UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
Four Penn Center
1600 John F. Kennedy Boulevard
Philadelphia, Pennsylvania 19103-2852

October 12, 2022

Mrs. Tiffani Doerr
Evergreen Resources Management Operations
2 Righter Parkway, Suite 200
Wilmington, DE 19803

Subject: Sitewide Fate and Transport Remedial Investigation Report Part 1 - Groundwater Flow Model and Part 2 - Contaminant Fate and Transport Assessment

Dear Mrs. Doerr:

The U.S. Environmental Protection Agency (EPA) has received and reviewed the Sitewide Fate and Transport Remedial Investigation Report Part 1 - Groundwater Flow Model and Part 2 - Contaminant Fate and Transport Assessment, Former Philadelphia Refinery, 3144 Passyunk Avenue Philadelphia, Pennsylvania prepared for Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC and by Stantec Consulting Services, Inc. submitted June 30, 2022. Included as Attachments A and B are comments provided by EPA and the U.S. Army Corps of Engineers, contracted to review and provided comments and assistance as groundwater flow model (MODFLOW) experts.

If you have any questions or concerns, please contact me at 215-814-2796 or bilash.kevin@epa.gov upon receipt and review of submitted comments.

Sincerely,

KEVIN BILASH

Digitally signed by KEVIN BILASH
Date: 2022.10.12 09:42:29 -04'00'

Kevin Bilash
Land, Chemicals & Redevelopment Division
US Environmental Protection Agency, Region III

cc: L. Strobridge, PADEP
file

Attachment A

U.S. Environmental Protection Agency comments

Part 1 – Groundwater Flow Model

Section 2.2.2:

- Key offsite property locations be identified on Figure 1-2.
- Include environmental remediation efforts associated with PES/Hilco. Indicate if data from new releases were specifically excluded from Part I or Part II of the report. The PES/Hilco discussion should premise any necessary comingled plume discussion in Part II that has the potential to influence the fate and transport of pre-existing contamination.

Section 3.2.2 Provide information to support the statement "PaGWIS … have not indicated the presence of water supply wells extracting significant quantities of groundwater from bedrock"

Section 3.2.3.1 Provide a list of wells that were excluded from the groundwater flow model because wells produced inconsistent water levels compared to neighboring wells. Please clarify if excluded wells, were carried through calibration and the Fate and Transport, Part II report.

Table 3-1 include model layers (Layers 1 through 7) in the table to the corresponding hydro stratigraphic unit.

Section 3.2.3.2.1: provide a figure showing the location of borrow pits and other referenced anthropogenic features

Section 3.4: It is current unclear how the water balance accounts for surface water and leaking infrastructure. Provide input/output quantities and site-specific data that support parameters used in the model to support the water balance.

- Section 3.4.1.3: Recharge precipitation estimate 10-12 in near property from data from 1971-2000: Can model be quickly adjusted to determine higher recharge from climate change or lower recharge for capping?

Section 5.2:

- Figures 5-2A through 5-2H, add point elevations to the Figures to assist in differentiating between layer elevations.
- Report text should generally describe the orientation of the model layers and if aquitard clay layers pinch out.
- Figure 5-3A and 5-3B, include layer numbers on the domain comparison cross section.

Figures 5-3A and 5-3B suggest anthropogenic fill materials (sand, clay, silt, gravel, cinders, concrete, asphalt, crushed stone, ash, glass, brick fragments, and wood) were categorized with K values that represent the unconsolidated soils underly fill materials. Additional explanation and supporting evidence is needed to support this assumption considering shallow groundwater and petroleum sources (LNAPL) are encountered within fill materials, and fill materials are likely to have higher K values and create preferential flow in the shallow zone.

Figures 5-5:

- Figure 5-5D, the extent of hydraulic conductivity values for layer 4, representing the middle clay, differ from Figure 3-23, the Isopach map of the middle clay. Specifically, Figure 3-23 suggest the middle clay pinches out in the vicinity of AOI-5, AOI-6, and AOI-7 but is present in AOI-9 which differs from K values observed on Figure 5-5D. Please provide rationale for k values used to represent the middle clay across the entire property when observations of the absence of the middle clay suggest the potential for presential flow in these portions of the facility.

