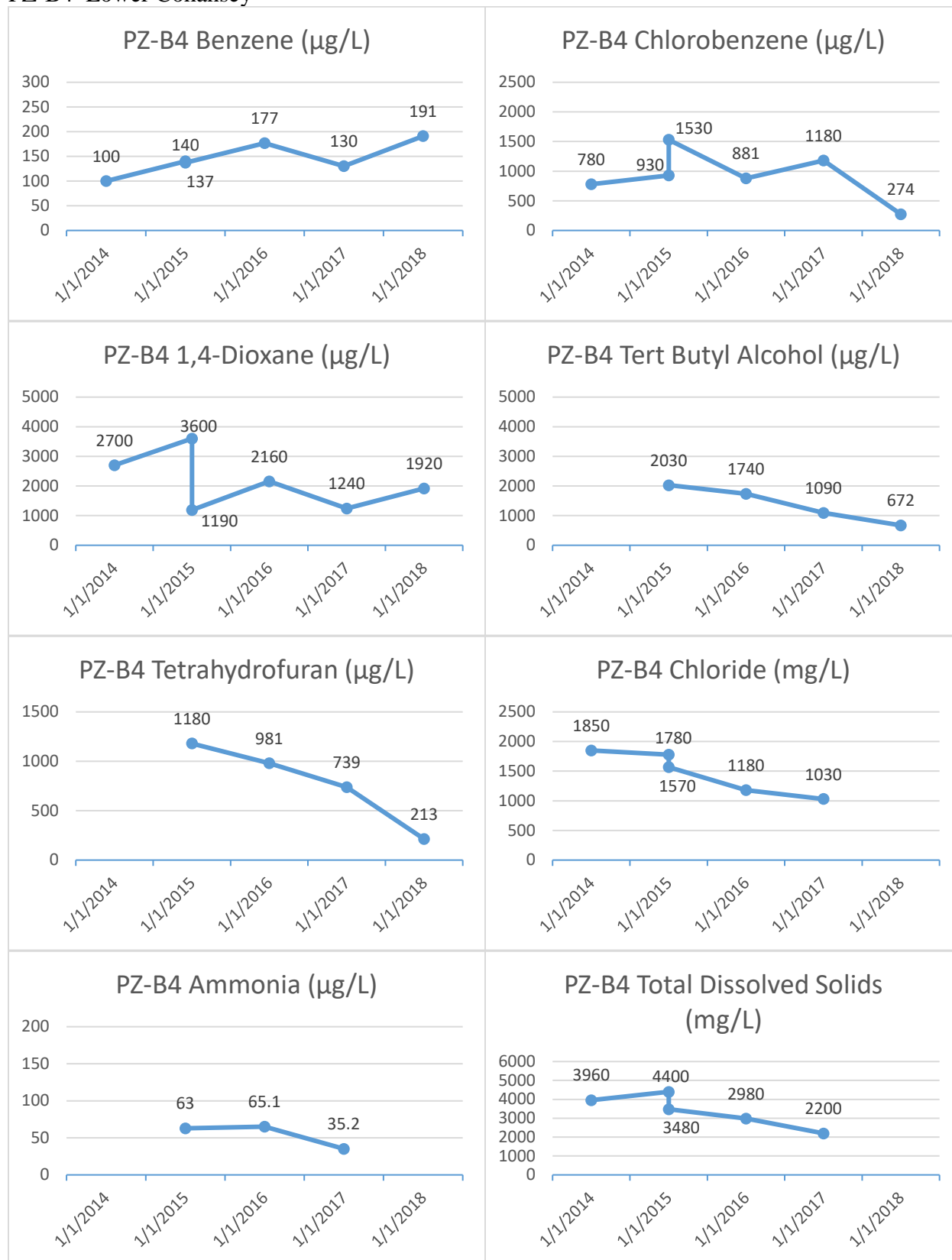


*Note that results shown in red are estimated as they are below the analytical detection limit.

