Addendum #1

Figure 1: Revised version included in Addendum #4

Figure 2: Revised version included in Addendum #2

Figure 3: This cross section is not applicable to 2021 work and may be revised based on future discussions with Regulators.

Figure 4: This cross section is not applicable to 2021 work and may be revised based on future discussions with Regulators.

Figure 5: Revised version for Remediation Area 16 only included in Addendum #2.

Figure 6: This cross section is not applicable to 2021 work and may be revised based on future discussions with Regulators.

Figure 7: This cross section is not applicable to 2021 work and may be revised based on future discussions with Regulators.

Figure 8: Revised version for area north of Field 4 only included in Addendum #3.

AECOM
500 Enterprise Drive
Rocky Hill, CT 06067
aecom.com

Project name:
Greenwich High School

Project ref:
60432365

From:
AECOM

Date:
April 26, 2021

To:
Kimberly Tisa
PCB Coordinator – Region 1
United States Environmental Protection Agency
1 Congress Street, Suite 1100
Boston, MA 02114-2023

Phase II RAP Cost-Benefit Analysis of Suggested Changes

On behalf of the Town of Greenwich, AECOM has prepared a focused evaluation of alternatives to address potential changes suggested by the Connecticut Department of Energy and Environmental Protection (DEEP) and United States Environmental Protection Agency (EPA) subsequent to an April 7, 2021 meeting, wherein AECOM and Agencies discussed the Phase II Remedial Action Plan (RAP) for Greenwich High School. The potential changes to the remedial design detailed in the Phase II RAP suggested by the Agencies related to whether the design could be modified to use a 2-foot clean material layer, rather than a 1.5-foot clean material layer along with the impermeable, welded linear low-density polyethylene (LLDPE) liner, high-density polyethylene (HDPE) geocomposite drains, and dense-graded aggregate (DGA) which comprise the proposed Engineered Control (EC) beneath the artificial turf fields. The Agencies specific suggestions and a cost-benefit evaluation of each are presented below.

Potential Changes to Design

Suggested Change 1: Remove an additional 6 inches of soil containing PCBs greater than 1 ppm within the top 2 feet to achieve a minimum of 2-feet of clean material overlying the remaining polluted soil.

There are two ways to effect this change, which maintains the proposed final surface grades. Either additional soil can be removed from below the liner without changing the liner's surface elevation (Suggested Change 1a), or an additional 6 inches of soil can be removed to allow for the liner to be relocated 6 inches deeper (Suggested Change 1b). The costs and benefits of these two options are detailed below.

Suggested Change 1a: Removal of additional soil from below the liner would entail additional excavation from areas below Field 3, Field 4, and the spectator area where excavation to 1.5 feet below proposed final grade surface is specified in the RAP. While this would not change the design of the EC or the fields, it would share many of the same impacts to cost and schedule as the Change 1b option.

<u>Impacts to Cost and Schedule:</u>

- Additional days to excavate impacted material.
- Additional disposal of PCB remediation waste.
- Loss of capacity beneath the impermeable liner to reuse and cap-in-place polluted soil.
- Additional import of clean fill/stone material below the liner.
- Additional days for backfilling.

- Additional days working with contaminated soil below Field 3 will extend Phase 2 beyond one summer season, which will result in loss of a field for over a calendar year and require the management of an open excavation throughout the school year.

Suggested Change 1b: Removal of additional soil from above the liner and lowering the liner to a depth of 2 feet below final surface grade would entail redesign of the impermeable liner system, stormwater features, groundwater collection system, and additional excavation from areas below Field 3, Field 4, and the spectator area where excavation to 1.5 feet is specified in the RAP.

Impacts to Cost and Schedule:

- Redesign of impermeable barrier Engineered Control and associated stormwater collection system and groundwater collection system.
- Project will be delayed one year, due to need for redesign.
- Additional days to excavate impacted material.
- Additional disposal of PCB remediation waste.
- Loss of capacity beneath the impermeable liner to cap-in-place polluted soil.
- Additional import of clean fill/stone material above the liner.
- Additional days for backfilling.
- Additional days working with contaminated soil below Field 3 will extend Phase 2 beyond one summer season, which will result in loss of a field for over a calendar year and require the management of an open excavation throughout the school year.

The lower liner elevation will result in collection of more groundwater in the HDPE geocomposite placed below the liner to alleviate static pressure and potentially risk the integrity of the liner due to pressure caused by groundwater. Based on continuous groundwater gauging data collected in the last three years, groundwater elevation at MW-Y9 (located at the southwest corner of Field 3) exceeded the lowered liner elevation for multiple days at a time. While installation of the impermeable liner is expected to reduce infiltration, thereby decreasing the episodic response to rainfall, the lower elevation of the impermeable barrier will likely necessitate more frequent pump outs of the groundwater collection cisterns and offsite disposal of impacted groundwater. Further evaluation would be required to determine the technical feasibility of lowering the liner.

Suggested Change 2: Add an additional 6 inches of clean soil above the impermeable liner and below the artificial turf fields, raising the proposed final grade of the fields 6 inches, to achieve a minimum of 2-feet of clean material overlying the liner and remaining polluted soil.

Impacts to Cost and Schedule

- Redesign of impermeable barrier Engineered Control, redesign Field 3 and Field 4 perimeter grading tie-ins, redesign of ADA compliant access ramp, adjacent spectator area, and block retaining wall.
- Redesign of stormwater conveyance and detention system and updating of the Stormwater Management Site Plan due to changes in the post-construction grades at the site.
- Reevaluation of hydraulic modelling completed for the project for the West Brothers Brook Watershed.
- Update and resubmit Inland Wetlands and Watercourses permitting due to changes in the post-construction grades at the site in the wetland buffer area.
- Project will be delayed one year, due to need for redesign.
- Additional import of clean fill/stone material above the liner.
- Additional days for backfilling.

Additional Alternatives to Increase Clean Soil

The Agencies requested an assessment of potential alternatives for increasing the thickness of the EC from 1.5 to 2 feet. Additional potential alternatives to place a 2-foot clean material layer above remaining polluted soil would involve a combination of Suggested Changes 1 and 2. Any change to the design elevation of the impermeable liner or change in grade would necessitate a redesign of the liner system and stormwater management system and an associated one-year delay to the project. Suggested Change 1a is the only alternative to designing a 2-foot-thick cap that would not involve such a delay.

Evaluation of Benefits of the Suggested Changes

The impermeable liner EC proposed in the RAP is located beneath the artificial turf field components which include 1-inch turf fibers, an infill layer, a 1-inch thick shock pad, and 6 inches of dynamic stone base. The top of the EC is demarcated by a high visibility geotextile followed by 12 inches of DGA or vegetative fill, an HDPE geocomposite, an LLDPE membrane liner, and a second HDPE geocomposite. The total thickness of this proposed cap, excluding the turf fiber and shock pad, is 18 inches.

- Increasing the thickness of soil incorporated into the EC by six inches will not reduce incremental risk or affect potential for exposure due to the EC.
- All soil beneath the fields will be rendered inaccessible and environmentally isolated by the EC and an Environmental Land Use Restriction. This will not change as a result of a thicker clean soil component of the EC.

While a 2-foot thick barrier can be more protective than a thinner barrier in some instances, the nature of the proposed cap for Fields 3 and 4 at the site is such that the additional thickness does not provide any additional protectiveness. The proposed cap includes 6 separate manufactured layers (i.e., turf, padding, flat drain, marker fabric, geocomposite drain (above liner), geomembrane liner, and geocomposite drain (below liner)), in addition to clean fill that act both as barrier and deterrent to disturbance of the underlying impacted material. With these manufactured components emplaced, which are unlikely to be disturbed, and an ELUR recorded to prevent disturbance of the bottom four artificial layers and the majority of the clean fill, the EC will be fully protective without an additional 6 inches of clean fill incorporated into it.

Table 1 presented below summarizes the costs for each of the Suggested Changes. A detailed cost estimate is provided as **Table 2.**

Additional Cost Item	**Suggested Change 1a** **Remove Additional 6 Inches Below Liner**	**Suggested Change 1b** **Remove Additional 6 Inches Above Liner**	**Suggested Change 2** **Raise Grade by Placing 6 Additional Inches of Clean Fill**
Soil Excavation	$54,000	$54,000	$0
Fill Placement & Impermeable Liner Install	$127,000	$155,000	$251,000
Post-Remediation Groundwater Treatment	$0	$1,000,000	$0
Air Monitoring	$11,000	$11,000	$6,000
Waste Transportation and Disposal	$935,000	$935,000	$0

Additional Cost Item	Suggested Change 1a Remove Additional 6 Inches Below Liner	Suggested Change 1b Remove Additional 6 Inches Above Liner	Suggested Change 2 Raise Grade by Placing 6 Additional Inches of Clean Fill
Remedial Design, Construction Management, Reporting	$69,000	$169,000	$302,000
Subtotal	$1,196,000	$2,325,000	$560,000
Total (including 20% contingency)	**$1,435,000**	**$2,800,000**	**$670,000**

Time constraints associated with the earthwork of contaminated materials during the summer break limit the amount of excavating and backfilling that can be performed in one mobilization. Therefore, additional digging and backfilling, particularly in Phase 2, may require work be completed in another mobilization, leaving a field unfinished for a year and requiring fencing and other interim measures to manage the open excavation during the school year until field construction can be performed. Please let us know if you have any questions or comments on the information provided.

Kind regards,

Pat Haskell

Patrick Haskell, LEP, CHMM
Technical Lead

Michael J. Doherty

Michael Doherty, Vice President

cc: Amy Siebert, Greenwich Department of Public Works
Jeff Wilcox, CT DEEP
Gary Trombly, CT DEEP
Amber Trahan, CT DEEP
Jane Warren, McCarter & English

Attachments:

Table 2 – Detailed Cost Estimate

Table 2
Cost-Benefit Analysis
Agency Suggested Changes
Phase II RAP
April 2021

	Additional Quantities for Change 1a:	Additional Quantities for Change 1b:	Additional Quantities for Change 2:
Number of Excavation Days	8 days	8 days	0 days
Number of Backfill Days	5 days	5 days	7 days
Soil Dry Volume	2200 CY	2200 CY	0 CY
Volume of Soil Excavated	2200 CY	2200 CY	0 CY
Tons of Soil Excavated	3740 tons	3740 tons	0 tons

Description	Unit	Unit Rate	Change 1b Additional Quantity	Change 1b Additional Cost	Change 1a Additional Quantity	Change 1a Additional Cost	Change 2 Additional Quantity	Change 2 Additional Cost
Site Clearing and Grubbing				**$0**		**$0**		**$0**
Excavation Shoring				**$0**		**$0**		**$0**
Stockpile, Laydown Area, Decon Construction				**$0**		**$0**		**$0**
Construction Dewatering				**$0**		**$0**		**$0**
Soil/Sediment Excavation				**$54,020**		**$54,020**		**$0**
Backhoe	Day	$950	8	$7,600	8	$7,600	0	$0
Excavator (2 excavators)	Day	$8	8	$11,040	8	$11,040	0	$0
Loader	Day	$8	8	$9,680	8	$9,680	0	$0
Skid Steer	Day	$4	8	$1,900	8	$1,900	0	$0
Laborer (3 laborers)	Day	$1,665	8	$13,320	8	$13,320	0	$0
Operator (2 operators)	Day	$1,310	8	$10,480	8	$10,480	0	$0
Drying of Saturated Soils	Ton	$22	0	$0	0	$0	0	$0
Sampling				**$0**		**$0**		**$0**
Fill Placement / Impermeable Barrier Install				**$126,740**		**$155,137**		**$251,111**
Compactor	Day	$4	5	$1,950	5	$1,950	7	$2,889
Excavator	Day	$4	5	$3,450	5	$3,450	7	$5,111
Loader	Day	$4	5	$3,025	5	$3,025	7	$4,481
Bulldozer	Day	$4	5	$3,200	5	$3,200	7	$4,741
Operator	Day	$1,310	5	$6,550	5	$6,550	7	$9,704
Laborer	Day	$1,665	5	$8,325	5	$8,325	7	$12,333
Backfill Analytical Test Samples	Each	$600	5	$3,000	5	$3,000	7	$4,444
Geocomposite Install (includes material)	SY	$0	0	$0	0	$0	0	$0
LLDPE Membrane Install (includes material)	SY	$0	0	$0	0	$0	0	$0
Demarcation Layer	SY	$1.3	0	$0	0	$0	0	$0
Membrane Boot	Each	$500.0	0	$0	0	$0	0	$0
Piping System (Gas)	LS	$50,000.0	0	$0	0	$0	0	$0
Common Fill (includes install)	Ton	$26	3740	$97,240	-3145	-$81,770	0	$0
Vegetative Fill (includes install)	CY	$37	0	$0	0	$0	0	$0
DGA (includes install)	CY	$56	0	$0	3704	$207,407	3704	$207,407
Post Remediation Groundwater Treatment				**$0**		**$1,000,000**		**$0**
Groundwater Collection System O&M (10 years)	Year	$100,000	0	$0	10	$1,000,000	0	$0
Air Monitoring				**$11,000**		**$11,000**		**$6,221**
Mob/Demob	Each	$1,100	0	$0	0	$0	0	$0
Equipment	Month	$2,800	0.5	$1,400	0.5	$1,400	0.3	$840
Air Technician	Day	$475	13	$8,320	13	$8,320	7	$4,741
Analytical Samples	LS	$500	0	$0	0	$0	0	$0
Office Support	Week	$475	2	$1,280	2	$1,280	1	$640
Site Restoration				**$0**		**$0**		**$0**
Waste Transportation and Disposal				**$935,000**		**$935,000**		**$0**
PCB Disposal > 50	Ton	$250	3740	$935,000	3740	$935,000	0	$0
Turf Field Installation				**$0**		**$0**		**$0**
EC Maintenance and Monitoring				**$0**		**$0**		**$0**
Program Management				**$69,000**		**$169,000**		**$302,222**
Remedial Design, Construction Management, Reporting	LS	Varies		$69,000		$169,000		$302,222
Subtotal				**$1,195,760**		**$2,324,157**		**$559,554**
Contingency (20%)				**$239,152**		**$464,831**		**$111,911**
Total			**Total Additional Cost for Change 1b**	**$1,434,912**	**Total Additional Cost for Change 1a**	**$2,788,989**	**Total Additional Cost for Change 2**	**$671,465**

AECOM Imagine it. Delivered.

AECOM
500 Enterprise Drive
Rocky Hill, CT 06067
aecom.com

April 26, 2021

Ms. Kimberly Tisa
PCB Coordinator – Region 1
United States Environmental Protection Agency
1 Congress Street, Suite 1100
Boston, MA 02114-2023

Contingency Groundwater Remedy Design
Greenwich High School
10 Hillside Rd
Greenwich, Connecticut

Dear Ms. Tisa,

On behalf of the Town of Greenwich (Town), AECOM is providing this summary of the groundwater contingency remedy design for your use in reviewing the January 15, 2021 Phase II Remedial Action Plan (RAP) for the Greenwich High School site. Based on verbal comments received from the United States Environmental Protection Agency (EPA) and Connecticut Department of Energy and Environmental Protection (DEEP), AECOM developed a design for a contingency groundwater containment system, elements of which will be installed in conjunction with soil excavation and Engineered Control construction activities. The conceptual basis for that design, a groundwater model used to develop the details of the design, and the elements of the design to be constructed as part of activities performed under the Phase II RAP are described herein.

Background

Soon after the Phase II RAP was submitted, DEEP indicated that although constituents associated with the soil to be capped under the proposed Engineered Control (EC) were not present in groundwater at concentrations exceeding Surface Water Protection Criteria (SWPC) near downgradient receptors, the installation of the underground components of a groundwater containment system in conjunction with soil remediation and EC construction would make it easier to approve the EC. Such a system would provide a means to address potential slow migration of dissolved constituents, should that be observed subsequent to the construction of the EC. In response to that request, AECOM developed a design for such a system based on hydrogeologic and groundwater chemistry data for the site. This system focuses on containing groundwater in the shallow aquifer, where constituent concentrations are highest and theoretically have the potential to migrate to surface water. During recent meetings between AECOM and the Agencies, where the design for the contingency groundwater containment system was discussed, CT DEEP expressed concern that deep groundwater could migrate off-site through bedrock independent of the shallow aquifer. This report therefore includes a broader discussion of groundwater flow behavior at the site, as well as presenting the conceptual design for the contingency groundwater remedy.

Site Hydrogeology

The site is located at 10 Hillside Road in Greenwich, Connecticut (see **Figure 1**). West Brothers Brook runs through the site, entering at the northwest corner of Field #4 (see **Figure 2**), being routed through a concrete channel around Fields #4, #3 and #2, before returning to its natural channel, flowing into Cider Mill Pond, south of the school buildings. Cider Mill Pond is formed by the impoundment of West Brothers Brook behind a man-made boulder dam, over which surface water falls approximately 15 feet and flows through three reinforced concrete pipes that convey surface water off-site beneath East Putnam Avenue, where West Brothers Brook discharges to Greenwich Creek. West Brothers Brook and Greenwich Creek form a sub-regional drainage basin that drains directly to Long Island Sound, and which is located immediately west of the Mianus River regional drainage basin and east of the Horseneck Brook sub-regional drainage basin. The extent of the Greenwich Creek drainage basin and the site location are depicted in **Figure 3**.

The site is located in the lower part of the Greenwich Creek drainage basin, where it narrows just upstream of the confluence of West Brothers Brook and Greenwich Creek. In this area, the drainage basin is bounded by bedrock highlands along Brookridge Drive, located one block east of the site, and Maple Avenue, located three blocks west of the site. Drainage patterns in this narrow part of the drainage basin are directly toward Greenwich Creek from the uplands to the east and west, as the land slopes steeply down to West Brothers Brook and Greenwich Creek.

The nature of the site hydrogeology is such that groundwater flows similar patterns. Site-wide groundwater elevations have consistently remained higher than surface water elevations since water level measurements began at the site in 2011, indicating the groundwater elevation gradient is oriented towards West Brothers Brook, rather than along the valley of the drainage basin. This is illustrated by site groundwater contour maps, a typical example of which is provided as **Figure 4**. In bedrock, the potential for down-valley flow is even less, as outcrops on valley sides allow for discharge to more permeable overburden formation material or to surface water, the transmissivity of which is many orders of magnitude more permeable than bedrock.