Section 5.3:

- EPA requests a table be prepared to present aquifer testing data from Figures 3-20, 3-21, and 3-22, and the depth, elevation, and which model layer the aquifer testing correlates too. The table can be expanded to include the range of K values used for each soil stratigraphic unit displayed on Figures 5-5A through 5-5G.
- Discuss, where applicable, any deviations from measured site-specific K values to those provided in the model input.
- Discuss how K values incorporated anthropogenic features (e.g. fill)
- The K value discussion should be expanded to define the x, y, and z inputs and associated assumptions with isotropic or anisotropic conditions.

Section 5.5: EPA request that all parameters and ranges of parameters used as model inputs be summarized in a table citing the specific sources of information and if the input is based on site-specific data or literary refences. Assumptions and clarification of currently known model inputs is requested for the below:

- Section 5.5.1: Include a discussion on the assumptions of impervious cover at the facility and how this is represented in percolation estimates.
- Section 5.5.2: Indicate if offsite remediation systems have been incorporated into the model and any limitations associated with this data. Influence from offsite remediation systems should be discussed and evaluated in the sensitivity of the model.
- Section 5.5.4: Rivers are tidal but elevations held constant for stress periods. Discuss validity of this approach and effects on the model if tidal changes were to be taken into consideration. What elevation was used and how does this relate to sewer discharge elevations and interactions?
- Section 5.5.5: The drain package incorporates groundwater loss from sewers. Opine on where sewers are discharging and if this should be incorporated as water inputs into the model.
- Section 5.5.6 The use of one input for the bulkhead horizontal flow barrier, with barrier conductance discussed in Section 7.2.4 is not consistent with observations of groundwater mounding discussed in Section 3.2.3.2.1 and depicted on Figures 3-25 through 3-29. Specifically, areas of observed groundwater mounding are likely to reflect competent physical barriers, as modeled, compared to other portions of the waterfront where mounding is not occurring and not subject to the same input assumptions. EPA recommends that bulkhead horizontal flow barrier be revised to reflect observed mounding and bulkhead construction details and/or provide supporting rationale that indicates this assumption does not create a sensitive condition that adversely effects contaminant discharge to surface water.

- Figure 5-4 suggest the bulkhead boundary extends beyond Girard point and the Navy Yard. Please confirm how this portion of the horizontal flow boundary is represented.

Section 6.3, indicate if the calibration data was representative of the entire monitoring well network or a subset of wells. If specific wells were excluded from the calibration, identify these locations and provide rational for removal.

Figure 6-2A, 6-2B, and 6-2C, suggests a combination of sewer drain boundaries, remediation system withdrawals, and mingo basin create a modeled cone of depression that extends over 1 mile to the east of the facility. Part II of the report suggests the "sub-watershed scale was selected to accommodate naturally occurring boundary conditions." There is limited offsite calibration data to support this modeled result. Considering there are likely multiple leaky sewers to the east of the Site and other hydrogeologic conditions that have not been evaluated as part of the remedial investigation, representation of these conditions may not be justified. EPA recommends that the modeled extent observed on Figures be limited to portions of the facility that have ample calibration data.

Appendix D EPA recommends that Figure 6-4, 6-6, and Appendix D calibration plots be prepared for each model layer and evaluated. Clusters of points outside the 1:1 ratio should be discussed. EPA notes that by evaluating each layer separately patters become apparent and should be discussed. For example, elevations in the deeper layers (layer 6 and 7) may be underrepresented when compared to observed measurements (i.e. all points across each gauging event are dispersed above the 1:1 ratio line).

Table 7-1: The sensitivity analysis for River Bed Conductance indicates the Schuylkill River is a prominent discharge point. However, as modeled, pumping at Mingo Basin suggest the Schuylkill River may be "losing water" to the basin. Please clarify how was this interpreted in the model. Does it suggest that portions of the river that may be losing are less likely to accept contaminant discharges?

Sections 7.2.5 and 8.0: Evergreen should expand upon the conclusions in relation to the discussion around aquifer pumping wells in NJ to assess whether the Groundwater Flow Model has/can simulate groundwater flow to/under the Delaware River to accurately forecast fate and transport of contaminants in groundwater.