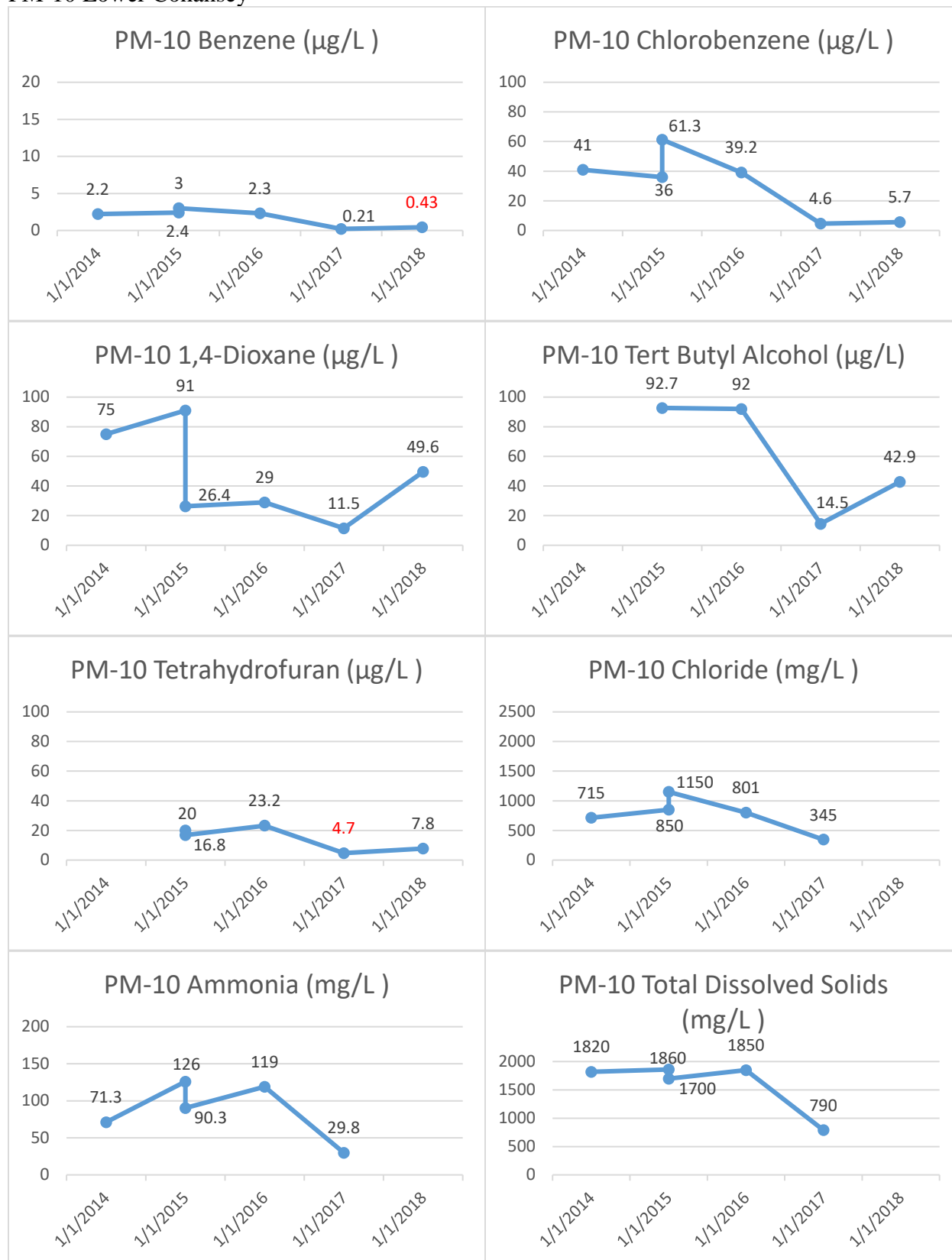
PZ-A4 Lower Cohansey



PZ-B4 Lower Cohansey