At the site, groundwater has been observed in shallow overburden materials that include till, fill, and wetland (peat or highly organic) deposits. The thickness of the fill material encountered varies greatly across the Site influencing the groundwater levels observed in monitoring wells across the Site. The thickest fill material and wetland deposits are observed to be below Fields 3 and 4, in an area of lower bedrock elevation, referred to as the bedrock bowl, in which the wetlands that were formerly present at the site developed. These wetlands received water and groundwater discharge from the surrounding uplands and were drained by West Brothers Brook. Groundwater in the bedrock bowl, like the former wetland, is still drained by West Brothers Brook.

Before the construction of Fields 3 and 4, historic wetland drainage channels flowed southeast and east across Fields 3 and 4 (see Figure 7 in **Appendix A**). These drainage channels originated at the base of the bedrock hillside, northwest of Field 4, indicating that groundwater is discharging from the western bedrock uplands to surface water at the site. Current shallow groundwater elevation contours indicate groundwater flow parallels the historic wetland channels. While steep gradients exist between the shallow aquifer and the culverted portions of West Brothers Brooks, indicating resistance to groundwater flow, the gradient on the eastern portion of the fields generally follows the southeasterly orientation of the historic location of West Brothers Brook that bisects the fields. The former channels represent areas where peat deposits are thinner and, thus, were filled with more permeable fill, that likely acts as a drain promoting flow to the southeast toward the existing natural channel of West Brothers Brook to the southeast.

Appendix A presents a series of figures from the Hydrogeologic Investigation Report that illustrate a geological cross-section along the direction of groundwater flow from the fields to the south, toward the brook. The extent of the silty peat unit is depicted in cross-section. The absence of the silty peat unit below the western portion of Field 2 means that the deep aquifer is hydraulically connected to West Brothers Brook. Because the silt unit does not extend across the site to the brook, deep overburden materials discharge to the brook, rather than flowing through bedrock.

While groundwater at some sites can migrate along permeable layers in highly fractured rock formations with dominant fracture orientations, such as weathered sandstone, in a massive rock formation such as the Harrison Gneiss, which underlies the site (Rogers, 1985), groundwater flow through bedrock generally occurs through secondary porosity (i.e., fractures), in smaller quantities. Where groundwater can discharge to surface bodies that provide virtually no resistance to flow; groundwater flow through bedrock occurs only over short distances.

Generally, in layered hydrogeologic systems with overburden and bedrock present, the majority of groundwater flow occurs in the overburden due to significantly higher hydraulic conductivity [Freeze and Cherry, 1979]. The overburden materials present at the site which overly the Harrison Gneiss consist primarily of silty sands and have an estimated hydraulic conductivity of approximately 15 feet per day, based on site specific-slug testing. The Harrison gneiss encountered at the site has been noted as weathered in the top one or two feet, but competency increases with depth. Literature values estimate the range of fractured crystalline rocks to be between 0.0003 and 30 feet per day [AGI, 2016]. The upper end of the range includes highly fractured bedrock, which has not been identified in the numerous outcrops at the Site. The more likely high-end range of the bedrock hydraulic conductivity based on observation of the lithology at the site is several orders of magnitude lower, approximately 0.3 feet per day. Even at this conservative estimate of hydraulic conductivity, it is still 50 times lower than that of the overburden materials.

Considering the hydraulic sink formed by West Brothers Brook, with heads below that of the surrounding overburden create a preferred flow path to the brook, rather than downward or laterally into the bedrock aquifer. Due to the high elevations of bedrock outcrops surrounding the site, which would be recharged by precipitation, heads in the bedrock are also likely higher than those in West Brothers Brook. The most logical conceptualization of the groundwater interactions between the overburden and bedrock is that groundwater recharged in the upland areas of bedrock outcrop discharge to the alluvium, and then eventually to West Brothers Brook. Discharge from the bedrock to overburden below Fields 3 and 4 likely represents a small fraction of the overall groundwater flow through the overburden, which is primarily controlled by recharge from precipitation and discharge to surface water. The deep overburden therefore discharges to the brook, and thus, the appropriate monitoring point for potential plume migration from the deep aquifer is the overburden adjacent to the brook.

Groundwater Chemistry

Site investigation activities have characterized the extent of PCBs and other constituents in groundwater. The extent of impacts and comparison of concentrations to applicable criteria were detailed in the Phase II RAP. In the deep overburden, PCB concentrations exceed the Surface Water Protection Criterion (SWPC) only at well MW-AJ13D, which is located near the center of Fields 3 and 4, approximately 625 feet upgradient of the brook. Concentrations of PCBs in the deep overburden nearer the brook, at well MW-V16 are two orders of magnitude below the SWPC (AECOM, 2020). Concentrations are also below the SWPC at wells MW-Y9D, MW-AA12D, and MW-Y15D, which are located approximately 160 to 450 feet upgradient of the brook. Based on the limited distribution of deep overburden contamination, and the reduction in flux into the deep aquifer from contaminated material in the shallow aquifer, due to expected reductions in downward hydraulic gradients, due to the installation of an impermeable cap below the fields, migration of groundwater into and through the deep overburden is expected to be further reduced. Therefore, groundwater containment in the deep aquifer is not necessary.

Contingency Groundwater Remedy Conceptual Design

Based on the above factors, the design of the contingency groundwater remedy for the Fields 3 and 4 area focuses on the shallow aquifer. The hydraulic design was developed through use of groundwater analytical element flow model simulating the shallow aquifer above the silty peat unit present at the site. This model was calibrated to current groundwater contours and then used to simulate placement of an impermeable cap and pumping of a series of shallow groundwater wells located beyond the limits of the impermeable EC to be installed above contaminated soil beneath Fields 3 and 4. Details of that model and the hydraulic design of the contingency containment system are provided in the groundwater model report provided as **Appendix B**. Based on the groundwater flow model, the design flow for the contingency remedy is 5 gallons per minute.

Contingency Groundwater Remedy Detailed Design

Because groundwater impacts associated with soil contamination in the area of the EC are generally confined to the area of the soil contamination and groundwater concentrations do not extend to West Brothers Brook, which is the nearest potential exposure point, the physical elements of the contingency groundwater remedy design focus on those elements that will be installed beneath the EC. These components include groundwater conveyance pumping, electrical conduits and associated pull boxes, and storage tanks. The tanks, which are a component of the passive groundwater control system already incorporated into the EC design, are located near the southeast corner of Field 3. Should the contingency system become necessary, a groundwater treatment system would be installed near these tanks and groundwater recovery wells would be installed at the locations determined based on the groundwater modeling. The storage tanks are equipped with fittings to make such a conversion simple and space is set aside for placement of a treatment system, which would incorporate physical and granular activated carbon filtration. Future recovery well locations will be monumented in the field during construction of the EC.

The locations of the physical components of the contingency groundwater recovery system are depicted in the attached drawings provided in **Appendix C**. Due to the low pumping rate necessary to obtain containment of water, the infrastructure that is being installed has a far greater hydraulic capacity than the design flow. The piping and tanks are capable of managing flow rates that are more than an order of magnitude higher than the design flow that was developed to obtain capture of groundwater flowing away from the EC. This will allow flexibility in implementation, including performance testing, should the contingency remedy become necessary.

Conclusions

Given that the contamination being addressed by the Phase II RAP has been in place for over 50 years and excavation and capping will reduce the potential for groundwater contamination and dissolved-phase migration, implementation of the contingency remedy is not expected. However, while current conditions do not indicate the need for groundwater recovery, the contingency groundwater remedy would allow for groundwater recovery and treatment to be performed in the future, should slow-moving constituents like PCBs demonstrate gradual mobility in the future. The contingency remedy design is robust and would readily contain any plume should one develop in the future.

Please let us know if you have any questions or comments on the attached materials.

Sincerely,

Patrick Haskell, LEP, CHMM
Technical Leader

Dave Estrella
Water Resources Engineer

cc: Jeff Wilcox, CT DEEP
Gary Trombly, CT DEEP
Amber Trahan, CT DEEP
Amy Siebert, Town of Greenwich
Toni Jones, Greenwich Public Schools
Dan Watson, Greenwich Public Schools
Jane Warren, McCarter & English

Attachments:
Figure 1 Site Location Map
Figure 2 Monitoring Well Network
Figure 3 Subregional Drainage Basins
Figure 4 November 2020 Shallow Potentiometric Surface Elevations
Appendix A Hydrogeologic Investigation Report Figures
Appendix B Contingency Groundwater Capture Evaluation
Appendix C Contingency Groundwater Capture Design Details

References

AECOM, 2019. Artificial Turf Field and Site Hydrogeologic Investigation Report. Greenwich High School. March 28, 2019.

AECOM, 2020. Annual progress report, June 2019 – May 2020. Greenwich High School. September 18, 2020.

Freeze, R. A., and J. A. Cherry. 1979. *Groundwater.* Englewood Cliffs, NJ: Prentice Hall, Inc.

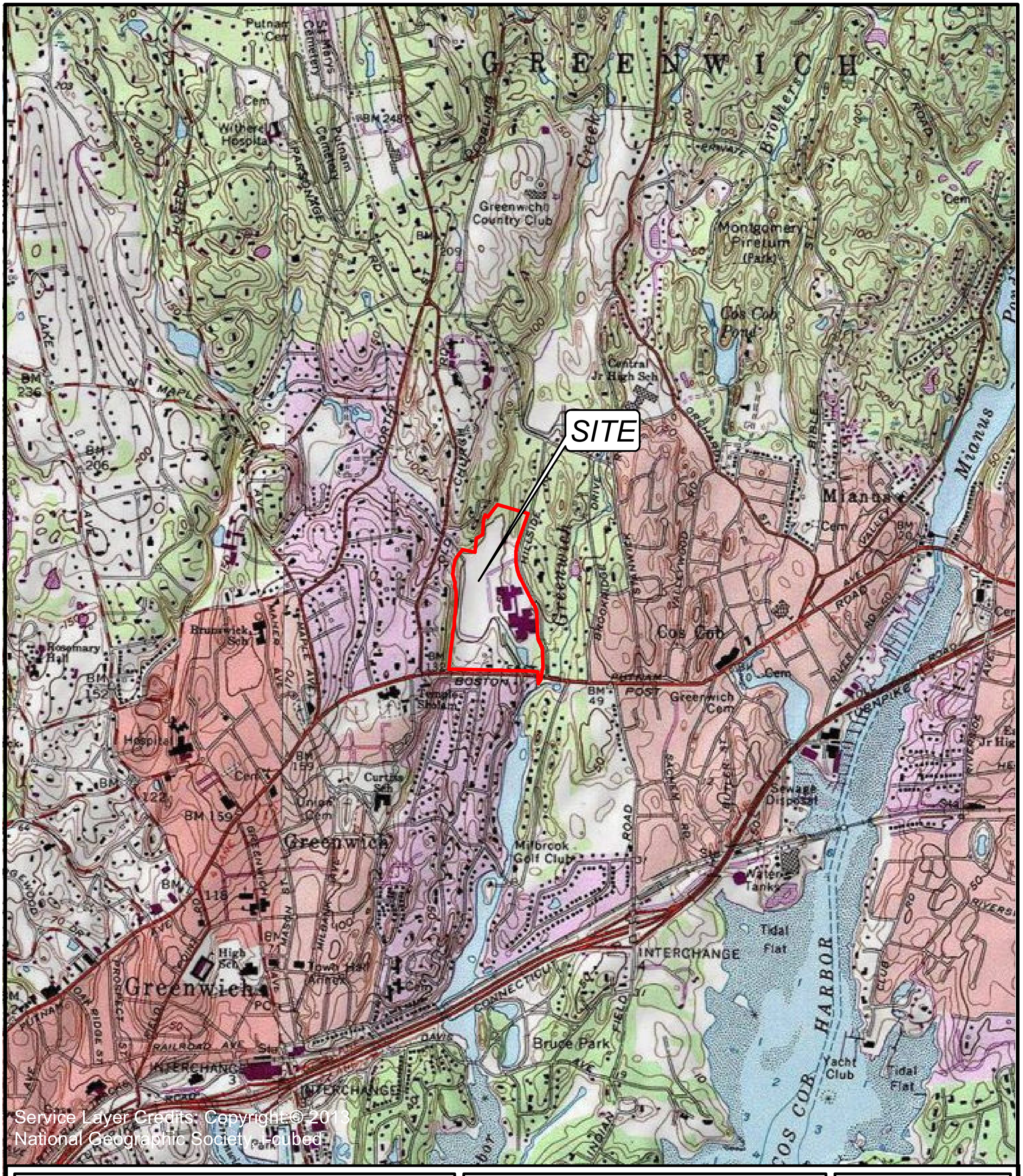
AGI, 2016. The Geoscience Handbook 2016: American Geosciences Institute Data Sheets, Fifth Edition. Edited and compiled by Mark B Carpenter and Christoper M. Keane.

Pyrak-Nolte, L.J., L. R. Meyer, N.G.W. Cook & P.A. Witherspoon, 1987. Hydraulic and mechanical properties in natural fractures in low permeability rock. *Proceedings of the 6th International Congress on Rock Mechanics*, G. Herget & S. Vongpaisal (ed.), pp. 225-231.

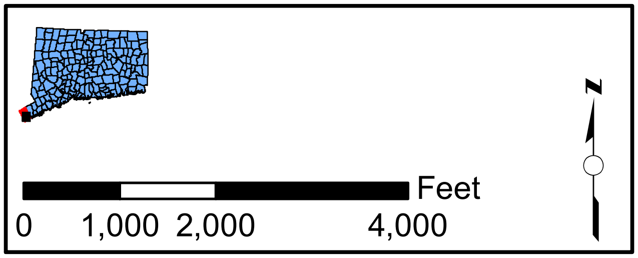
Raven, K.G., K.S. Novakowski & P.A. Lapcevic, 1988. Interpretation of field tracer tests of a single fracture using a transient solute storage model. *Water Resources Research* 24: 2019-2032.

Rogers, 1985. Bedrock Geological Map of Connecticut. Connecticut Geological and Natural History Survey.

Figures



Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed



Site Location

Phase II Remedial Action Plan
Greenwich High School
10 Hillside Road
Greenwich, Connecticut

SCALE	DATE	PROJECT NO.
1 IN = 2000 FT	11/18/2020	60432356

AECOM

Figure Number

1

Path: \\usrkh2fp001\data\EVERYONE\60432356 Greenwich High School Remediation\900-Work\GIS\MXDs\RAR-SiteLocus.mxd

Path: \\usrkh2fp001\data\EVERYONE\60432356 Greenwich High School Remediation\900-Work\GIS\MXDs\EMD\2020 Well Network.mxd

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

SOURCE:
2010 AERIAL ORTHOPHOTO FROM STATE OF CONNECTICUT
DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION.

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

N

SCALE:

1" = 70'

0 35 70 140 210 Feet

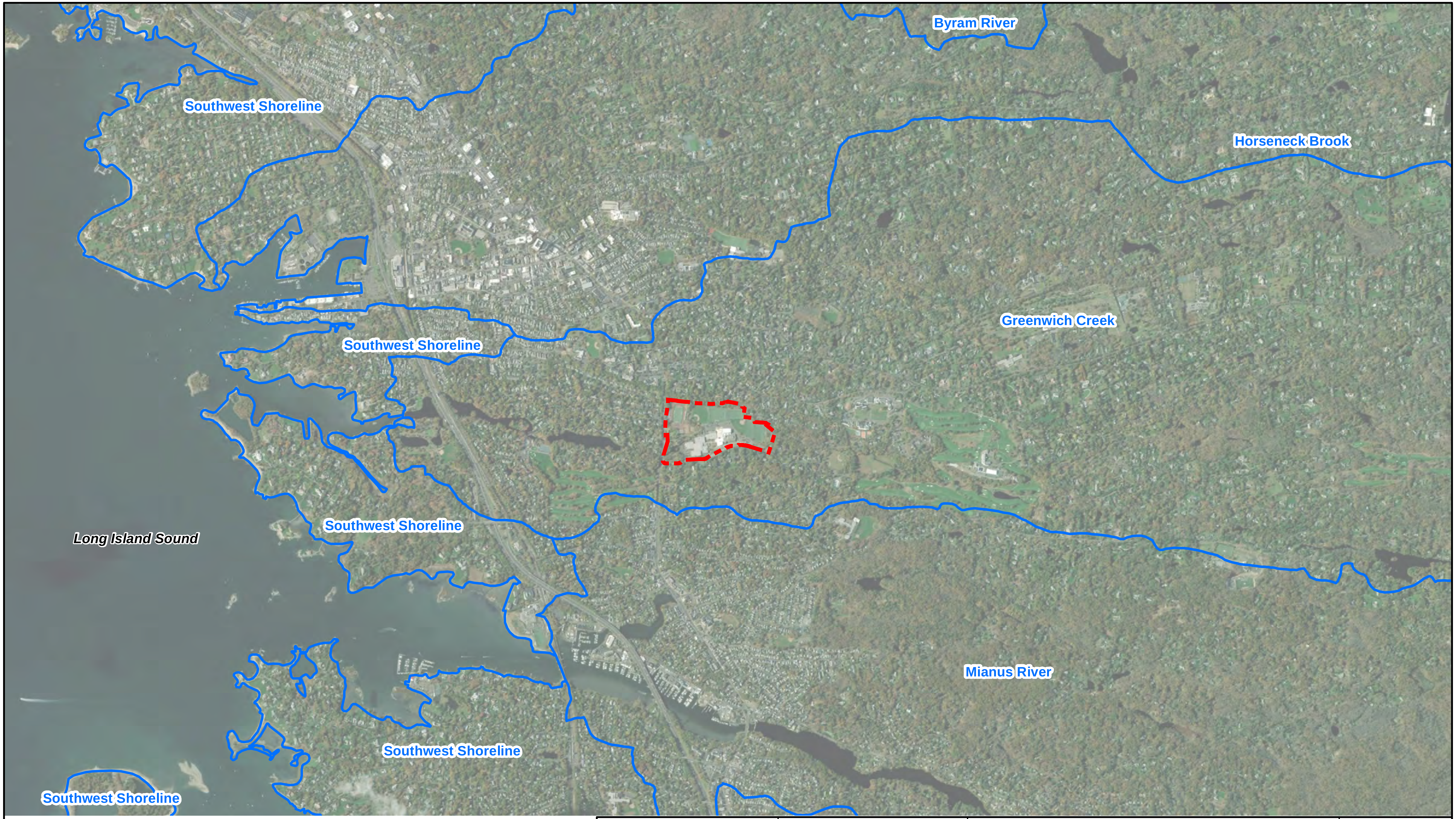
SCALE

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

MONITORING WELL NETWORK
PHASE II REMEDIAL ACTION PLAN

PROJECT NUMBER:
60432356

FIGURE:
2



Legend

▭ Subregional Basin

▭ Property Boundary

Sources:
1. Subregional Drainage Basins from CT DEEP GIS Open Data.
2. Aerial Orthophoto from Esri World Imagery, 11/3/2019.