Section 9.0 notes, "*it is expected that the GWF Model will be utilized by Evergreen on an on-going basis…. it is essential that the model be diligently maintained, and additional data incorporated into the model and/or conceptual model as it is made available.*" Please describe how and when the model will be updated and incorporated into future reporting. Will triggers in site development, changes in remediation strategy (cessation of pumping from remediation systems), and installation of new wells trigger model updates?

Part 2 Contaminant Fate and Transport Assessment

Section 2.2 and 3.0: Several additional evaluations were performed to evaluate the extent of contaminant plumes, including LNAPL, associated with the facility. Considering the Fate and Transport is based on a Sitewide modeling approach, the current extent of each contaminant of concern, including LNAPL should be provided on Figures and discussed in the text.

Section 2.2: Facility operations have included the use of gasoline additives 1,2-dicoloroethane (1,2-DCA) and ethylene dibromide (EDB), these constituents are denser than water and have the potential to drive risk based decisions. In lieu of relying on detection frequencies, the selection of indicator parameters should consider if releases of 1,2-DCA and EDB have occurred, the extent of these contaminants, and the potential for a 1,2-DCA/EDB dense non-aqueous phase liquid (DNAPL) source.

Section 2.3.1: Please explain why increased is in parentheses describing travel time of Benzene.

Section 3.0: Several on and offsite groundwater plumes are discussed in the text. For clarity, EPA requests that a matrix be prepared to identify all contaminant plumes associated with the facility and offsite properties. The matrix should identify plume locations, suspected on or offsite sources, COCs associated with the plume, monitoring wells delineating the vertical and horizontal extent of impacts, whether modeling indicates the plume is stable or expanding, if the plume is discharging to surface water, and other relevant information (e.g. comingled with contamination originating offsite). The matrix should correlate with a Figure showing the extent and location of groundwater contaminants.

Section 3.1/Appendix C: Evaluation of the submerged oil / MGP coal tar should include an expanded laboratory analysis to incorporate all contaminants associated with coal tar (cyanides, arsenic, phenolics, additional VOCs and PAHs). This can be addressed in future regulatory submittals associated with the Belmont Terminal.

Section 3.3/Appendix E: Sampling location SSL2 mentioned on P3.23 was not identified on App E figures.

Section 4.2.2.2: Dispersivity estimates were based on literary resources and factoring ratios associated with site stratigraphy. Evergreen should evaluate how literature values compare to site specific data and if these values are more conservative as model input compared to site-specific data.

Section 4.2.3.3: To support assigning a relatively low laboratory method detection limits (MDLs) to non-detect contaminants in monitoring well inputs, the dataset should be reviewed to evaluate if source or plume wells have laboratory dilutions and elevated MDLs. If elevated MDLs are observed a deviation of the standard MDL should be considered as a model input.

Section 4.2.3.4 and Figures 4-3 through 4-7: A description and discussion of specific interpolation methods should be included in this section. Additionally, a figure showing the well network used to present the interpolation results should be included. Certain interpolation results appear suspect without this information such as MTBE near AOIs 4&9 and Benzene near AOIs 1&4 that show abruptly ending straight contour lines.

Section 4.3 and corresponding figures. Fate and transport simulations should project groundwater plumes to a calculated site-specific standard or tapwater RSL. It is also recommended that fate and transport simulations be prepared for alternative/additional timeframes (50, 100, etc years).

Table 4-2: Zone 1 and Zone 2 for parameter inputs should be defined as modeled layers or upper and lower aquifer for consistency with report text.

Section 4.3.1.1 and associating figures: Please expand upon the statement that over the simulated period of 30 years, dissolved benzene is generally predicted to decrease. While this appears to hold true for certain AOIs such as AOI8, the figures depict areas of increasing/expanding benzene concentrations such as near AOIs 1&9.

Section 4.3.1.1 and Figure 4-12: It is currently unclear how flux into the sewer system is incorporated into the model and the predictive simulation. Additional explanation is needed to clearly define how flux was evaluated, specific locations identified, if the data was calibrated, if and where contaminants are discharging from the sewer (such as at a treatment plant, river, or residential neighborhood), if other COCs were considered, and how this influences the fate and transport evaluation.