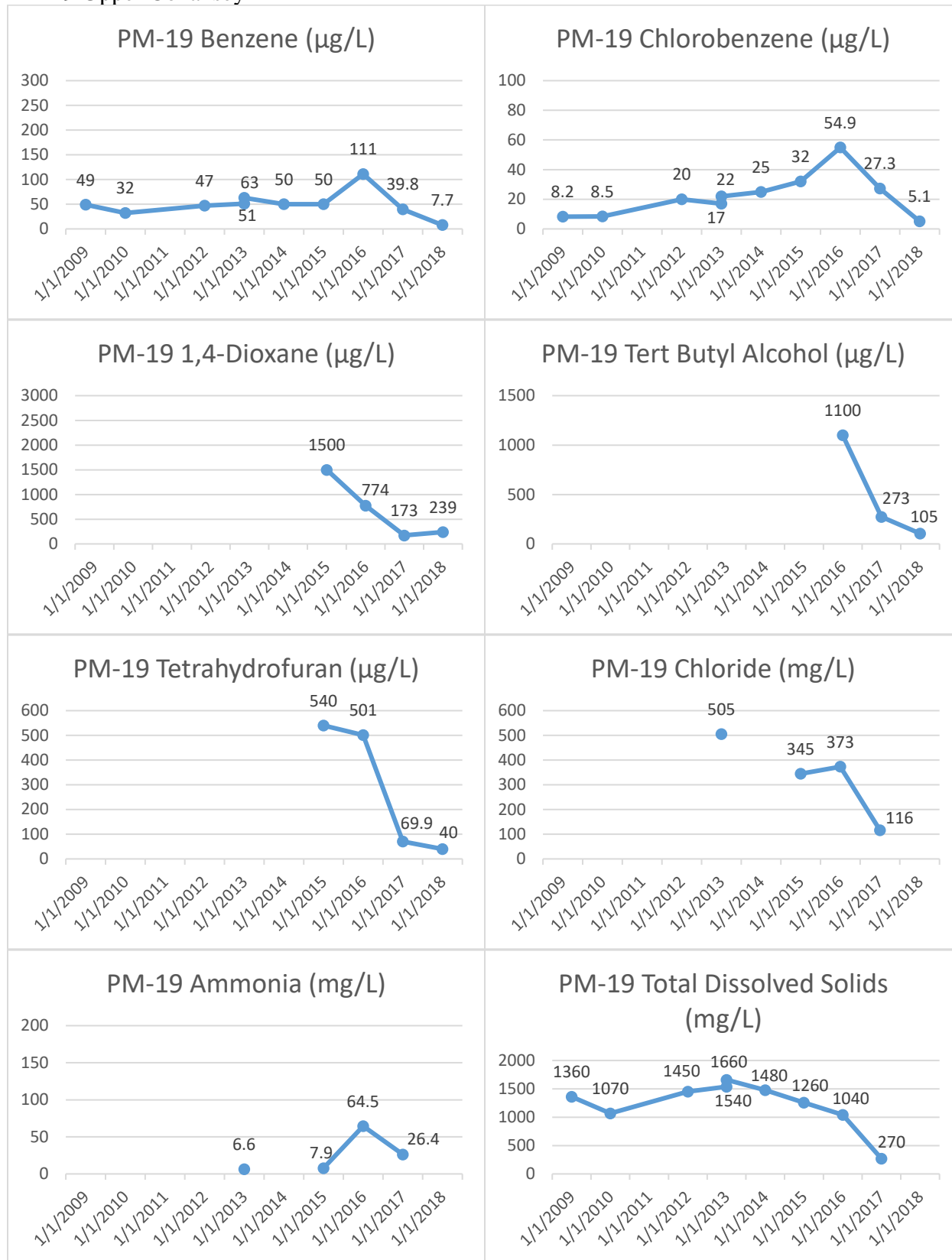


PM-10 Lower Cohansey

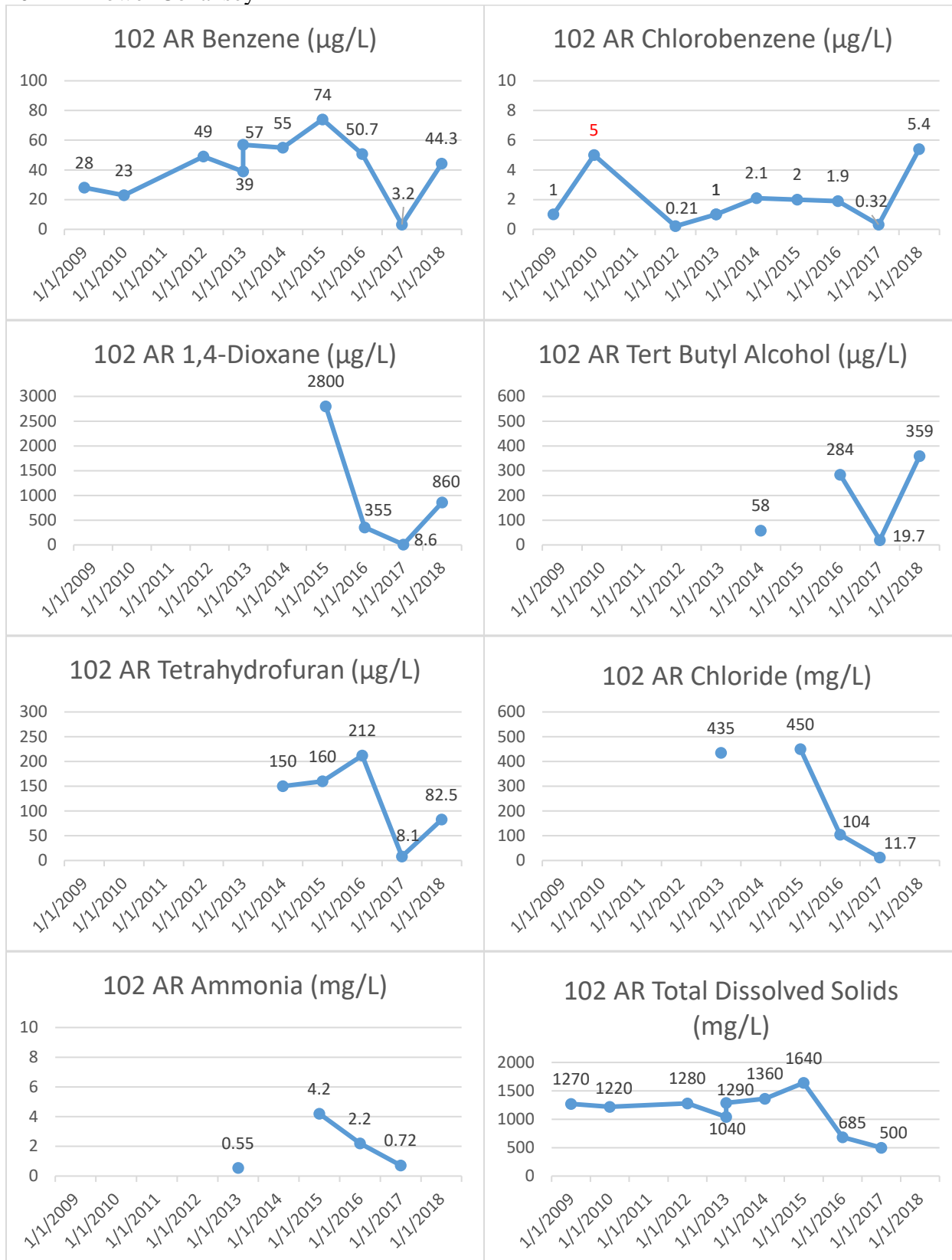


*Note that results shown in red are estimated as they are below the analytical detection limit.