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

N

SCALE:

0 1,000 2,000 Feet

1 " = 2,000 '

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

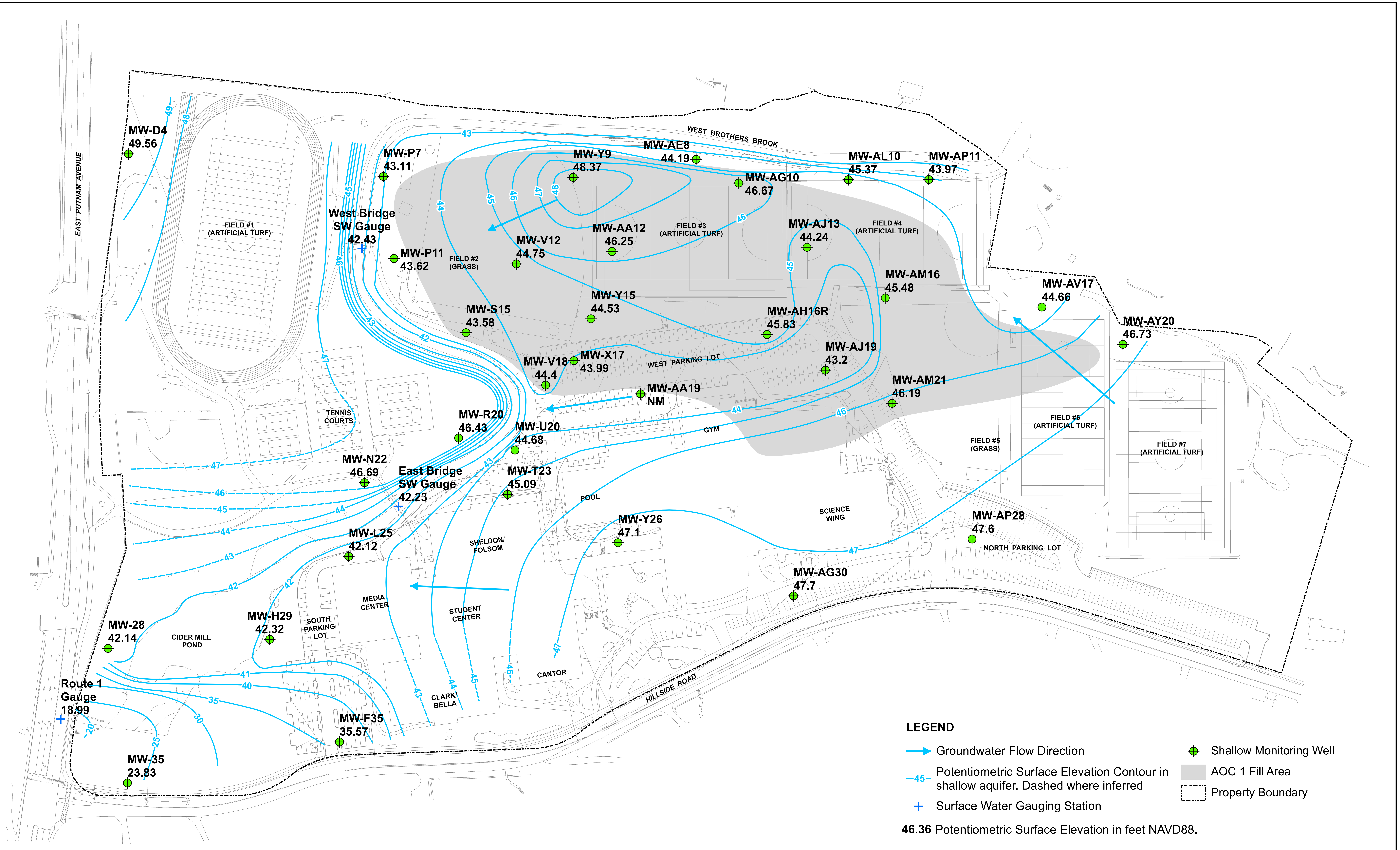
FIGURE 3
SUBREGIONAL DRAINAGE BASINS

JOB 60432356

FILE NO.

CAD FILE

SHEET



LEGEND

- Groundwater Flow Direction
- Potentiometric Surface Elevation Contour in shallow aquifer. Dashed where inferred
- Surface Water Gauging Station
- Shallow Monitoring Well
- AOC 1 Fill Area
- Property Boundary

46.36 Potentiometric Surface Elevation in feet NAVD88.

Note: Water levels measured by AECOM on November 11, 2020.

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

N

SCALE:

1" = 80'
0 40 80 160 240 Feet
SCALE

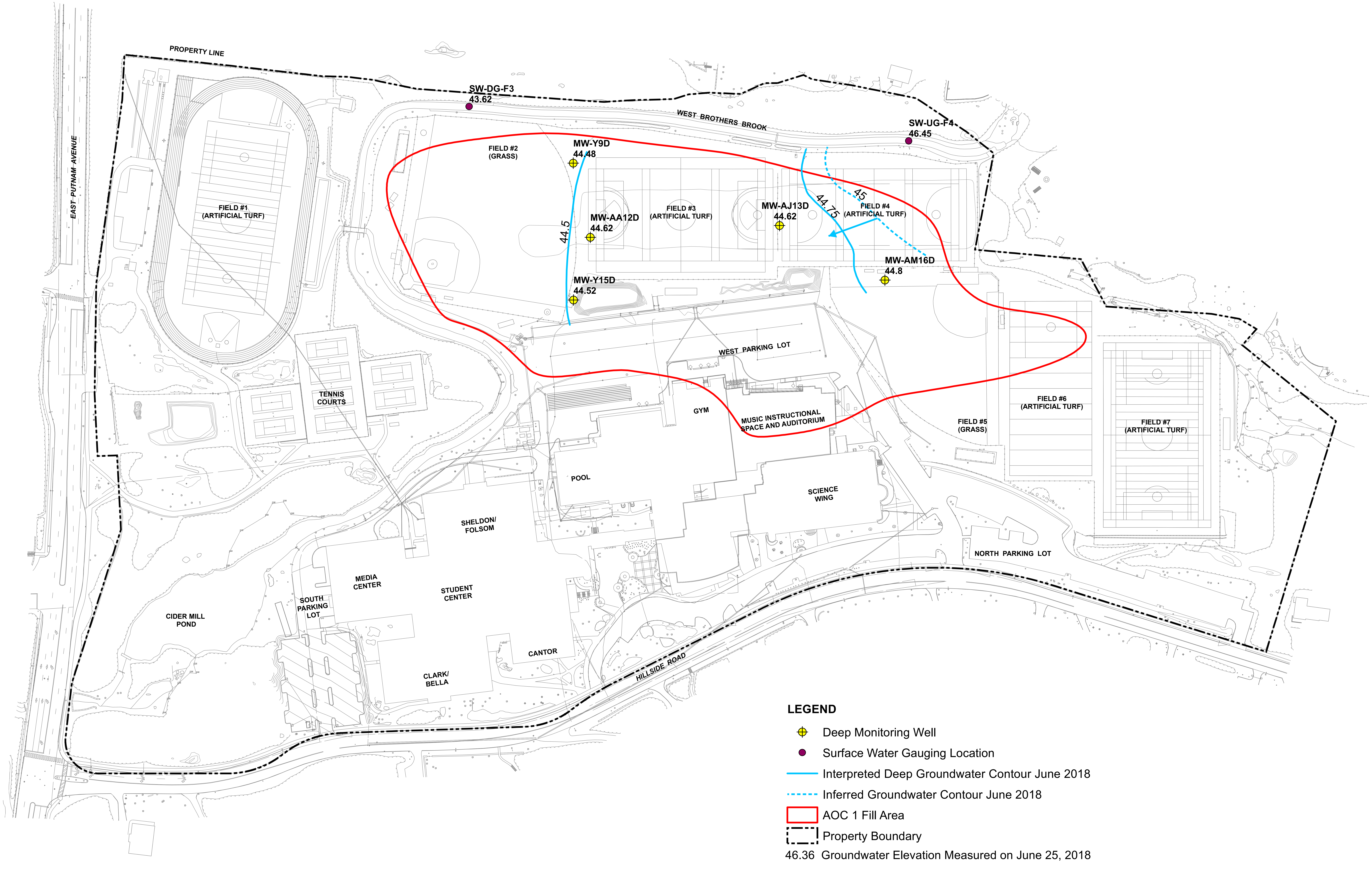
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

FIGURE 4
NOVEMBER 2020
SHALLOW POTENTIOMETRIC SURFACE ELEVATIONS

JOB 60225155
FILE NO.
CAD FILE
SHEET

Appendix A

Hydrogeologic Investigation Report Figures



LEGEND

⊕ Deep Monitoring Well

● Surface Water Gauging Location

— Interpreted Deep Groundwater Contour June 2018

- - - Inferred Groundwater Contour June 2018

▭ AOC 1 Fill Area

▭ Property Boundary

46.36 Groundwater Elevation Measured on June 25, 2018

Path: X:\60432356 Greenwich High School Remediation\900-Work\GIS\MXDs\Hydro Report GPK Edits\Figure 25_ June 2018 Deep Contours.mxd

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

SOURCE:
2010 AERIAL ORTHOPHOTO FROM STATE OF CONNECTICUT
DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION.

AECOM

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

N

SCALE:

0 40 80 160 240
1" = 80' Feet
SCALE

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

FIGURE 25
JUNE 2018
DEEP OVERBURDEN GROUNDWATER CONTOURS

JOB 60225155

FILE NO.

CAD FILE

SHEET

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

SCALE:

1" = 80'

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE RD
GREENWICH, CT

FIGURE 7
1934 AERIAL MAP
HYDROGEOLOGIC INVESTIGATION
REPORT

JOB 60225155
FILE NO.
CAD FILE FIGURE_2-2_1934_AERIAL_PHOTOGRAPH
SHEET

LAST UPDATE: Tuesday, February 26, 2013 11:06:02 AM
PLOT DATE: Tuesday, February 26, 2013 11:06:43 AM
ARCH D - 3-7-05

LEGEND

● SOIL BORING LOCATION (DTC)	✱ MISA PROJECT SOIL BORING LOCATION (AECOM)
▲ 0-3" ONLY SAMPLE LOCATION (DTC)	● SOIL BORING LOCATION (AECOM)
● 0-1' ONLY SAMPLE LOCATION (DTC)	● STEP OUT BORING LOCATION (AECOM)
▲ 0-3" and 0-1' SAMPLE LOCATION (DTC)	✛ MONITORING WELL LOCATION (AECOM)
CROSS-SECTION TRANSECT LINE	✛ PIEZOMETER LOCATION (AECOM)
	✛ GEOTECHNICAL MONITORING WELL LOCATION

AREAS OF CONCERN

AOC 1 - FILL AREA

NOTE:
MW-AM16D IS OFFSET 12.63' FROM TRANSECT A-A'
MW-AJ13D IS OFFSET 40.06' FROM TRANSECT B-B'
MW-Y9D IS OFFSET 25.40' FROM TRANSECT C-C'
MW-Y15D IS OFFSET 10.90' FROM TRANSECT C-C'
MW-AA12D IS OFFSET 35.26' FROM TRANSECT C-C'

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

SCALE:
1" = 80'
0 80 160 240
SCALE FEET
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

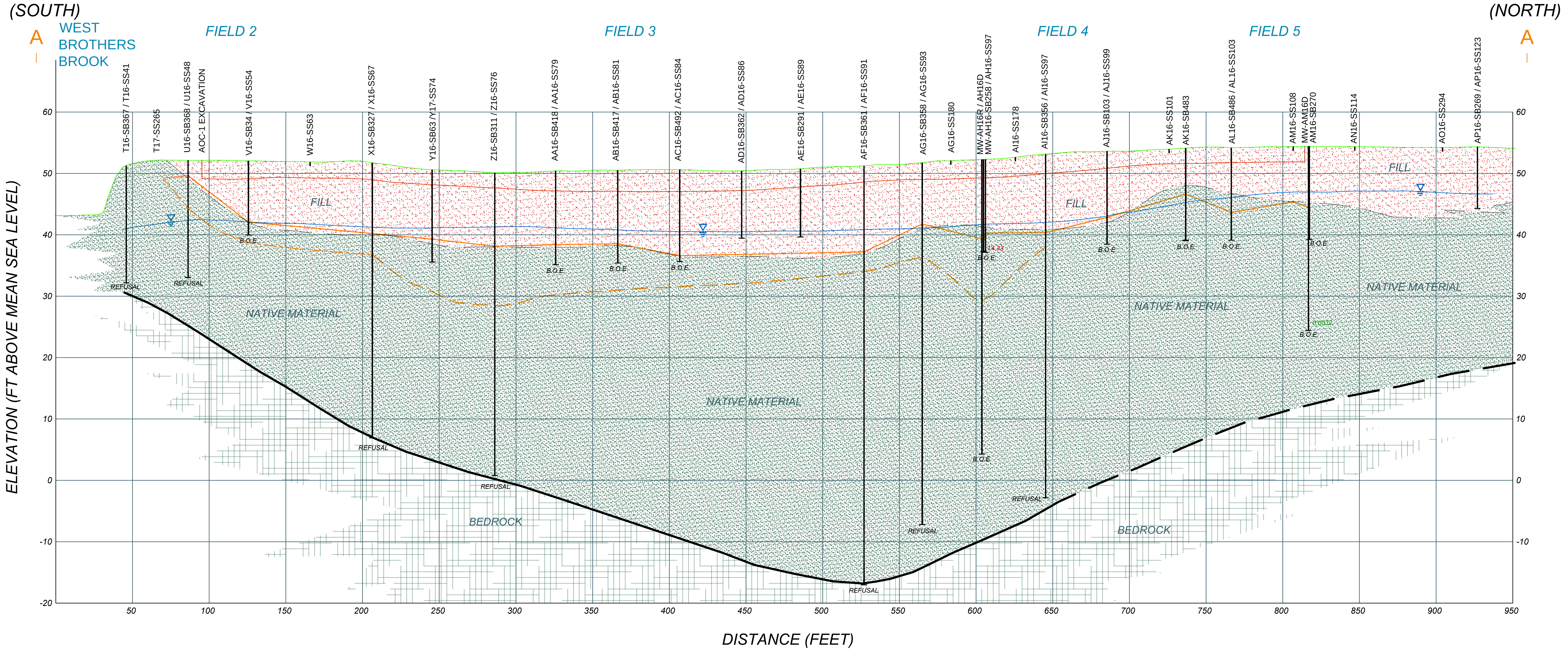
GREENWICH HIGH SCHOOL
10 HILLSIDE RD
GREENWICH, CT

FIGURE 3
SITE PLAN WITH CROSS-SECTION LOCATIONS
HYDROGEOLOGIC SITE INVESTIGATION

JANUARY 2019

JOB 60432356
FILE NO.
CAD FILE CROSS SECTIONS PLAN VIEW8.18
SHEET

PATH/FILENAME: P:\60225155 - GHS\GREENWICH HIGH SCHOOL\ORIGINAL DRAWING FILES\PROJECT\UPDATED\SUPPLEMENTAL DRAWINGS\CROSS SECTIONS PLAN VIEW8.18.DWG
LAST UPDATE: Thursday, February 07, 2019 2:41:21 PM
PLOT DATE: Thursday, February 07, 2019 2:45:29 PM
ARCH D - 3-7-05



NOTES:

1. ELEVATIONS SHOWN ARE BASED ON THE 1929 NGVD.
2. GROUNDWATER ELEVATIONS ARE BASED ON THE JULY 23, 2012 GENERALIZED GROUNDWATER CONTOUR MAP.