Sucralose sampling suggests the sewage/sewer is discharging to groundwater at the Facility. The fate and transport evaluation should be expanded to identify sewer discharge locations and other preferential pathways that are facilitating the distribution of contamination associated with the Facility.

Section 4.3.1.5 and Figures 4-23 through 4-26: Simulated concentrations of lead suggest that lead will not exceed the current MSC in a ten-year period. The discussion should be expanded to incorporate trends in analytical data to support the simulation. Considering the relatively short timeframe for lead to achieve the MSC, a calibration for the dissolved lead fate and transport should be conducted using existing data.

Section 4.5 it is unclear how produced maps are utilized as calibration targets. Please specify which maps serve as calibration and if the approach to calibration includes incorporating future groundwater monitoring. EPA notes that maps predicting the historic maximum extent of the plume in contrast to the current extent will provide a line of evidence that the fate and transport model is representative of subsurface conditions at the facility.

Analytical results from the 2022 annual sampling event should be provided with the report. This data should be reviewed in context of the model and could serve as a calibration for fate and transport predictive simulations.

Section 4.5 notes "Additional hydraulic data… may be beneficial in further validating the groundwater transport model…" Specify how new data will be used to update and validate the model and if updated versions of the model will be incorporated into future reporting.

Section 5.0:

a. All COCs should be reviewed and incorporated into the surface water model if there is a potential to discharge to surface water at a concentration that exceeds the applicable criteria. If excluding a COC, the text should specifically state why each COC was excluded in the surface water model.

b. Additional explanation is needed to summarize river boundary and shoreline hardening conditions and how these are incorporated into the surface water model.

c. Considering the pumped discharge from Mingo Basin to the Schuylkill River results in a BaP exceedance at the discharge location, the surface water in Mingo Basin is presumable contaminated. The potential for COCs to exceed the applicable criteria in Mingo Basin should be acknowledge and if removed as a surface water receptor due to results from the Risk Assessment, results of that report should be referenced.

e. the report should include proposed next steps for further evaluation or remediation of BaP at the Mingo Pump discharge location.

Section 6.0 Climate Resilience: EPA does not concur with the statement "Because groundwater gradient is not anticipated to change substantively, groundwater fluxes of contaminants are similarly assumed to remain consistent over time." Considering increasing groundwater elevations have the potential to mobilize contaminants currently located in the unsaturated or seasonally saturated portion of the soil column, elevated concentrations of COCs or observances of measurable LNAPL in source areas is considered likely. EPA requests that the evaluation be expanded to incorporate mapping source areas that have the potential to create hot spots in groundwater. This information can be used to support post remediation care monitoring at these locations. The impact of raising groundwater levels on preferential pathways, including but not only limited to flux to/from the sewer system, should be considered and evaluated.

Figures 4-18 and 4-22 are stamped draft. Appendix B / Attachment A Aestus Report is missing appendices.

Appendices:

1. App B – Does Evergreen have confirmation/agreement with PGW that apparent MGP based impacts noted in Belmont Terminal (BT)/AOI8 are PGW's source/responsibility? This information will be necessary to approve conclusions of this report as an appendix to the Fate & Transport Report and may be impossible with Belmont Terminal info included, as it has yet to have a Facility Investigation Report submitted.
    a. Aestus report graphic figures of BT outline do not appear to match actual. Please explain.

2. App E, Att A - figure 6 shows sheen beyond boom (compare with boom extent figure 2 App E)– is the boom not working? Also refer to figure 8 showing visible sheen.
    a. Att B Uvost report does not provide conclusions.
    b. Att C LNAPL Sch River Seep report – Recommended additional work to define seeps – Has Evergreen completed this? A complete Fate & Transport evaluation cannot be accomplished if unidentified seep locations exist along the river.
3. App L – Delft3D model
    a. Were LNAPL and seeps included? 5.1 conclusion clarifies no background or sewer inputs included. The model results may underrepresent total surface water impacts.
    b. Climate change scenario only done for Benzene – BaP should also be assessed due to exceedances.
    c. Evaluation and conclusions derived from model – Please refer to both EPA and PADEP ERA comments regarding recommended surface water sampling.
    d. Appendix L: Provide a visual representation of groundwater flow rates and contaminant inputs in the surface water modeled grid. Provide references that support the inflow to Mingo Basin represented in the model.
4. App H Aestus – Report discusses that Sewers bring in organic material which assists NZSD/biodegradation. How was this information incorporated into the Fate & Transport predictions?