PM-19 Upper Cohansey

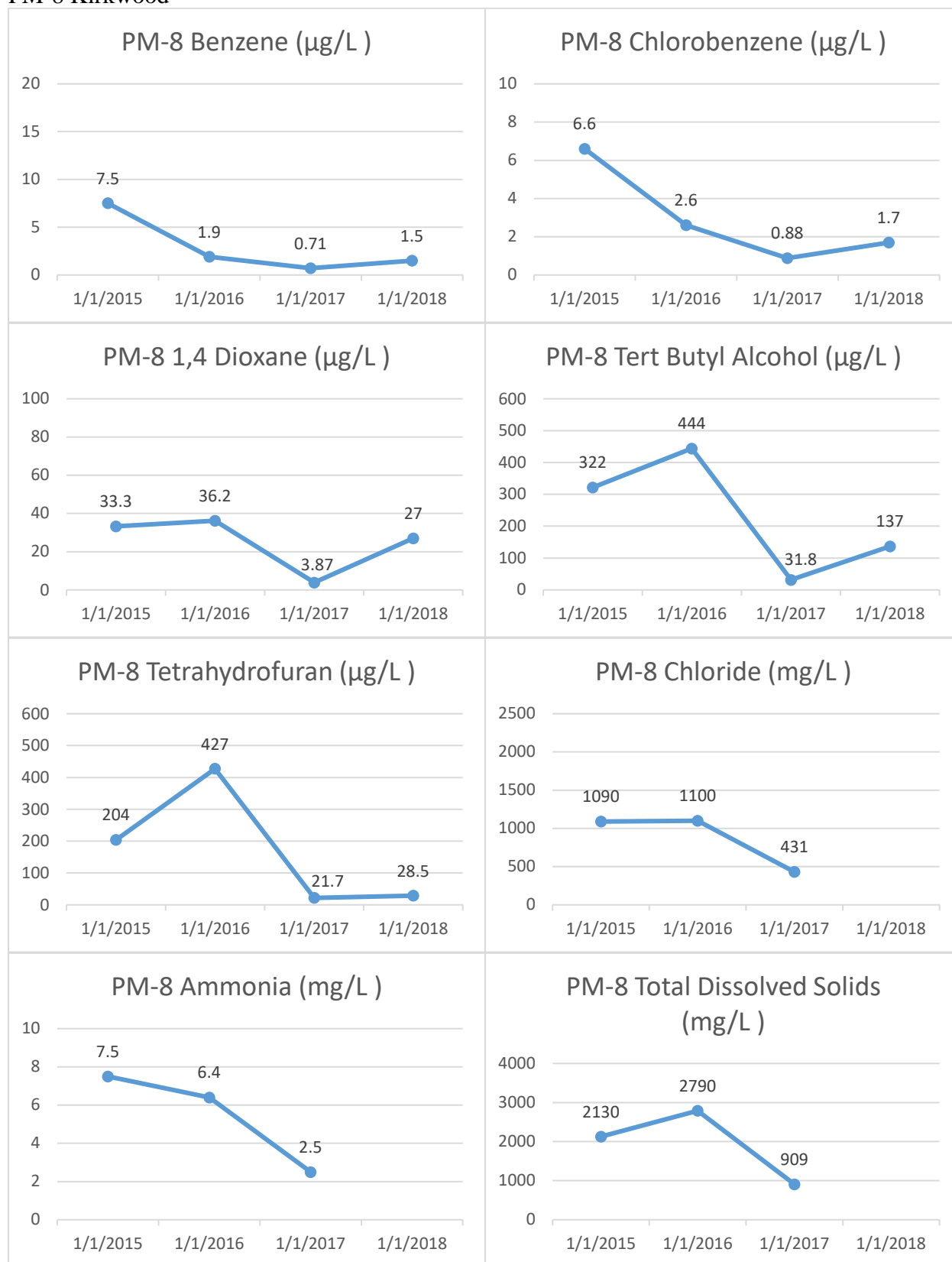


102 AR Lower Cohansey

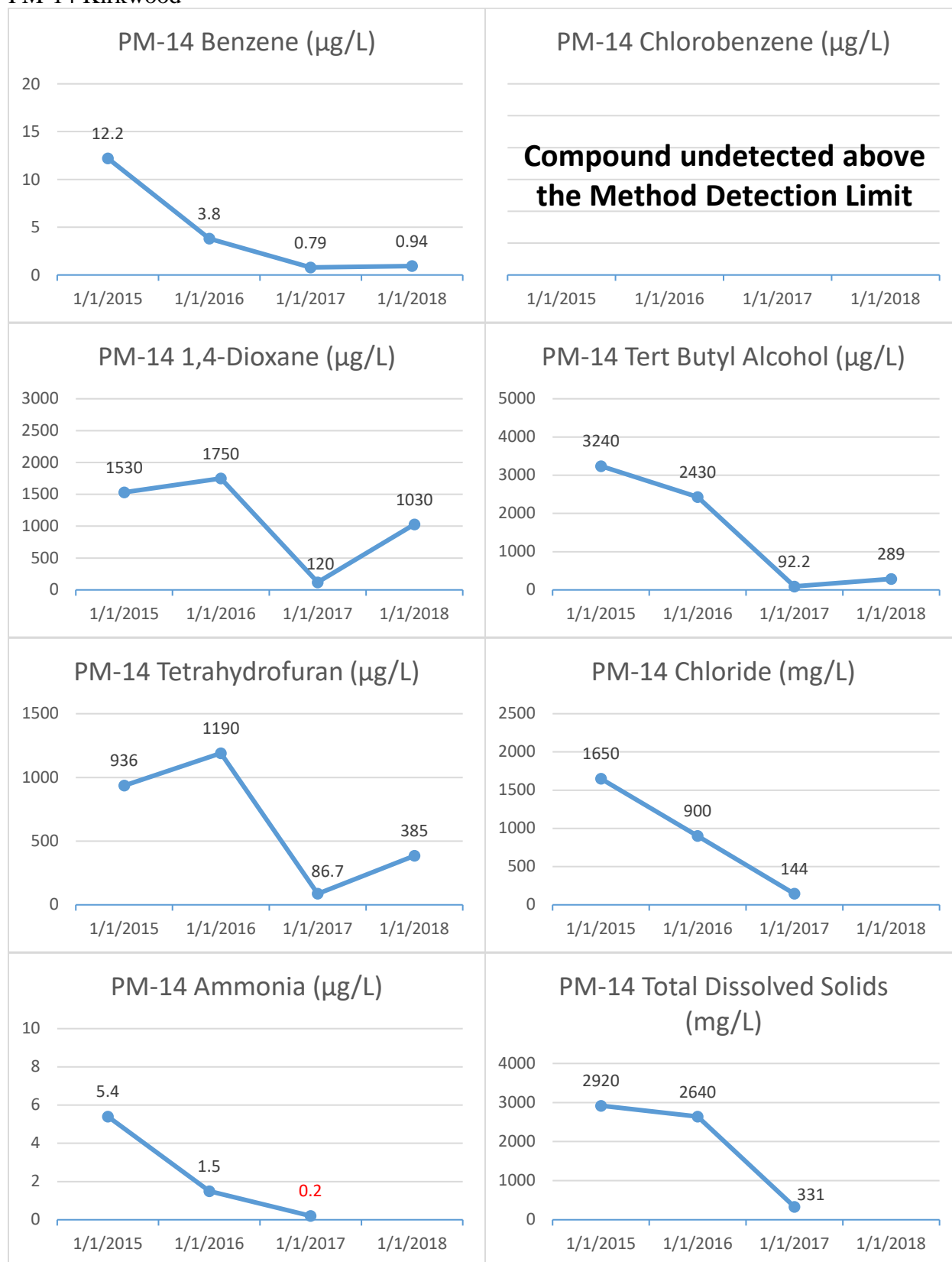


*Note that results shown in red are estimated as they are below the analytical detection limit.

PM-8 Kirkwood



PM-14 Kirkwood



*Note that results shown in red are estimated as they are below the analytical detection limit.

PM-20 Kirkwood