LEGEND:

▼	WATER TABLE
▲	PEAT MARKER
——	PEAT UPPER BOUNDARY
— —	PEAT LOWER BOUNDARY
B.O.E.	BOTTOM OF EXPLORATION

GROUNDWATER PCB CONCENTRATION (μg/kg) (JUNE 2018)

14.338	PCB CONCENTRATION (μg/kg) >0.5
0.0026	PCB CONCENTRATION (μg/kg) <0.5
ND	PCB NOT DETECTED

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

SCALE:

1" = 10' VERTICAL SCALE 0 10 20 30 40 FEET

1" = 40' HORIZONTAL SCALE 0 40 80 120 FEET

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

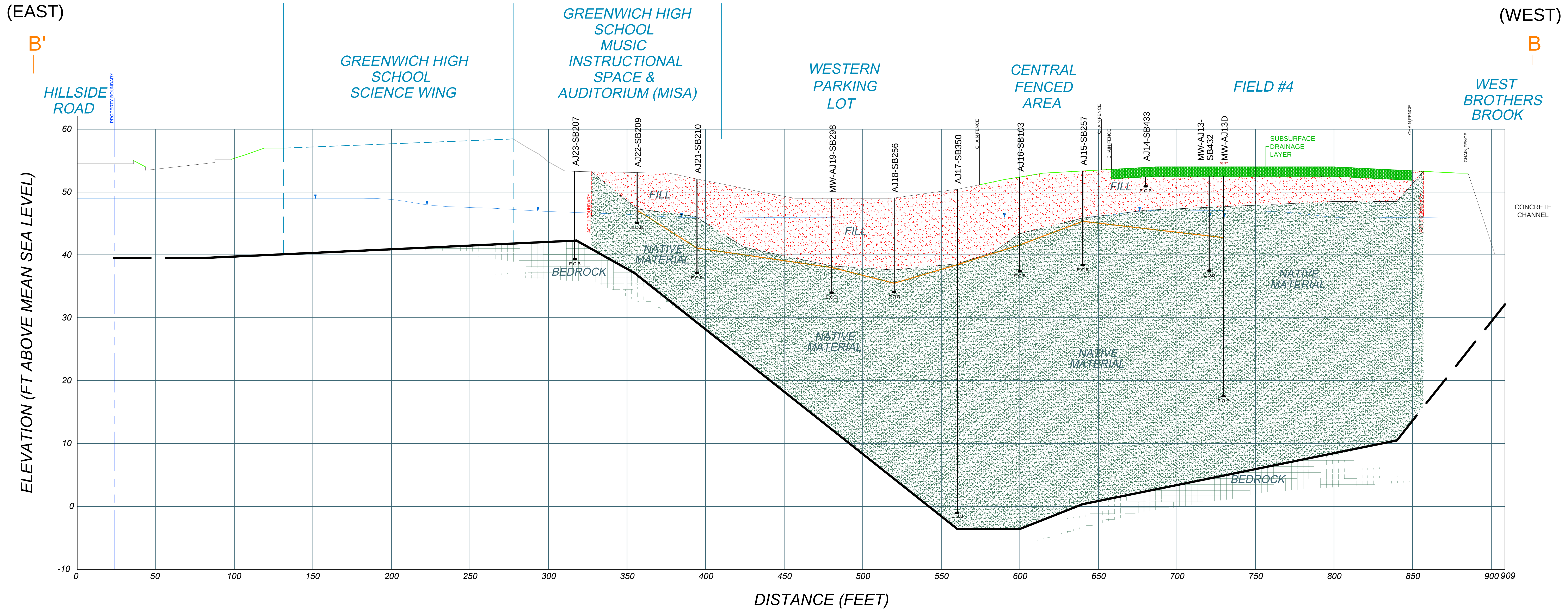
GREENWICH HIGH SCHOOL
10 HILLSIDE RD
GREENWICH, CT

FIGURE 4
CROSS SECTION A - A'
HYDROGEOLOGIC SITE INVESTIGATION

AUGUST 2018

JOB 60432356
FILE NO.
CAD FILE CROSS SECTIONS8.18
SHEET

PATH/FILENAME: C:\USERS\THIBODM\DESKTOP\GHS\CROSS SECTIONS8.18 – STANDARD\CROSS SECTIONS8.18.DWG
LAST UPDATE: Monday, October 01, 2018 3:23:34 PM
PLOT DATE: Monday, October 01, 2018 3:59:36 PM
ARCH D – 3–7–05



NOTES:

1. ELEVATIONS SHOWN ARE BASED ON THE 1929 NGVD.
2. GROUNDWATER ELEVATIONS ARE BASED ON THE JULY 23, 2012 GENERALIZED GROUNDWATER CONTOUR MAP.

LEGEND:

▼	WATER TABLE
▲	PEAT MARKER
——	PEAT UPPER BOUNDARY
— —	PEAT LOWER BOUNDARY
B.O.E.	BOTTOM OF EXPLORATION

GROUNDWATER PCB CONCENTRATION (μg/kg) (JUNE 2018)

14.338	PCB CONCENTRATION (μg/kg) >0.5
0.0026	PCB CONCENTRATION (μg/kg) <0.5
ND	PCB NOT DETECTED

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

SCALE:
1" = 10' VERTICAL SCALE 0 10 20 30 40 FEET
1" = 40' HORIZONTAL SCALE 0 40 80 120 FEET
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE RD
GREENWICH, CT

FIGURE 4
CROSS SECTION B - B'
HYDROGEOLOGIC SITE INVESTIGATION

AUGUST 2018

JOB 60432356
FILE NO.
CAD FILE CROSS SECTIONS8.18
SHEET

PATH/FILENAME: P:\60225155 – GHS\GREENWICH HIGH SCHOOL\ORIGINAL DRAWING FILES\PROJECT\UPDATED\SUPPLEMENTAL DRAWINGS\CROSS SECTIONS\CROSS SECTIONS8.18.DWG
LAST UPDATE: Wednesday, October 24, 2018 11:45:41 AM
PLOT DATE: Wednesday, October 24, 2018 2:03:27 PM
ARCH D – 3–7–05

SOURCE:
2010 AERIAL ORTHOPHOTO FROM STATE OF CONNECTICUT
DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION.

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

N

SCALE:

1" = 80'

0 40 80 160 240 Feet

SCALE

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

FIGURE 16
PCBs in Groundwater
September 2018
GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

JOB 60225155

FILE NO.

CAD FILE

SHEET

Appendix B

Contingency Groundwater Capture Evaluation

Contingency Groundwater Capture Evaluation

Analytical Element Model Analysis

Greenwich High School

Project number: 60432356

April 2021

Quality information

Prepared by	Checked by	Verified by	Approved by
		Pat Haskell	
Dave Estrella Civil Engineer	Craig Drennan Water Resources Engineer	Patrick Haskell, LEP Sr. Technical Specialist	Michael Doherty, P.E. Vice President

Revision History

Revision	Revision date	Details	Authorized	Name	Position

Distribution List

# Hard Copies	PDF Required	Association / Company Name
0	Yes	Kim Tisa, USEPA
0	Yes	Jeff Wilcox, CT DEEP

Prepared for:

Town of Greenwich
10 Hillside Road
Greenwich, Connecticut

Prepared by:

AECOM
500 Enterprise Drive
Rocky Hill, CT 06067
aecom.com

Table of Contents

List of Tables

List of Figures

1. Introduction

Purpose

The purpose of this study was to use an analytical element model to assist in the design of a pump and treat system that could be used in the future to control groundwater migration, if necessary, in the shallow aquifer beneath athletic fields at Greenwich High School in Greenwich, Connecticut (Site). The scope of work included development of a two-dimensional (2-D) analytical element groundwater flow model using the software GFLOW, with the objective of evaluating well configurations and pumping rates necessary to establish a capture zone around the source of a polychlorinated biphenyl (PCB) plume in shallow groundwater beneath Fields 3 and 4 (see Figure 1-1). Study tasks included review of available data, development of the analytical element model, model calibration, pump and treat design simulations, and sensitivity analysis. Model calibration was limited to one set of water levels. Predictive simulations were conducted to develop well configurations and pumping rates which will produce capture of the plume. A sensitivity analysis was performed to demonstrate capture through a range of possible uncertainties.

Software Selection

An analytical element model (AEM), GFLOW V. 2.2.3 (Haitjema Software, 2018) , was utilized to achieve the objectives of this study. GFLOW is a Windows-based and highly efficient stepwise groundwater flow modeling system based on the analytic element method developed by Haitjema Software, a subdivision of Haitjema Consulting, Inc. It models 2-D steady-state flow in a single heterogeneous aquifer using the Dupuit-Forchheimer assumption.

The analytic element method was developed by Otto Strack at the University of Minnesota and avoids the requirement of discretized grids, specific domains, traditional boundary conditions. Instead, lake and stream sections, wells, and recharge are represented by closed-form analytical solutions called analytic elements, and the solution is obtained by the superposition of all elements in the model. The GFLOW computational engine is incorporated in the Environmental Protection Agency (EPA) software Wellhead Analytical Element Model (WhAEM), which is designed for capture zone delineation and protection area mapping in support of the Wellhead Protection Program (WHPP) and Source Water Assessment Planning (SWAP) for public water supplies in the United States (Kraemer & Haitjema, 2018).

2. Conceptual Site Model

The hydrogeological conceptual site model (CSM) has been documented in the Artificial Turf Field and Site Hydrogeological Investigation Report (AECOM, 2019). A brief summary is presented in this section.

Two water bodies have been observed on historical maps. The central portion of the property was a former wetland. An unnamed pond that is currently referred to as Cider Mill Pond is shown in the southeast corner. West Brothers Brook historically entered the property at the same location as it does currently, flowed southeast into the wetlands and then beyond through Cider Mill Pond. Construction of the high school resulted in the wetlands being filled and West Brothers Brook being diverted through a concrete lined channel to accommodate playing fields and other improvements associated with the school. Currently, West Brothers Brook enters the Site near the northwest corner of Field 4, at which point it is culverted and returns to its natural channel approximately 200 feet southwest of Field 3.

The geologic materials present at the site include:

- Surficial Materials - Generally six inches of topsoil, asphalt in parking lot areas, and artificial turf beneath Fields 3, 4, 6 & 7.
- Fill - medium to very dense, fine to medium sand with some traces of silt or gravel with debris containing trace amounts of cinders, brick, glass, roots, wood, plastic, and rubber. Fill is encountered from ground surface to depths of up to 14 feet below ground surface (bgs). Fill material extends from the northwestern corner of the school, beneath much of the western parking lot, to Fields 2, 3, and 4, much of Field 5, and portions of Field 6.
- Peat/Organic Silt - Beneath the non-native fill, a layer of soft organic material extended to depths ranging from 2.5 to 28 feet bgs, with a maximum thickness of 18.5 feet. This peat is generally present in the same area as the fill material and is inferred to act as an aquitard in the area of the athletic fields.
- Dense Till: A layer of dense silty sands (till) was encountered beneath the non-native fill and the peat/organic silt units. This material contained varying amounts of gravel, cobbles and boulders and extended to depths ranging from 8.5 to 59 feet bgs.
- Gneiss Bedrock: Gneiss was encountered in numerous borings across the Site. Depth to bedrock surface ranges from zero to 59 feet bgs.

The Site is surrounded by elevated land features to the east, north, and west, and bedrock outcrops are present around and on much of the Site. The bedrock surface beneath the Fields #2, #3, and #4 forms a bowl-like structure, in which a wetland formed with fine-grained sediment and plant materials accumulating into a silty peat layer over time. Prior to the construction of the athletic fields, historical channels were present in the wetland complex, some of which appeared to act as headwater-like groundwater discharge zones adjacent to upland areas, alongside a main channel (i.e. West Brothers Brook prior to its relocation), which bisected the wetland complex from northwest to southeast. Fill materials were placed in these channels and over the wetland to build the Site recreational facilities. However, groundwater recharge is still understood to occur from the area of the former headwaters and filled channels may act as preferential migration pathways where silt/peat deposits are thinner.

Groundwater flow contours indicate a primary northwest to southeast direction to groundwater flow across the Site. A mound is evident in the water table that is centered beneath the southern portion of Field #3, which is the portion of the filled wetlands that is furthest removed from locations with natural discharge to surface water, subsequent to the construction of a concrete culvert to re-route West Brothers Brook.

3. Model Inputs and Calibration

Input Parameters

Input parameters for GFLOW include linesinks, used to represent water sources or sinks (such as rivers, lakes, and drainages), aquifer base elevation, hydraulic conductivity, porosity, and recharge. A summary of model inputs is presented in Table 3-1. Model setup is presented on Figure 3-1.

Table 3-1: Model Input Parameters

Parameter	Zone	Value	Source	Notes
Aquifer Base Elevation	Background	42 ft amsl	Boring Logs	Denotes top of peat elevation
Aquifer Base Elevation	Along west and south of Fields 3 and 4	45 ft amsl	Boring Logs	Denotes top of peat elevation, (adjusted in calibration)
Aquifer Thickness	Entire Domain	10 ft	Boring Logs	Ground surface - top of peat elevation
Hydraulic Conductivity	Background	15.9 ft/d	Slug Test Results	Adjusted in calibration
Hydraulic Conductivity	Along west and south of Fields 3 and 4	4.9 ft/d	Slug Test Results	Adjusted in calibration
Hydraulic Conductivity	Bedrock	0.01 ft/d	Literature Value	(Heath, 1983)
Porosity	Entire Domain	20%	Literature Value	(Morris & Johnson, 1967)
Recharge	Grass Area North of Fields 6 and 7	5.30 in/yr	11.5% of precipitation	Adjusted in calibration
Recharge	Turf Fields 3, 4, 6, and 7	1.06 in/yr	2.3% of precipitation	Adjusted in calibration
Recharge	Baseball fields 2 and 5	3.18 in/yr	6.9% of precipitation	Adjusted in calibration
Recharge	Area of added recharge along west and south of Fields 3 and 4	12.88 in/yr	28.0% of precipitation	Adjusted in calibration
Recharge	Parking lots and Buildings	0 in/yr	0% of precipitation	Adjusted in calibration
Recharge	Bedrock	0.0001 in.yr	1 % of precipitation	
Linesink	Wetland / Low Area on Northeast corner of site	Head - ranges from 46.5 to 46 ft amsl Resistance - 0 days	Site Topographic Survey	
Linesink	Lined Portion of West Brothers Brook	Head - ranges from 46 to 44 ft amsl Resistance - 1 day	Site Topographic Survey	Resistance adjusted in calibration
Linesink	Unlined portion of West Brothers Brook and Cider Mill Pond	Head - ranges from 44 to 42.5 ft amsl Resistance - 0 day	Site Topographic Survey	
Linesink	Flow interaction with bedrock to east of Site	Head - ranges from 52 to 25 ft amsl Resistance - 10 days	July 2019 Groundwater Elevation Map	Resistance adjusted in calibration

Notes:

ft amsl - feet above mean sea level
ft - feet
ft/d feet per day
in/yr - inches per year

Recharge rates as a percentage of precipitation are compared to total precipitation over the month of July 2019 at Westchester County Airport Station. Precipitation total was 3.9 inches (Weather Underground, 2021).

Model Calibration

The GFLOW model was calibrated to one set of 32 water level measurements collected in July 2019. The calibration process included altering parameters discussed above within reasonable ranges until water levels were matched as well as possible given limitations of the simplified model setup. A typical metric for adequate model calibration for a groundwater flow model is a scaled root mean square error (RMSE) of the observed versus computed heads of less than 10%. Observed and simulated water levels are shown in Table 3-2 and calibration statistics are presented in Table 3-3. The model calibration resulted in a scaled RMSE of 10.10%. From a statistical perspective, the model is slightly above the threshold for adequate calibration; however, given the simplified model setup, the model is calibrated well enough to be used for pump and treat design with an appropriate sensitivity analysis. Through the model calibration process, it was determined that only unreasonable parameter inputs would further reduce calibration statistics. Simulated heads and residuals are shown on Figure 3-2. A plot of observed versus simulated heads is shown on Figure 3-3.

Table 3-2: Comparison of Observed and Modeled Heads

Well ID	Observed Head (ft amsl)	Model Head (ft amsl)	Residual (ft)	Absolute Residual (ft)	Square Residual (ft2)
MW-Y9	49.57	46.71	-2.86	2.86	8.18
MW-AL10	48.89	46.50	-2.39	2.39	5.73
MW-Y26	48.1	46.09	-2.01	2.01	4.05
MW-AJ13	44.74	46.69	1.95	1.95	3.81
PZ-AM22	45.38	47.22	1.84	1.84	3.38
MW-AM16	44.97	46.69	1.72	1.72	2.97
MW-AG10	48.26	46.55	-1.71	1.71	2.93
MW-AJ19	45.25	46.90	1.65	1.65	2.73
MW-T23	46.09	44.49	-1.60	1.60	2.55
PZ-AH19	45.22	46.82	1.60	1.60	2.55
MW-AA12	48.54	47.01	-1.53	1.53	2.35
MW-28	42.13	40.63	-1.50	1.50	2.24
MW-U20	45.44	44.24	-1.20	1.20	1.43
PZ-AG18	45.57	46.73	1.16	1.16	1.35
MW-AE8	44.68	45.77	1.09	1.09	1.19
MW-AG30	48.76	47.68	-1.08	1.08	1.18
MW-AA19	45.02	46.09	1.07	1.07	1.15
MW-V12	44.53	45.47	0.94	0.94	0.89

Well ID	Observed Head (ft amsl)	Model Head (ft amsl)	Residual (ft)	Absolute Residual (ft)	Square Residual (ft2)
MW-AP28	48.78	47.90	-0.88	0.88	0.77
MW-X17	44.64	45.51	0.87	0.87	0.75
MW-F35	36.57	35.71	-0.86	0.86	0.74
MW-AH16R	47.54	46.73	-0.81	0.81	0.65
MW-P7	43.88	44.67	0.79	0.79	0.62
MW-Y15	46.51	45.91	-0.60	0.60	0.36
MW-AM21	47.55	47.13	-0.42	0.42	0.17
MW-S15	44.23	44.60	0.37	0.37	0.14
MW-AP11	45.34	45.67	0.33	0.33	0.11
MW-P11	44.42	44.69	0.27	0.27	0.08
MW-L25	42.54	42.80	0.26	0.26	0.07
MW-AV17	46.14	46.33	0.19	0.19	0.04
MW-V18	44.74	44.91	0.17	0.17	0.03
MW-H29	42.4	42.50	0.10	0.10	0.01

Table 3-3: Model Calibration Statistics

Statistic	Value	Unit
Residual Mean	-0.10	ft
Abs Residual Mean	1.12	ft
Sum of Square Residual	55.17	ft2
RMSE	1.31	ft
Min Head	36.57	ft
Max Head	49.57	ft
Range	13.00	ft
Scaled RMSE	10.10%	-

4. Pump and Treat Simulation

Predictive simulations were set up to evaluate locations and rates for pumping wells which will adequately capture the PCB plume. The only changes made between the calibrated model and predictive simulations were reduction of recharge to zero beneath the extent of the liner and addition of six pumping wells. Locations of the liner and pumping wells are shown on Figure 4-1. The pumping well rates were adjusted manually to be the maximum allowable without allowing the aquifer to go dry. Pumping rates allocated to each of the six wells are presented in Table 4-1. Capture of the pumping wells was assessed using forward particle tracking with particles place on a grid over the entire liner area. Simulation results presented on Figure 4-1 demonstrate full capture of all particles. Well-5 is located in the area of lower transmissivity near the mounding groundwater. Variability is expected during field operation of the pumping wells and it is possible that this well in particular yields a higher volume. Another factor which may lead to higher well yields in the field is vertical flow from the deep aquifer not accounted for in the 2-D GFLOW model. It is recommended that a contingency capacity of the system of at least 1 gallon per minute (gpm) is available to account for increased yields and seasonal variability.