Review and approval of memorandums included in Appendix D, E, and F outside of how this data may have been incorporated into the fate and transport analysis is beyond the scope of this report.

Attachment B
U.S. Army Corps of Engineers comments

Memorandum documenting review of the Sitewide Fate and Transport Remedial Investigation Report, Former Philadelphia Refinery

U.S. Army Corps of Engineers, Philadelphia District
September 2022

The USACE reviewed the Draft Sitewide Fate and Transport Remedial Investigation Report, Part 1 (Groundwater Flow Model) and Part 2 (Contaminant Fate and Transport Assessment) prepared by Stantec Consulting Services Inc., dated June 30, 2022. The review mainly focused on verifying that the modeling approach was sound and consistent with standard modeling practices. The following are general observations made while reviewing the report:

1. Stantec took a previously constructed MODFLOW model (Schreffler, 2001 and Sloto, 2012) and updated it with site-specific geologic data. Additional resolution was added in the area of interest. This an acceptable approach for constructing a groundwater flow model for the Former Philadelphia Refinery Site. During review, it was noted that Sloto, 2012 was referenced many times; however, the Sloto model report has been marked with "U.S. Geological Survey Administrative Report - for internal use of the U.S. Environmental Protection Agency; do not quote or cite."
2. The groundwater flow model was adequately calibrated to water levels collected in May 2017 from a large number of wells. The calibration was also compared to water level datasets collected during six other time periods, which showed small variations in results. Assumption of steady-state flow conditions for the calibration period is valid.
3. The calibrated groundwater flow model was used to generate a steady-state flow field for contaminant transport simulations which used the MT3D-USGS modeling code. It is reasonable to assume steady-state conditions for the transport scenarios in order to simulate long-term, average conditions at the site.
4. Modeled source areas were set at a constant concentration for the duration of the model simulation, which is a conservative approach.
5. Calibration of transport parameters was not attempted due to the complexity of the contaminant releases. Instead, transport parameters were based on literature values or calculated using site-specific data, if possible. This is a reasonable approach as long as the assumptions are explored through the appropriate sensitivity analyses. Modeled degradation rates were generally conservative with respect to literature values.
6. Fate and transport simulations included predicting plume extents of benzene, MTBE, naphthalene, BaP, and lead for 30 years. These simulations show that the plumes are stable or decreasing in size in most situations. Exceptions include:
    a. Benzene migration in the water table aquifer to the east along the Pollock Street/Packer Ave sewer (underneath the Sienna Place townhomes) and to the southeast of where 26th Street intersects Penrose Ave (southeast of AOI 4; Figure 4-9).
    b. Benzene migration from the water table aquifer to the lower aquifer on the Philadelphia Gas Works property, Belmont Terminal, AOI 3, AOI 6, and AOI 9.
    c. Benzene migration within the lower aquifer in AOI 6 and AOI 9.

d. Slight MTBE migration in the water table aquifer within AOI 1 and to the east of AOI 1 as well as downward migration of MTBE at the Belmont Terminal and AOI 1 from the water table aquifer to the lower aquifer.

7. Details of additional site investigations (e.x. Belmont Terminal, AOI 8 Ball Field) as well as environmental forensics analyses were included as appendices to the Fate and Transport report and summarized in Section 3.0. Details of these investigations were reviewed by the USACE for the purpose of understanding the Fate and Transport model but the appendices were not reviewed in detail for technical competency.
8. Model files (i.e. MODFLOW and MT3D-USGS input and output files) were not reviewed along with the report.

Specific comments have been included in the table below. In addition to those comments, the following are general comments and suggestions for improvement of the groundwater flow and contaminant transport study:

1. The terminology used to present inputs and outputs from various layers of the model was sometimes difficult to interpret. Results of the groundwater flow model were presented by model layer (i.e. Figures 6-2A through 6-2D show the potentiometric surface maps for model layers 1, 3, 5, and 7) while the fate and transport results are presented in terms of the "water table aquifer" and the "lower aquifer". This change in terminology is confusing and makes it difficult to understand what model layers are being presented in the fate and transport report. Some clarification is needed to understand which model layers are being shown as the "water table" results and which layers are shown as the "lower aquifer" results.

   Some discussion is also needed on the extent of the vertical migration of contaminants since it is unclear which model layers are included in the "lower aquifer" results. It seems as though no contamination was initially present in Layer 7 (lower sand of the PRM), but there was no discussion if this layer stayed clean throughout the 30-year model simulation.

2. Although the flow model was adequately calibrated, the large number of variable parameters in the flow and transport models result in the possibility for non-unique solutions. This type of uncertainty is typically unavoidable to some extent in flow and transport models, but confidence in the model solution can be increased through sensitivity analysis. A sensitivity analysis was conducted on the extent of the contaminant plumes; however, it was limited to a selected few transport parameters. Some flow parameters should be included in the fate and transport sensitivity analysis, even if only to show a lack of sensitivity to the parameter. The fate and transport sensitivity analysis should also include an evaluation of contaminant flux to the Schuylkill River since this is an input to the surface water model, as well as contaminant flux to the sewers. The groundwater flow results may have been only locally sensitive to parameters such as HFB conductance and riverbed conductance, but these parameters might have more of an impact on the flux of contaminants to the Schuylkill River, and thus inputs into the surface water model.

   In addition to examining the sensitivity of the fate and transport results to changes in HFB and riverbed conductance, changes in recharge, river stage, drain boundary conditions, and porosity should be explored. A sensitivity analysis including hydraulic conductivity may also be warranted due to the discrepancy between model calibrated values and values determined from aquifer tests. Sensitivity to vertical as well as horizontal conductivities should be considered. Results of the sensitivity analyses should be presented visually and discussed in the text so that readers from the public with a non-modeling background can understand the significance of each scenario. The discussion should also include how parameter changes impact contaminant fluxes to the Schuylkill River and sewers.

Specific Comments:

Comment #	Document	Section	Page	Comment
1	Part 1	Section 3.2	3.11-3.12	Consider providing the database of geologic picks as an appendix
2	Part 1	Figure 3-20	N/A	The upper ranges of color coded symbols are rather large (10-100 ft/day, 100+ ft/day). Consider providing an accompanying table that lists the K values at each testing location.
3	Part 1	Section 5.1	5.32	From the statement "The initial model steps were used to refine the model grid, **revise the boundary conditions to accommodate the new model grid**…", it is unclear if the boundary conditions were changed or if the same boundary conditions were applied, just to the new grid resolution. Please clarify.
4	Part 1	Section 5.2	5.32-5.33	This section refers to both active and inactive cells. Are all the cells shown on Figure 5-1 active? Where are the inactive cells?
5	Part 1	Figure 5-4	N/A	From the small inset in the upper right of this figure, it appears as though no boundary conditions were assigned over a majority of the Delaware River. Is this correct?
6	Part 1	Figures 3-36 and 5-4	N/A	There is a discrepancy between Figures 3-36 and 5-4 in the locations of bulkheads/HFB package near where I-95 crosses the Schuylkill River. It seems unlikely that there is a flow barrier extending across the entrance to the Philly Navy Yard as shown on Figure 5-4.
7	Part 1	Figures 5-5A thru 5-5G	N/A	These figures show that the Schuylkill River boundary was applied all the way through Layer 7. Is this correct?