Table 4-1: Pumping Well Locations and Rates

Well ID	Northing	Easting	Pumping Rate (gpm)
Well-1	576991	761397	0.50
Well-2	576838	761389	0.40
Well-3	576643	761375	0.50
Well-4	576505	761372	0.35
Well-5	576370	761401	0.07
Well-6	576380	761633	0.50
Total			2.32

Notes:

Coordinate System NAD 1983
State Plane Connecticut

5. Sensitivity Analysis

A sensitivity analysis was performed to assess potential uncertainties in model inputs. A sensitivity analysis was used to demonstrate that through a wide range of reasonable parameter input values, full capture of the plume is still achieved. A total of ten simulations were carried out, comparing both the changes to model calibration and predictive results. The analysis was performed in accordance with ASTM Designation D5611-94 (2016). Each parameter was categorized as Type I, II, III, or IV. Definition for parameter types is as follows:

Type I Sensitivity*—When variation of an input causes insignificant changes in the calibration residuals as well as the model's conclusions, then that model has a Type I sensitivity to the input. Type I sensitivity is of no concern because regardless of the value of the input, the conclusion will remain the same.*

Type II Sensitivity*—When variation of an input causes significant changes in the calibration residuals but insignificant changes in the model's conclusions, then that model has a Type II sensitivity to the input. Type II sensitivity is of no concern because regardless of the value of the input, the conclusion will remain the same.*

Type III Sensitivity*—When variation of an input causes significant changes to both the calibration residuals and the model's conclusions, then that model has a Type III sensitivity to the input. Type III sensitivity is of no concern because, even though the model's conclusions change as a result of variation of the input, the parameters used in those simulations cause the model to become uncalibrated. Therefore, the calibration process eliminates those values from being considered realistic.*

Type IV Sensitivity*—If, for some value of the input that is being varied, the model's conclusions are changed but the change in calibration residuals is insignificant, then the model has a Type IV sensitivity to that input. Type IV sensitivity can invalidate model results because over the range of that parameter in which the model can be considered calibrated, the conclusions of the model change. A Type IV sensitivity generally requires additional data collection to decrease the range of possible values of the parameter.*

The results of the sensitivity analysis are presented in

Table 5-1. Sensitivity simulation #1 represents a case where the heterogeneous zone to the west and south of Fields #3 and #4, used to simulate the observed groundwater mound, was removed. Although the calibration residuals are greater, it represents a more conservative scenario where the transmissivity of the aquifer in that area is higher, thus requiring increases pumping to maintain capture zones. Results for this simulation, presented in Figure 4-2, demonstrate that even in this scenario full capture is still achieved. Full capture was achieved in all other sensitivity simulations as well leading to either type I or type II sensitivity for all parameters.

Table 5-1: Sensitivity Analysis Results

Sensitivity Run	Parameter Change	Residual Mean	Scaled RMSE	Adequate Calibration	Full Capture Achieved	Sensitivity Type
Base	-	-0.10	10.10%	Yes	Yes	-
#1	Removed low K, high base zone on Fields 3 and 4	-0.41	12.03%	No	Yes	II
#2	Hydraulic Conductivity x2	-0.40	10.72%	Yes	Yes	I
#3	Hydraulic Conductivity /2	0.35	10.64%	Yes	Yes	I
#4	Recharge +50%	0.08	10.09%	Yes	Yes	I
#5	Recharge - 50%	-0.22	10.30%	Yes	Yes	I
#6	Aquifer Base Elevation -4 ft	-0.73	13.02%	No	Yes	II
#7	Resistance of lined West Brothers Brook x10	0.19	10.70%	No	Yes	II
#8	Resistance of lined West Brothers Brook /10	-0.14	10.04%	Yes	Yes	I
#9	Resistance of eastern Bedrock Linesinks x10	-0.34	10.47%	Yes	Yes	I
#10	Resistance of eastern Bedrock Linesinks /10	0.34	11.33%	No	Yes	II

6. Conclusions

A 2-D analytical element model was developed for the shallow aquifer at the Greenwich High School Site using the Software GFLOW. The GFLOW model was calibrated to 32 water levels measured in July 2021. Calibration residuals were slightly higher than the conventional criterion for calibration of a groundwater model of a scaled root mean square error of less than 10%. However, a sensitivity analysis was performed to bracket the uncertainty within reasonable ranges. Parameter values to achieve better calibration were not considered reasonable by AECOM hydrogeologists, and a limited number of model inputs were contributing factors. Predictive simulations were carried out to evaluate well locations and pumping rates using forward particle tracking to assess capture of the currently existing PCB plume. Based on the predictive simulations, the following conclusions can be made for the Site:

- Capture of the PCB plume can be achieved with a liner in place and 6 wells pumping a total of approximately 2.32 gpm.
  - One well was only simulated to yield 0.07 gpm due to its location in a low transmissivity zone.
  - Upward vertical flow from the deep is not accounted for in the GFLOW model, based on the presence of the low-permeability peat unit in the area of interest.
  - A contingency of at least 1 gpm is recommended in system design.
- A sensitivity analysis was performed and demonstrated that through a range of reasonable changes to parameter inputs, capture of the PCB plume was achieved.
  - The sensitivity analysis accounts for uncertainty in model inputs and acts as validation of sufficient conservatism in the system design.

7. References

AECOM. (2019). *Artificial Turf Field and Site Hydrogeological Investigation Report.*

ASTM International. (2016). *Standard Guide for Conducting a Sensitivity Analysis for a Ground-Water Flow Model Application.* D 5611 – 94, West Conshohocken, PA.

Haitjema Software. (2018). *GFLOW V2.2.3*. Retrieved from http://haitjema.com/

Heath, R. C. (1983). *Basic Ground-Water Hydrology.* U.S. Geological Survey.

Kraemer, S., & Haitjema, H. (2018). *Working with WhAEM Demonstration of Capture Zone Delineation for a City Wellfield in a Valley Fill Glacial Outwash Aquifer for Wellhead Protection.* Washington, D.C.: U.S. Environmental Protection Agency.

Morris, D., & Johnson, A. (1967). *Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey.* U.S. Geological Survey.

Weather Underground. (2021, February 2). *Harrison, NY Weather History*. Retrieved from https://www.wunderground.com/history/monthly/us/ny/harrison

Figures

PLAN

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

SCALE:

1" = 80'

0	80	160	240

SCALE FEET

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE RD
GREENWICH, CT

FIGURE 1-1
SITE PLAN
PHASE II REMEDIAL ACTION PLAN
GREENWICH HIGH SCHOOL

DATE: DECEMBER 2020

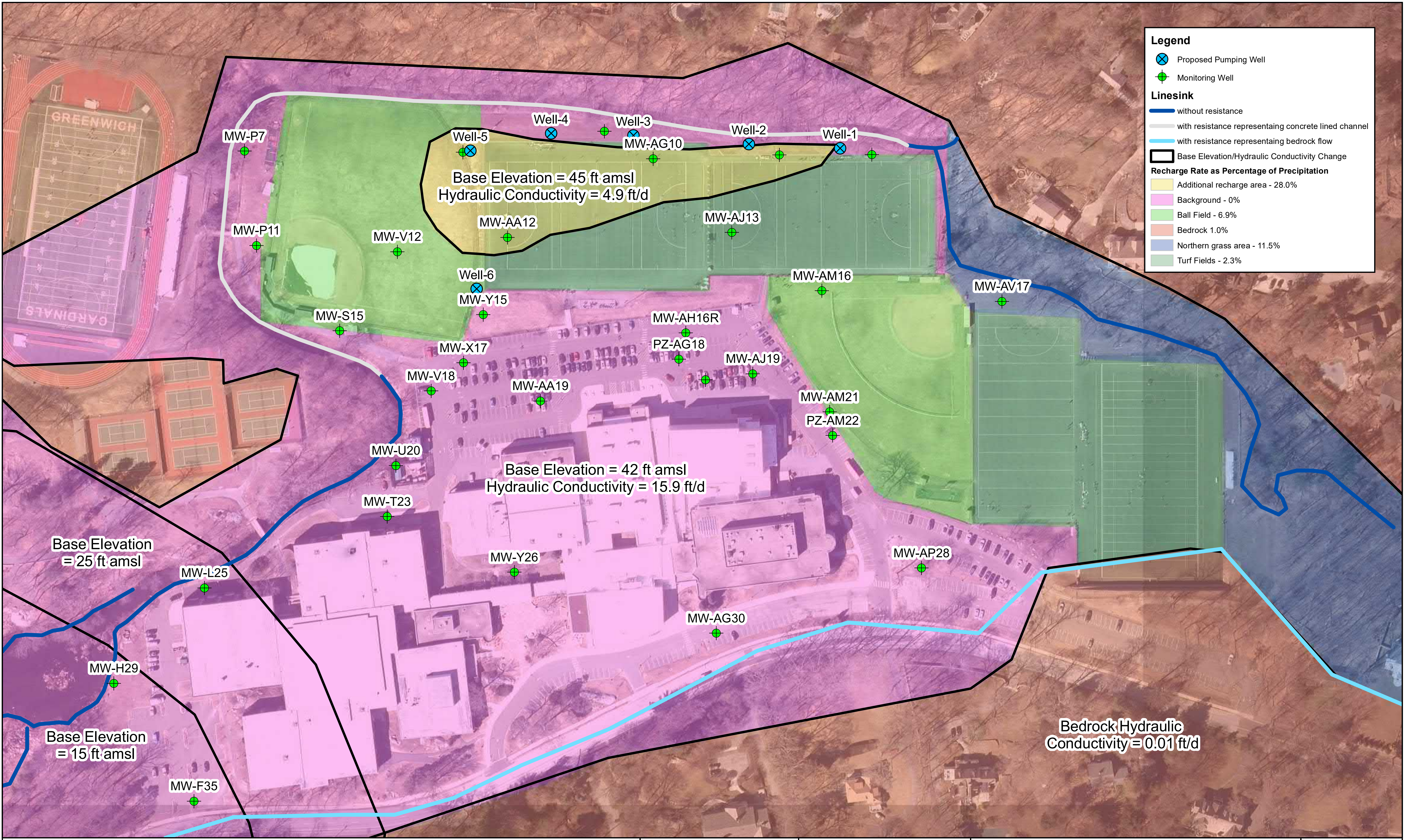
JOB 60432356

FILE NO.

CAD FILE SITE-PLAN-2020

SHEET 1-1

PATH/FILENAME: \\USRKH2FP001\DATA\EVERYONE\60432356 GREENWICH HIGH SCHOOL REMEDIATION\900-WORK\GIS\CAD\PHASE II RAP\SITE-PLAN-2020.DWG
LAST UPDATE: Wednesday, December 30, 2020 3:34:01 PM
PLOT DATE: Wednesday, December 30, 2020 3:36:46 PM
ARCH D – 3-7-05



Path: C:\Users\dave.estrella\Documents\Greenwich High School\GIS\Report_Figures\Figure03-01_Greenwich_HS_GFLOW_Setup.mxd

Note:
Aerial Imagery Source -
University of Connecticut
2019 Orthophotography
Recharge rates as a percentage of precipitation are compared to total precipitation over the month of July 2019 at Westchester County Airport Station. Precipitation total was 3.9 inches (Weather Underground, 2021).

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

N

SCALE:

Feet
0 75 150

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

FIGURE 3-1
GFLOW Model Setup

JOB 60432356
FILE NO.
CAD FILE
SHEET

Path: C:\Users\dave.estrella\Documents\Greenwich High School\GIS\Report_Figures\Figure03-02_Greenwich_HS_SimulatedHeads.mxd

Note:
Aerial Imagery Source -
University of Connecticut
2019 Orthophotography
Recharge rates as a percentage of precipitation are compared to total precipitation over the month of July 2019 at Westchester County Airport Station. Precipitation total was 3.9 inches (Weather Underground, 2021).

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

N

SCALE:

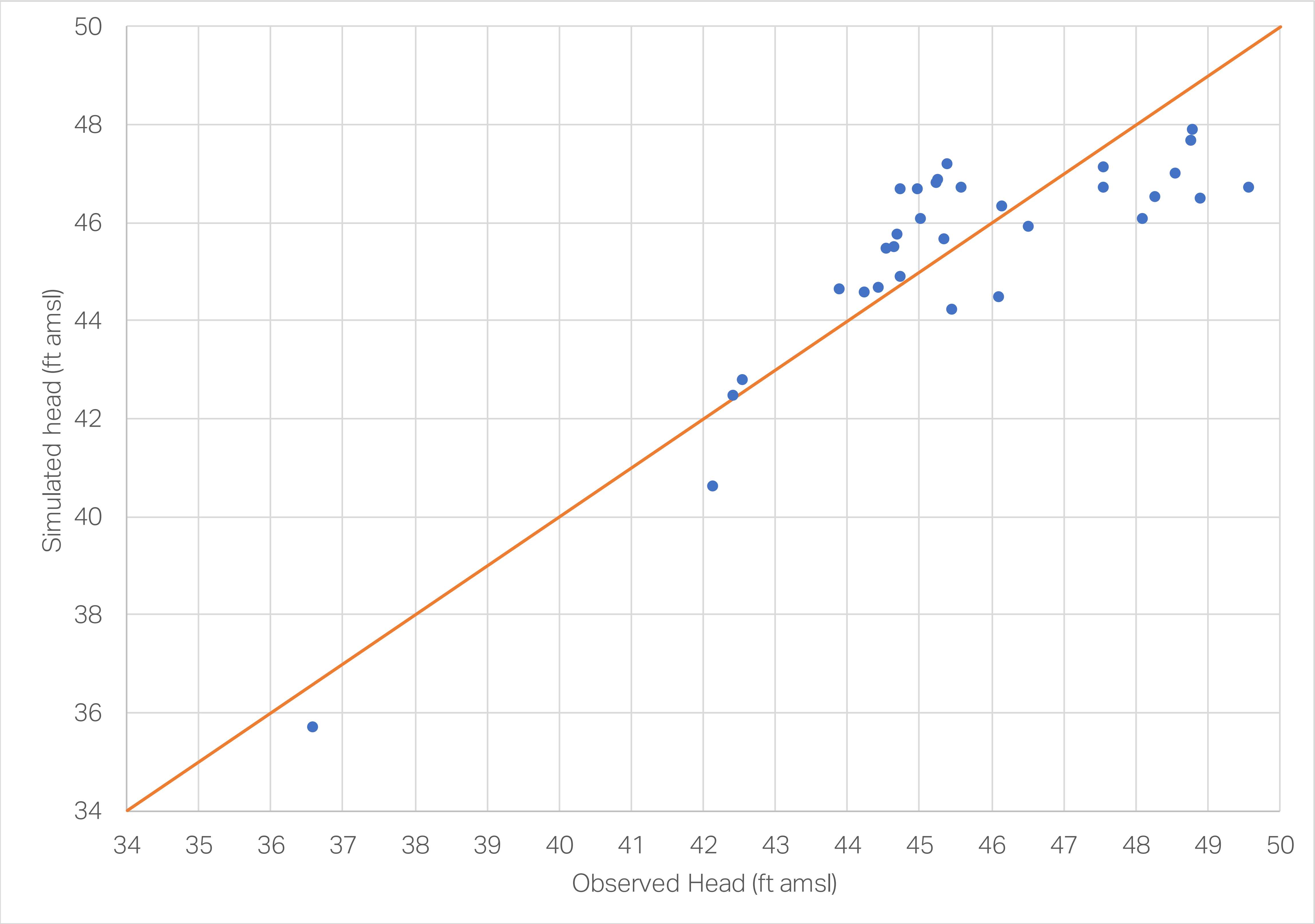
Feet
0 75 150

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

FIGURE 3-2
GFLOW Model Calibration Simulated Heads and Residuals

JOB 60432356
FILE NO.
CAD FILE
SHEET



Note:
Aerial Imagery Source -
University of Connecticut
2019 Orthophotography
Recharge rates as a percentage of precipitation are compared to total precipitation over the month of July 2019 at Westchester County Airport Station. Precipitation total was 3.9 inches (Weather Underground, 2021).