Comment #	Document	Section	Page	Comment
8	Part 1	Figures 5-5A thru 5-5F	N/A	It is very hard to differentiate between the dark green color shading on these figures making it almost impossible to tell which areas were modeled as areas where the layers pinched out (with the high Kz value) and which areas are low K areas.
9	Part 1	Section 3.2.1.2.2/Figure 3-20/Figure 5-5A	3.14-3.15	The pumping test conducted at RW-2 suggests Ks of over 400 ft/d, but these Ks do not seem to be reflected in the hydraulic conductivity distribution of Layer 1 shown on Figure 5-5A. Ks in the area of the pumping test seem to have been modeled in the range of 5-20 ft/day. Please discuss why the calibrated hydraulic conductivity was much less than the aquifer test. Even if the aquifer test represents a localized phenomenon, wouldn't zones of high K material be important from a fate and transport perspective?
10	Part 1	Figure 3-20/Figure 5-5A	N/A	Aquifer testing data points on Figure 3-20 in AOIs 5 and 9 suggest Ks in the range of 10-100 ft/day and 100+ ft/day but layer 1 Ks were much lower in these areas. Are these aquifer tests reflective of a different model layer? Please clarify the discrepancy.
11	Part 1	Section 5.5.4	5.37	This section talks about 11 different river "reaches". Please identify these reaches on a map.
12	Part 1	Section 5.5.4	5.37	What values were used for the riverbed conductance? How were they determined?
13	Part 1	Section 5.5.4	5.37	Using the long-term average river stage is appropriate for long-term F&T simulations, but calibration was done to data collected at a specific time (May 2017). How did this long term average river stage compare to the average river stage during the calibration period?
14	Part 1	Section 5.5.4	5.37	Please include details of the stage assigned to the Delaware River and which layers of the model were assigned these boundary conditions. This information is not available in Sloto 2012 as referenced.

Comment #	Document	Section	Page	Comment
15	Part 1	Section 5.5.4	5.38	Please clarify what is meant when it is stated "Heads were assigned based upon the DEM" in reference to creeks and channels in the model. Were heads set equal to the elevation of the DEM?
16	Part 1	Section 5.5.5	5.38	Section 5.5.5 states that the Mingo Creek Basin is approximately 25 ft deep, which is shown on Figure 3-19 to extend into the Pleistocene Alluvium, but Figure 6-2C shows drains have been assigned as deep as layer 5 in this area. Please add a justification for assigning drains to this depth. A cross section from the model along profile N-N' might help clarify.
17	Part 1	Section 5.5.6	5.39	Please include the hydraulic characteristic values used in the HFB package (or Ks and width)
18	Part 1	Figures 6.2a-6.2d	N/A	Consider using the same contour shading that was used for the groundwater elevation contours in section 3 (example, Figure 3-28) so that these figures are easier to compare.
19	Part 1	Figures 6.2a-6.2d	N/A	The 2 ft contour interval makes it difficult to interpret groundwater flow direction across much of AOIs 1, 2, 3, and 4 as well as AOIs 5, 6, and 7 in layers 5 and 7. Consider using a smaller contour interval and making the contours visually more distinct.
20	Part 1	Figures 6-2, 6-3 & 6-5	N/A	It would be helpful to break down the residual plots by model layer and include error statistics calculated by layer. Including calibration targets on Figures 6-2A through 6-2D would also be helpful.
21	Part 1	Section 6.5	6.44	The error statistics reported for 2017 on page 6.44 don't agree with those shown on Figures 6-3 and 6-4
22	Part 1	Section 6.7	6.45	The error statistics reported for 2018 on page 6.45 don't agree with those shown on Figures 6-5 and 6-6
23	Part 1	Section 7.0	N/A	Were drains tested through sensitivity? If not, consider adding this sensitivity.

Comment #	Document	Section	Page	Comment
24	Part 1	Section 7.0	N/A	Were side boundaries (heads) tested during sensitivity? If not, consider adding this sensitivity. If side head boundaries were not updated since the Schreffler/Sloto models, the sensitivity analysis needs to demonstrate that the choice of head boundaries at the sides of the model doesn't impact the area of interest.
25	Part 1	Section 7.2.2	7.48	This states that recharge ranged between 10 to 12 inches (per year) but elsewhere in the report it is said to range from 4 to 9 in/yr (Section 5.5.1, Figure 5-6). Please verify the values of recharge used in the model and that the values used in the sensitivity were adjusted appropriately. If a multiplier was used, what was done with the large blue area in Figure 5-6 with 0 in/yr recharge?
26	Part 1	Section 7.2.3	7.48	What was the "reasonable range" that was used to test the sensitivity of riverbed conductance?
27	Part 1	Section 7.2	7.48-7.49	Some sort of sensitivity results need to be presented so that the reader can evaluate the overall sensitivity of the results to each parameter tested. This could be a comparison of calibration statistics, water level contour maps, etc.
28	Part 1	Section 7.2	7.48-7.49	The Mingo Creek Drainage basin sensitivity needs to be described in the text, not just in Table 7-1.
29	Part 2	Section 4.2.1.2	4.30	Please provide a reference for the "multiple lines of evidence that indicate that biodegradation is actively occurring at the facility". Also provide a potential explanation as to why calculated degradation rates were biased high and therefore not used in the model.
30	Part 2	Section 4.2.2.1	4.30-4.31	The text states that porosity is "not considered to be a sensitive parameter in the transport model." In my experience, I have not found this to be true. It can have a significant impact on how fast contaminants will travel, and thus how far contaminants can spread. This statement needs to be backed up with a sensitivity analysis.