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

SCALE:

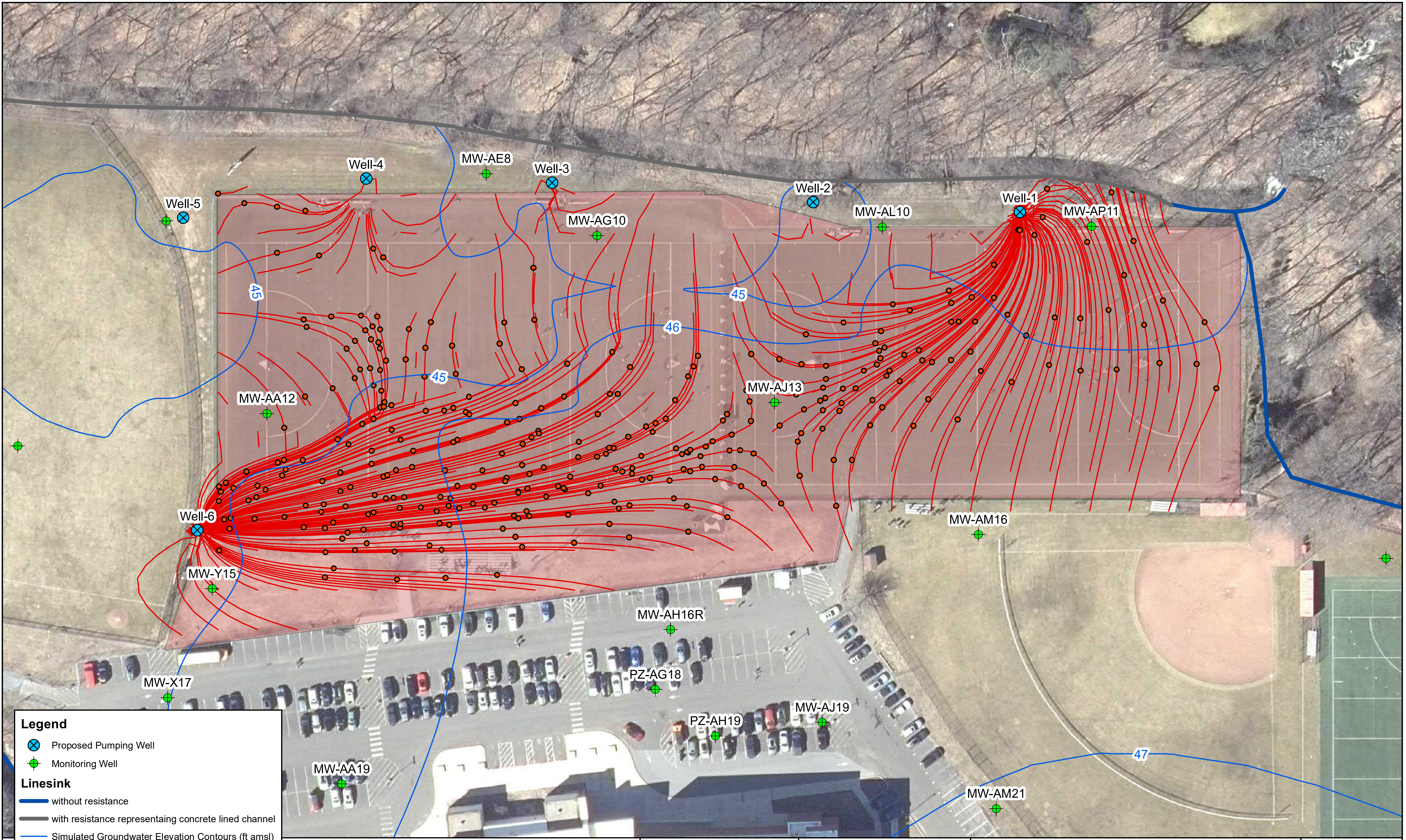
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

FIGURE 3-3
GFLOW Model Calibration
Plot of Simulated versus Observed Heads

JOB 60432356
FILE NO.
CAD FILE
SHEET

Path: C:\Users\dave.estrella\Documents\Greenwich High School\GIS\Report_Figures\Figure03-03_Greenwich_HS_Observed_vs_Simulated.mxd



Legend

⊗ Proposed Pumping Well

⊕ Monitoring Well

Linesink

- without resistance
- with resistance represantaing concrete lined channel
- Simulated Groundwater Elevation Contours (ft amsl)
- ● One Year Travel Time Tick Mark
- Forward Particle Tracking Pathline
- ▨ Liner

Path: C:\Users\dave.estrella\Documents\Greenwich High School\GIS\Report_Figures\Figure04-01_Greenwich_HS_Design_Simulation.mxd

Note:
Aerial Imagery Source -
University of Connecticut
2019 Orthophotography

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

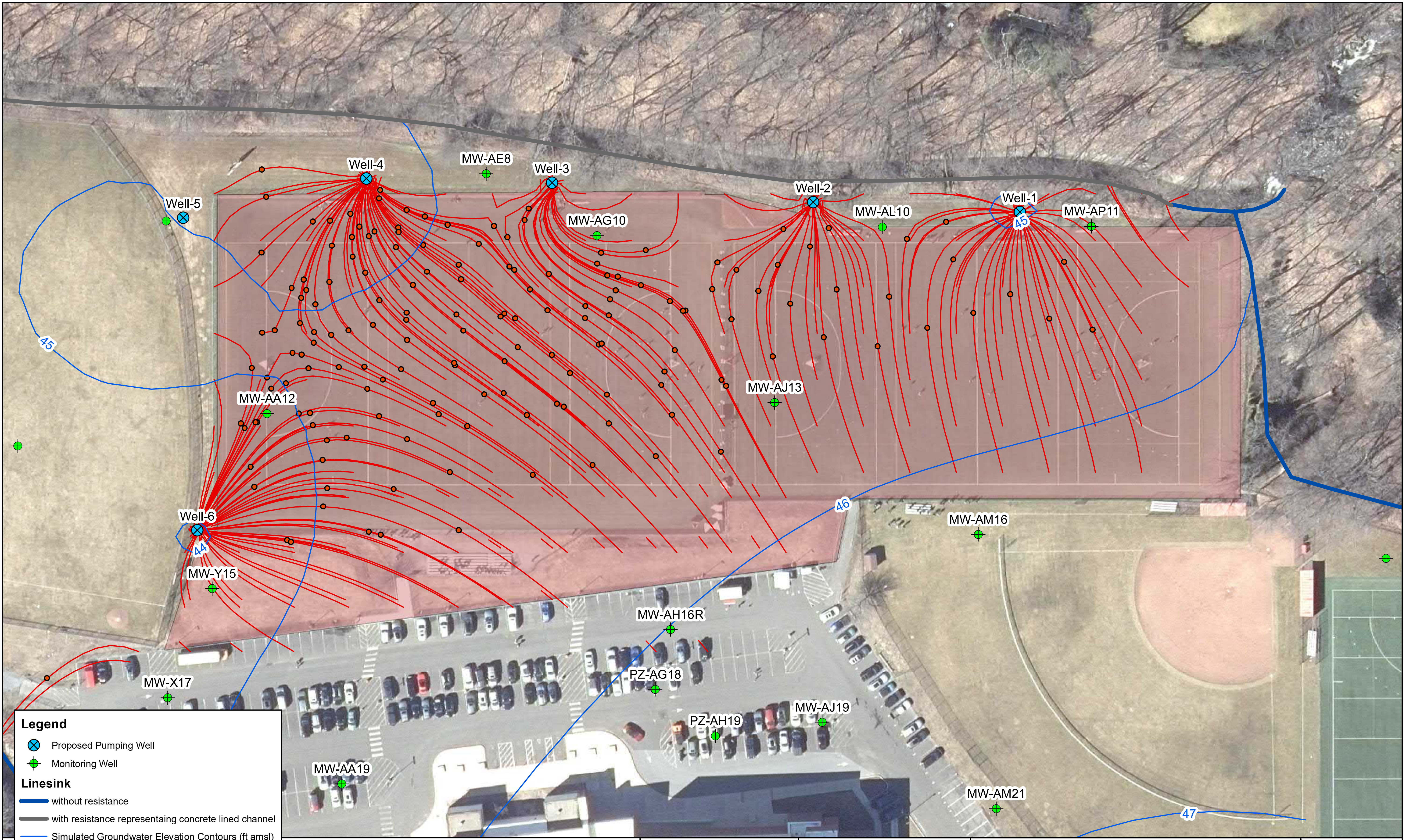
N

SCALE:
Feet
0 50 100
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

FIGURE 4-1
Simulated Heads and Forward Particle Tracking For Pump and Treat Design

JOB 60432356
FILE NO.
CAD FILE
SHEET



Note:
Aerial Imagery Source -
University of Connecticut
2019 Orthophotography

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

N

SCALE:

Feet

0 50 100

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

FIGURE 5-1

Simulated Heads and Forward Particle Tracking For Sensitivity Simulation #1

JOB 60432356

FILE NO.

CAD FILE

SHEET

Path: C:\Users\dave.estrella\Documents\Greenwich High School\GIS\Report_Figures\Figure05-01_Greenwich_HS_Sensitivity1.mxd

Appendix C

Contingency Groundwater Capture Design Details

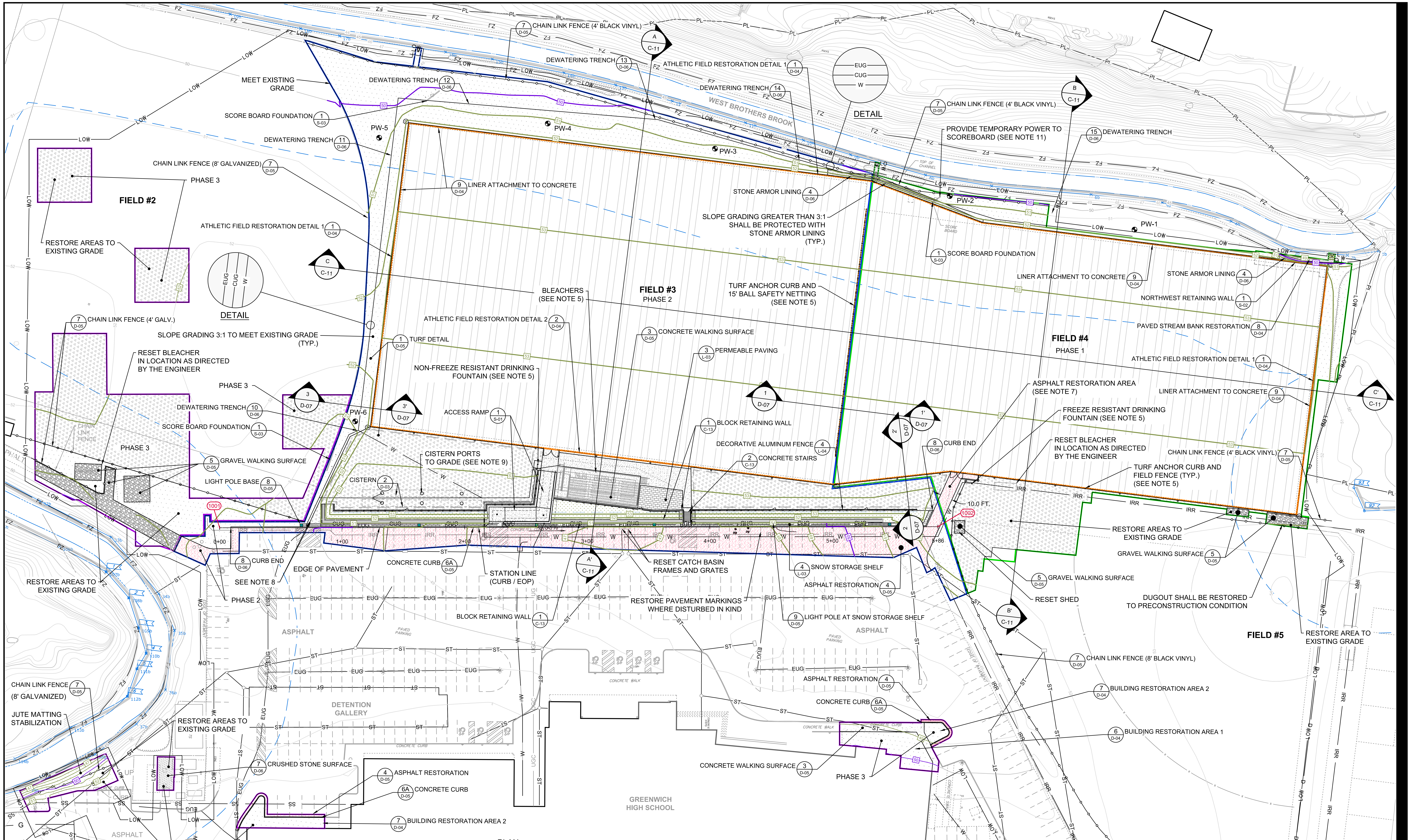
ANSI D 22" x 34"

Approved:

Checked:

Designer:

Project Management Initials:



PLAN

NOTES

1. RESTORE SURFACES TO EXISTING GRADE IN AREAS INDICATED.
2. SEE SHEET C-15 FOR ADDITIONAL FINAL GRADING INFORMATION.
3. EXISTING SIGNS TO BE REMOVED, STORED AND REPLACED IN LOCATIONS AS DIRECTED BY THE ENGINEER.
4. SEE SHEET C-16 FOR REMEDIATION AREA 02 RESTORATION.
5. SEE REFERENCE DRAWING SET BY MILONE & MACBROOM (SLR) FOR SYNTHETIC TURF, TURF CURB AND FIELD FENCING / GATE, BLEACHERS AND DRINKING FOUNTAIN INFORMATION AND DETAILS.
6. RESTORATION SHALL BE COMPLETED FOR EACH PHASE UNLESS OTHERWISE NOTED.
7. FINAL ASPHALT RESTORATION SHALL BE COMPLETED DURING PHASE 2. CONTRACTOR TO INSTALL BINDER COURSE PAVEMENT FOR THE AREA INDICATED AT THE COMPLETION OF PHASE 1.
8. END OF CONDUITS SHALL BE CAPPED, LEFT BELOW GRADE AND SURVEYED FOR FUTURE CONNECTIONS.
9. TWO 2-INCH SCH80 PVC PIPES SHALL BE INSTALLED THROUGH CISTERN RISERS (LIQUID TIGHT PENETRATIONS) AND WYE INTO A 3-INCH SCH80 PVC PIPE (MIN. 42 INCH BELOW GRADE) FOR FUTURE PUMP DISCHARGE.
10. SEE SHEET C-12 FOR ADDITIONAL FIELD ACCESS AND RETAINING WALL INFORMATION AND PROFILE.
11. CONTRACTOR TO PROVIDE TEMPORARY SOLAR POWER WITH BATTERY BACKUP TO SCOREBOARD AT COMPLETION OF PHASE 1 WORK UNTIL PERMANENT POWER IS PROVIDED AT THE COMPLETION OF PHASE 2.

LEGEND

▨	SYNTHETIC TURF RESTORATION AREA	═	CONCRETE CURB
▨	GRASS TURF RESTORATION AREA	—o—o—o—	CHAIN LINK FENCE
▨	GRASS SOD RESTORATION AREA	—□—□—□—	DECORATIVE ALUMINUM FENCE
▨	BRICK PAVER RESTORATION AREA	▣	LIGHT POLE BASE
▨	ASPHALT RESTORATION AREA	— W —	WATER LINE
▨	CONCRETE RESTORATION AREA	— EUG —	UNDERGROUND ELECTRIC
▨	DGA RESTORATION AREA	— CUG —	UNDERGROUND COMMUNICATION (CCTV / SIGNAL)
▨	STONE RESTORATION AREA	— IRR —	IRRIGATION WATER LINE
▨	STRUCTURE RESTORATION (CONCRETE SLAB)	— — —	IRRIGATION SYSTEM LIMITS
■	BLOCK RETAINING WALL	—LOW—	LIMITS OF WORK
□	CONCRETE RETAINING WALL	—50—	PROPOSED CONTOURS (1 FT. INTERVAL)

●	PROPOSED PUMPING WELL LOCATION (FUTURE BY OTHERS)

PHASE KEY

🟩	LIMITS OF PHASE 1 EXCAVATION AND RESTORATION
🟦	LIMITS OF PHASE 2 EXCAVATION AND RESTORATION
🟪	LIMITS OF PHASE 3 EXCAVATION AND RESTORATION

AECOM

PROJECT

Phase II Remedial Action
Town of Greenwich
Greenwich High School
10 Hillside Road
Greenwich, Connecticut

CLIENT

CONSULTANT

AECOM
500 Enterprose Drive Suite 3B
Rocky Hill, CT 06067-3913
860.529.8882 tel 860.529.3991 fax
www.aecom.com

REGISTRATION

No. 33626
04-12-2021

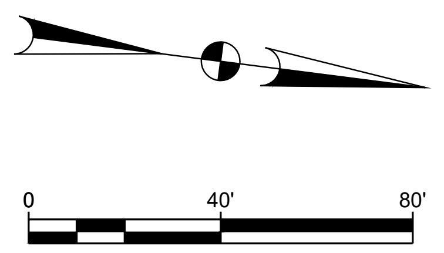
Date: 04-12-2021

RANDALL TWISS, P.E.
CTPE Lic. No. 33626

ENGINEER'S CERTIFICATION:

THE UNDERSIGNED HEREBY CERTIFIES THIS PLAN TO BE AN APPROPRIATE REPRESENTATION OF THE PROPOSED SITE FEATURES. THE COMPLIANCE OF THE IMPLEMENTATION OF CONTRACT WORK IS THE CONTRACTOR'S SOLE RESPONSIBILITY.

REFERENCE



ISSUE/REVISION

I/R	DATE	DESCRIPTION

PROJECT NUMBER

60432356

SHEET TITLE

RESTORATION PLAN

SHEET NUMBER

C-10

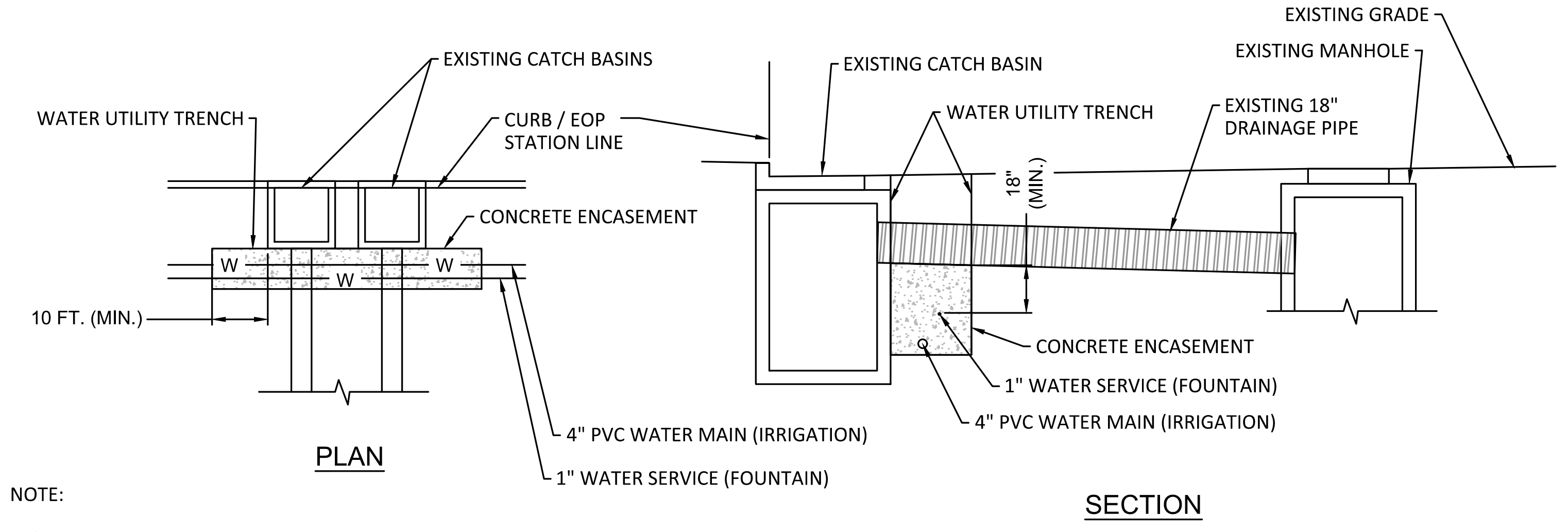
ANSI D 22" x 34"

Approved:

Checked:

Designer:

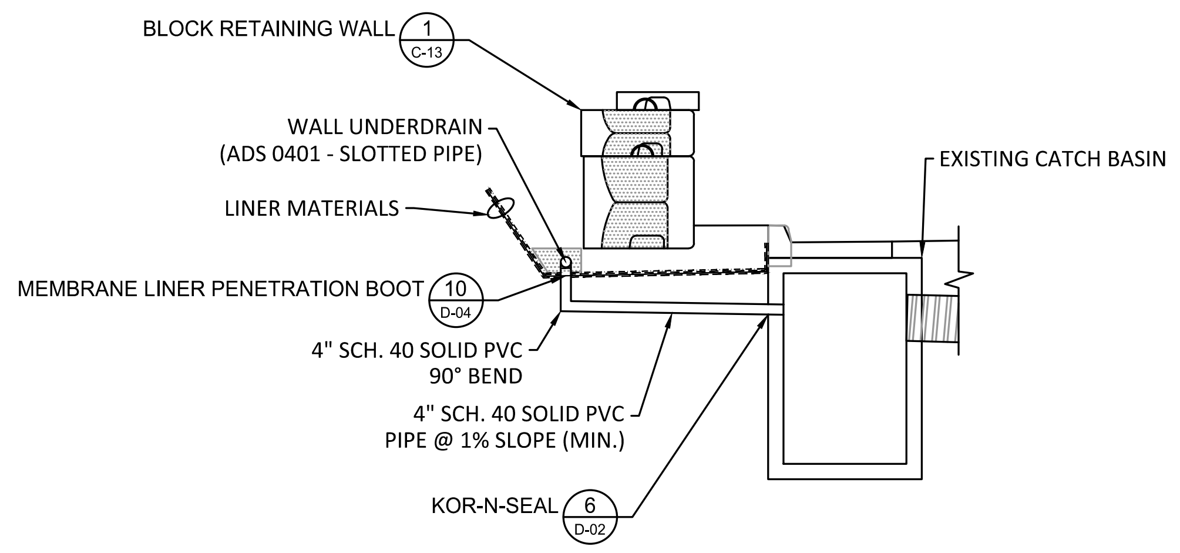
Project Management Initials:



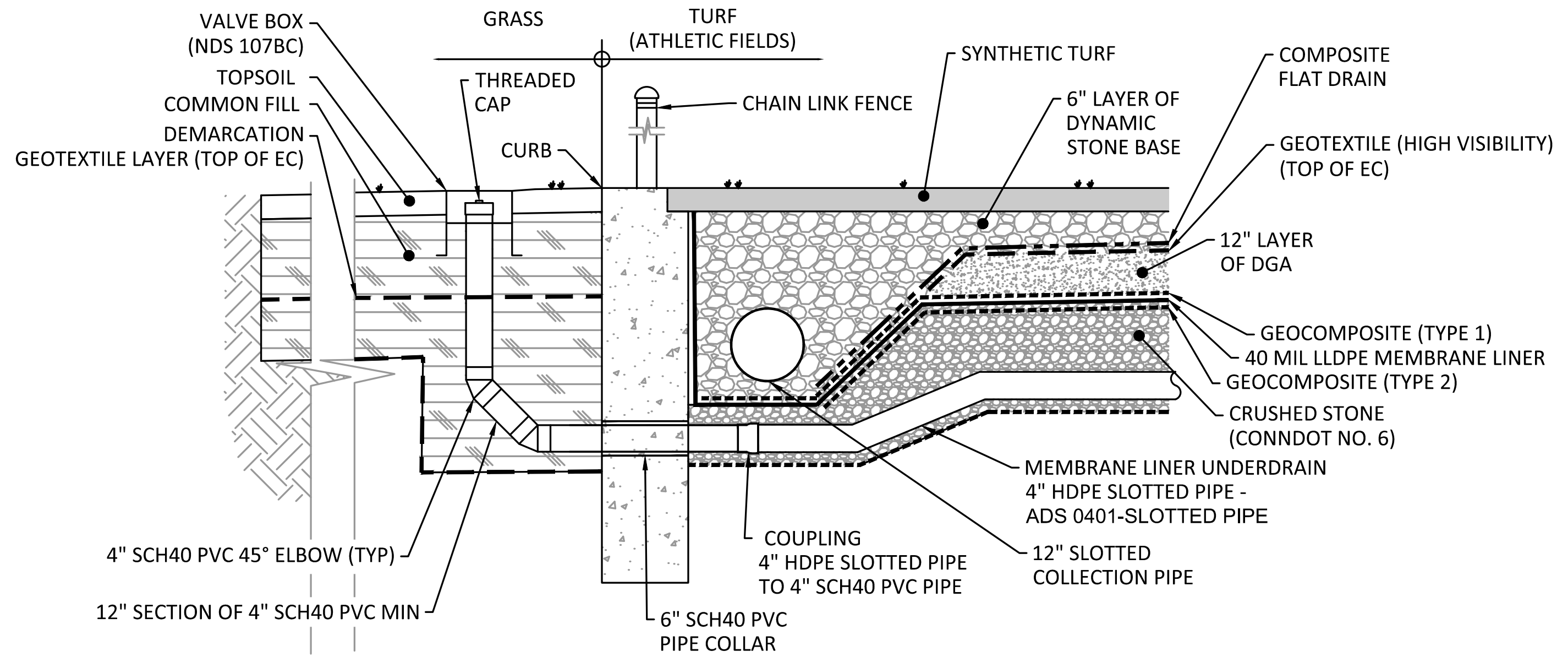
NOTE:

1) ONE FULL SECTION OF PIPE SHALL BE CENTERED ON CROSSING PIPE(S) TO ACHIEVE GREATEST DISTANCE TO NEAREST JOINT.

1 WATER UTILITY AT STORM SEWER
C-14
NOT TO SCALE



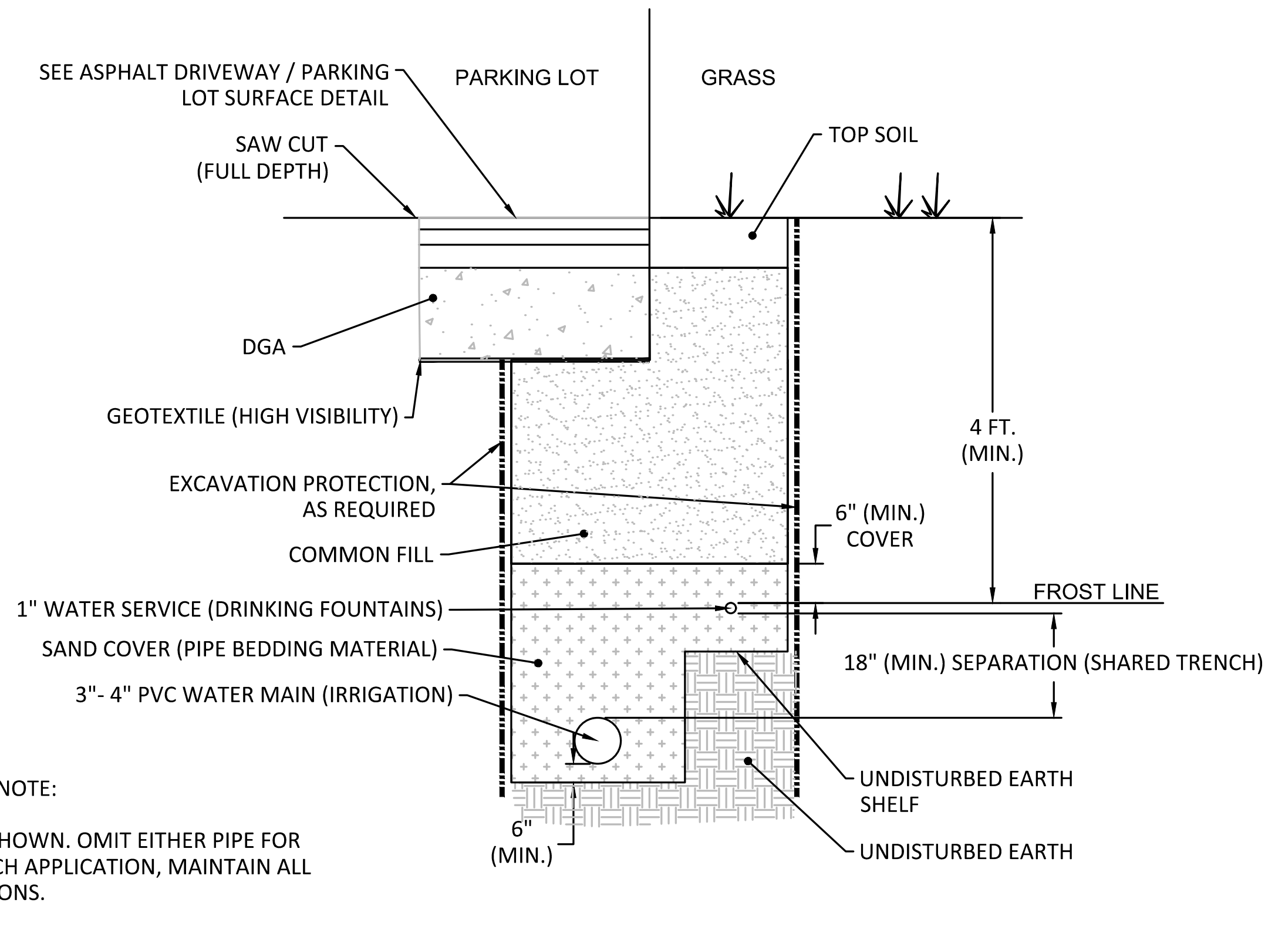
3 UNDERDRAIN CONNECTION TO STRUCTURE
C-14
NOT TO SCALE



NOTE:

1) SHALL BE PLACED AT BEGINNING AND ENDING OF EAST AND WEST RUNS.

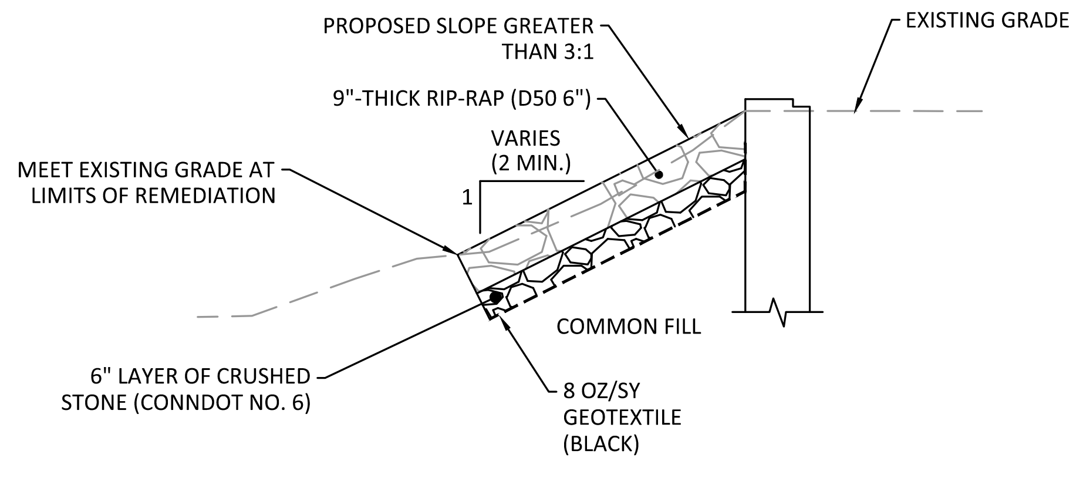
5 UNDERDRAIN CLEANOUT -1
C-07
NOT TO SCALE



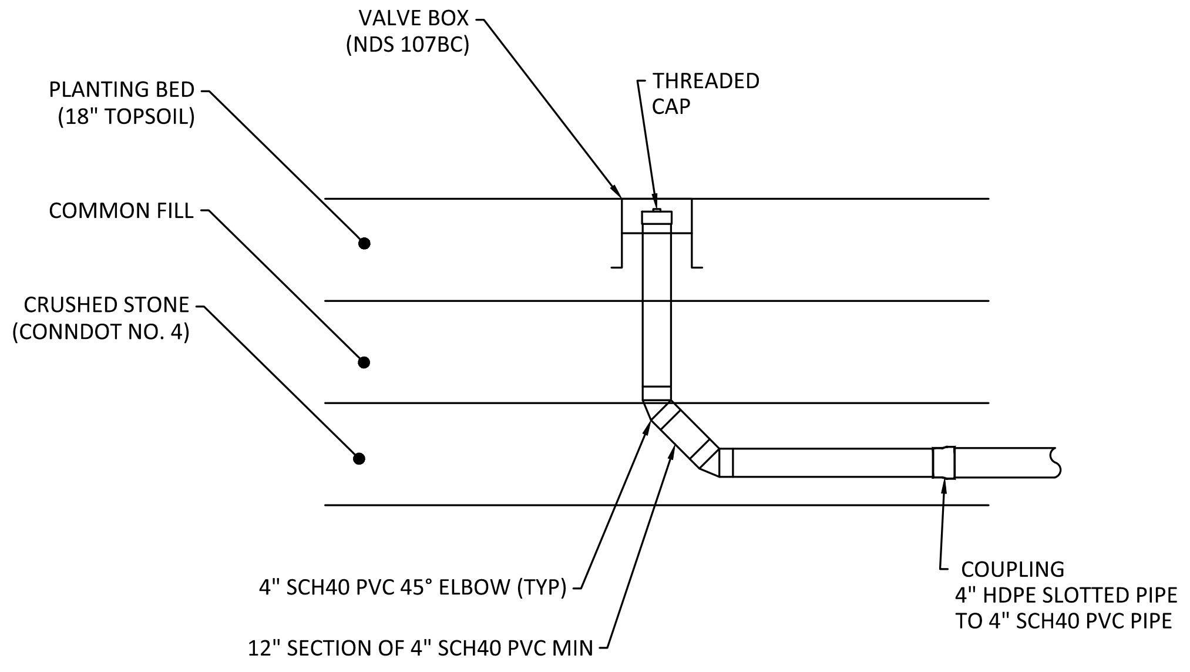
WATER UTILITY TRENCH NOTE:

1) SHARED TRENCH SHOWN. OMIT EITHER PIPE FOR SINGLE PIPE TRENCH APPLICATION, MAINTAIN ALL BEDDING DIMENSIONS.

2 WATER UTILITY TRENCH
*
NOT TO SCALE
* C-14, D-06



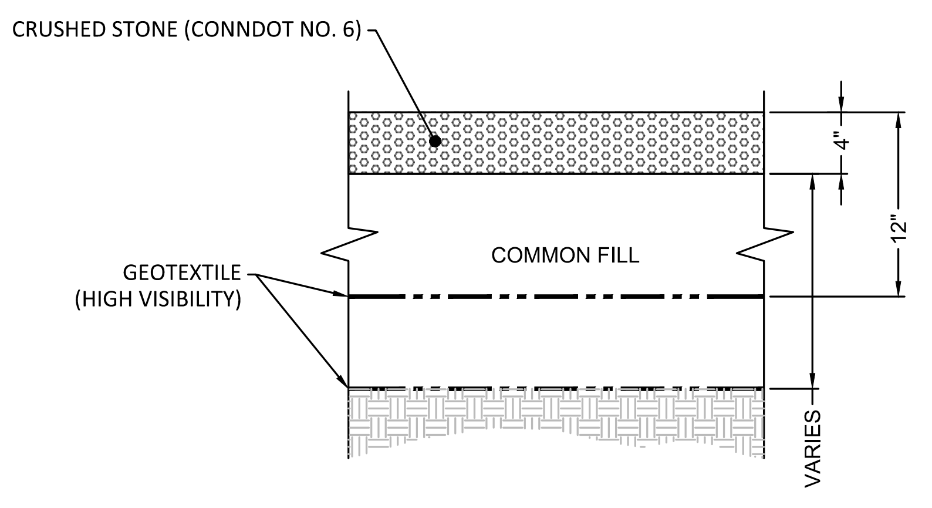
4 STONE ARMOR LINING
*
NOT TO SCALE
* C-10, S-02



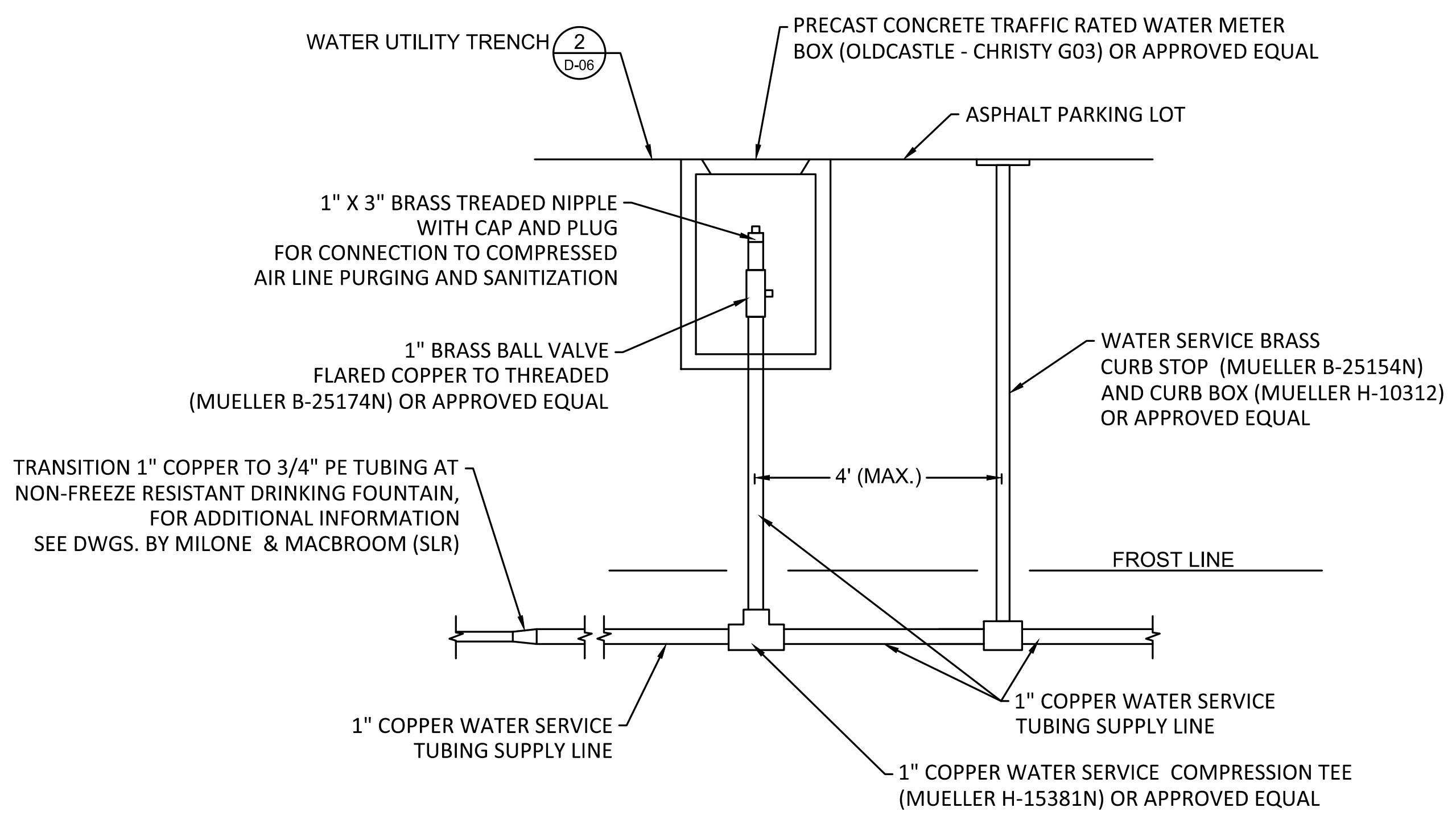
NOTE:

1) SHALL BE PLACED AT NORTH AND SOUTHMOST ENDS ALONG BLOCK RETAINING WALL.