Comment #	Document	Section	Page	Comment
31	Part 2	Section 4.2.2.2	4.31	Please clarify why studies from literature were used to determine plume lengths for benzene and MTEB instead of using actual plume lengths. Because actual plume lengths cannot be determined due to multiple releases and comingled plumes?
32	Part 2	Figure 4-2	N/A	This figure shows that the river boundary condition was applied vertically through layer 7 of the model. Is this correct? This vertical extent seems like it would be much too deep for the bottom of the river.
33	Part 2	Figures 4-3 through 4-7	N/A	Were areas outside of the color flooding shown on these figures also assigned an initial concentration (i.e. Concentrations < the MSC)? From the text, it seems as though initial concentrations as low as the MDL were assigned to the grid. A note on Figures 4-3 through 4-7 and/or in Section 4.2.3.4 would help to clarify.
34	Part 2	Figures 4-3 and 4-4	N/A	Initial concentrations of MTBE and benzene look oddly truncated to the east of AOI 1 and SE of AOI 4 in layer 5. Is this a contour display issue or were portions of these plumes purposely removed due to other sources? (The contour interval in Figure 6-2c of Part I makes it impossible to tell which way groundwater is flowing in this area.)
35	Part 2	Section 4.2.4	4.37	Please add a justification for not including lead source zones in the model.
36	Part 2	Section 4.3	4.37	Predictive simulations were run for a period of 30 years. Please discuss if dissolved phase plumes had reached steady-state conditions within this time. If not, consider extending the simulation period until plumes reach a steady-state condition.
37	Part 2	Section 4.3	N/A	The flux of benzene to the sewer was computed and shown on Figure 4-12. Consider providing similar figures for the other modeled constituents.

Comment #	Document	Section	Page	Comment
38	Part 2	Figures 4-23a through 4-23e and 4-25a through 4-25e	N/A	The lead concentrations in the legend on these figures need units. The contour interval is also rather large. Since it appears that all initial concentrations are < 100 (ug/l?), consider narrowing the contour interval so the reader can identify which areas are closer to 5 ug/L and which areas are closer to 100 ug/L
39	Part 2	Section 4.3, Multiple Figures	N/A	What model layers are being shown in figures showing contaminant distribution in the lower aquifer (example: Figures 4.10a-e and 4.11 for benzene)? Is this just model layer 5 or the maximum extent from model layers 3, 5, and 7? The text should also discuss if there was any vertical migration into model layer 7 and show additional figures if necessary.
40	Part 2	Section 4.3.1.5	4.40	What degradation processes are responsible for the attenuation of lead in the model? Please clarify if declining concentrations are due only to dispersion/dilution or if geochemical processes were included in the model.
41	Part 2	Section 4.3.1.5	4.40	Please discuss if model predictions of lead concentrations are in-line with historic observations of lead concentrations. Is it reasonable to assume that all dissolved lead concentrations will drop below the PA MSCs within 10 years (4 years according to Table K-1) when we are still seeing lead in the groundwater several decades after historical releases?
42	Part 2	Section 4.4	4.41	Some sort of discussion on the sensitivity results is needed in the text. Since this report is being released to the public, simply presenting a series of pictures without further explanation is not adequate for the reader to understand the significance of the parameters being tested in the sensitivity analysis.
43	Part 2	Section 4.5	4.42	The final sentence of the second bullet point in this section states "These maps are the calibration targets." What is this sentence referring to?