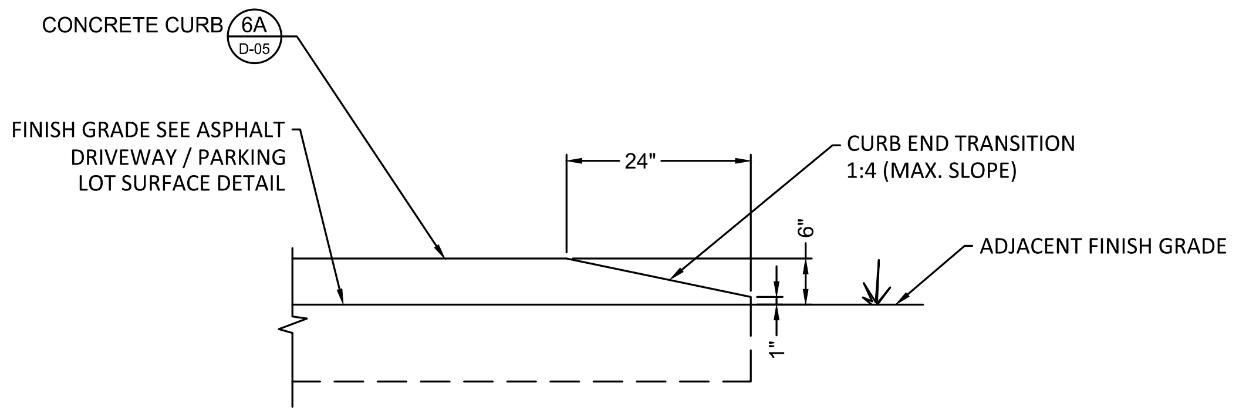
6 UNDERDRAIN CLEANOUT -2
C-07
NOT TO SCALE



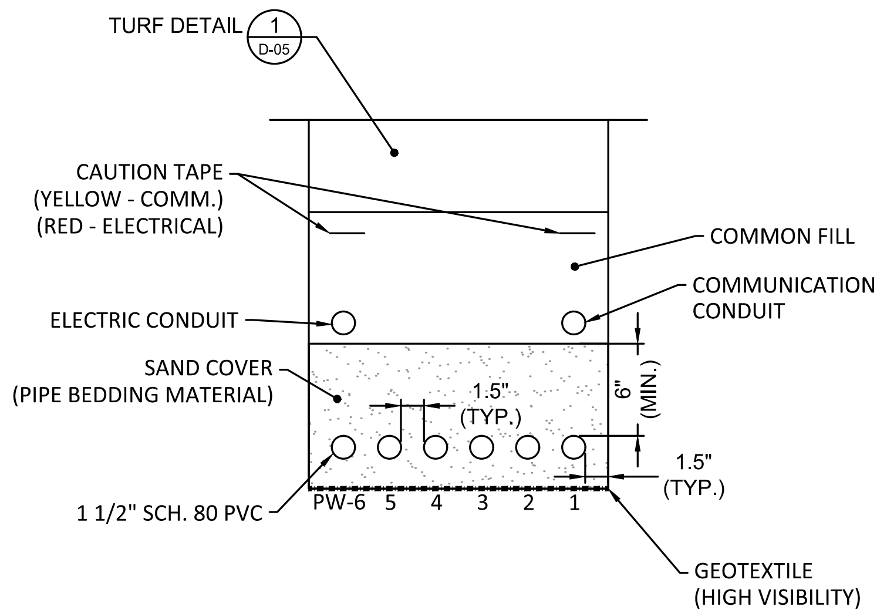
7 CRUSHED STONE SURFACE
C-10
NOT TO SCALE



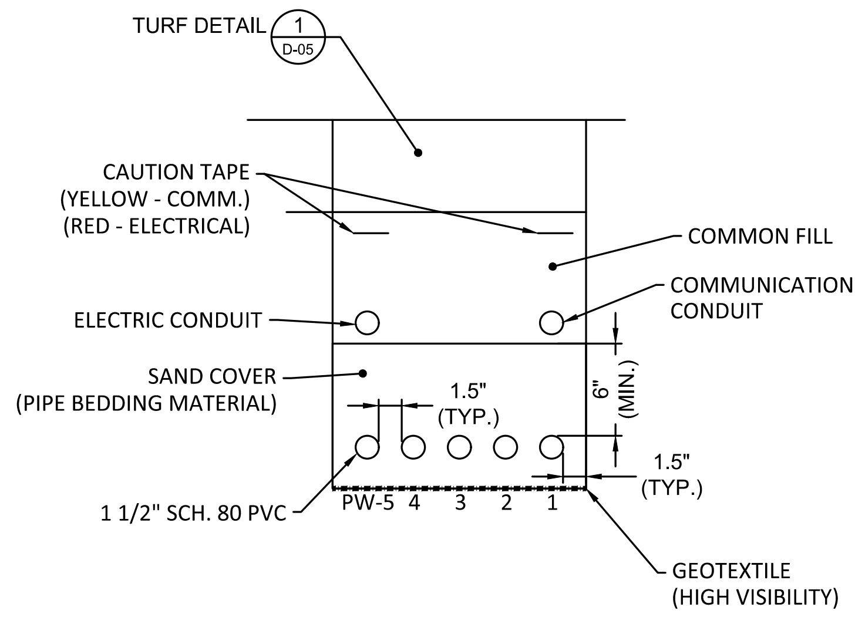
9 WATER SERVICE VALVE AND METER PIT
C-14
NOT TO SCALE



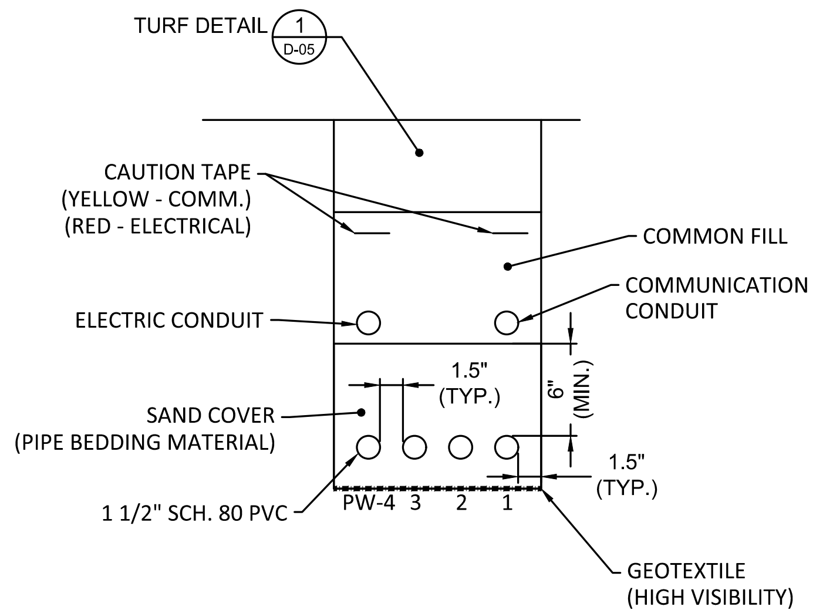
8 CURB END DETAIL
*
NOT TO SCALE
* C-10, C-12



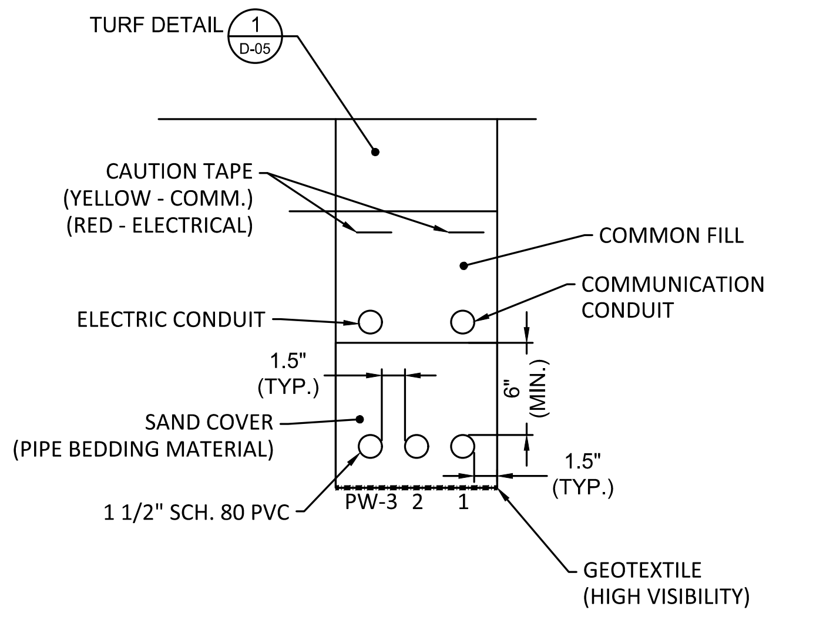
10 DEWATERING TRENCH
C-10
NOT TO SCALE



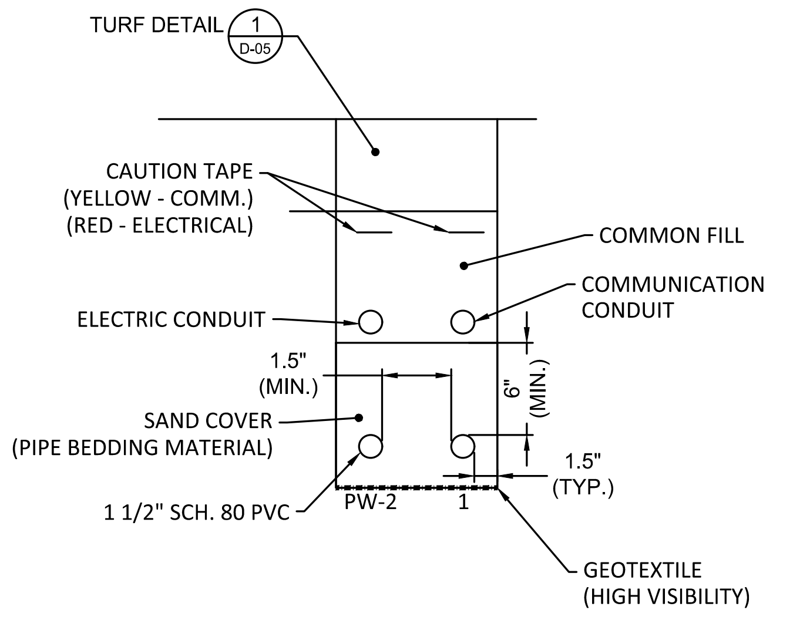
11 DEWATERING TRENCH
C-10
NOT TO SCALE



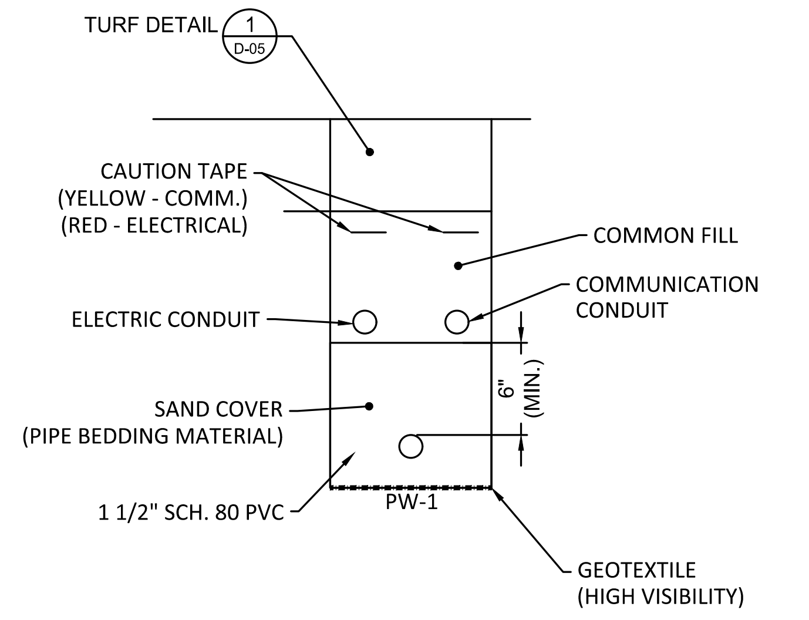
12 DEWATERING TRENCH
C-10
NOT TO SCALE



13 DEWATERING TRENCH
C-10
NOT TO SCALE



14 DEWATERING TRENCH
C-10
NOT TO SCALE



15 DEWATERING TRENCH
C-10
NOT TO SCALE

DEWATERING TRENCH NOTES:

1) CONDUIT SIZED FOR 6 - 1.5 HP SUBMERSIBLE PUMPS AND POWER FOR SCOREBOARDS.
2) WATER LINES SHALL HAVE LONG SWEEP ELBOWS FOR 90° BENDS.

PROJECT

Phase II Remedial Action
Town of Greenwich
Greenwich High School
10 Hillside Road
Greenwich, Connecticut

CLIENT

CONSULTANT

AECOM
500 Enterprise Drive Suite 3B
Rocky Hill, CT 06067-3913
860.529.8882 tel 860.529.3991 fax
www.aecom.com

REGISTRATION

RANDALL TWISS
No. 33626
04-12-2021

Date: 04-12-2021

RANDALL TWISS, P.E.
CTPE Lic. No. 33626

ENGINEER'S CERTIFICATION:

THE UNDERSIGNED HEREBY CERTIFIES THIS PLAN TO BE AN APPROPRIATE REPRESENTATION OF THE PROPOSED SITE FEATURES. THE COMPLIANCE OF THE IMPLEMENTATION OF CONTRACT WORK IS THE CONTRACTOR'S SOLE RESPONSIBILITY.

REFERENCE

ISSUE/REVISION

I/R	DATE	DESCRIPTION

PROJECT NUMBER

60432356

SHEET TITLE

DETAILS
6 OF 7

SHEET NUMBER

D-06

Addendum #2

AECOM
500 Enterprise Drive
Rocky Hill, CT 06067
aecom.com

May 19, 2021

Ms. Kimberly Tisa
PCB Coordinator – Region 1
United States Environmental
Protection Agency
1 Congress Street, Suite 1100
Boston, MA 02114-2023

Phase II RAP Addendum #2
Greenwich High School
10 Hillside Road
Greenwich, Connecticut

Dear Ms. Tisa,

On behalf of the Town of Greenwich, AECOM has prepared this addendum to the Phase II Remedial Action Plan (RAP) for the above referenced property (the site). The Phase II RAP was submitted to the United States Environmental Protection Agency (EPA) and the Connecticut Department of Environmental Protection (DEEP) on January 7, 2021. This addendum details the scope of work for which the Town of Greenwich is requesting approval to perform in the year 2021 and presents revised limits of the Engineered Controls (ECs) to be constructed in 2021, based on conversations between the Town, DEEP, and EPA.

Scope of Work for 2021

The scope of work for 2021 includes:

- Excavate and backfill Remediation Areas (RAs) RA10, RA10A, RA11, RA12, RA13, RA14, RA16, RA17, and RA18, as shown on **Figure 1**.
- Load, transport, and dispose impacted soil from Remediation Areas RA10, RA10A, RA13, RA16, RA17, and RA18 as PCB Remediation Waste (greater than 50 mg/kg).
- Load, transport, and dispose impacted soil from Remediation Area RA14 as PCB Remediation Waste (less than 50 mg/kg) in accordance with 40 CFR 761.61(a)(5)(i)(B)(2)(ii). Additional data demonstrating that PCB concentrations in that area are provided in **Attachment 1**.)
- Remove and replace Field 4 artificial turf and field infrastructure including turf carpet, infill, shock pad, concrete perimeter curbing, and perimeter fencing.
- Consolidate beneath the impermeable liner impacted soil containing PCBs at a concentration of less than 10 mg/kg excavated from 0 to 1.5 feet bgs in RA11 and RA12.
- Construct an Engineered Control cover system beneath the artificial turf of Field 4.
- Construct stormwater piping and the stormwater detention system associated with Field 4.
- Construct an Engineered Control cover system in the grassy areas in the southwest corner of Field 5 (RA16 area) and west of Field 4 (RA12 area).

- Construct an Engineered Control cover system at the southeast corner of Field 4 consisting of asphalt and subbase where an asphalt walkway to the field is present and will be restored following earthwork activities.

Details of the engineered controls are provided below. The elements of work proposed for 2021 are shown on **Figures 1 and 2**.

Engineered Controls

Based on discussions with EPA and DEEP, the vertical limits of ECs to be constructed in 2021 have been updated as follows:

- The EC beneath artificial turf Field 4 will begin beneath the turf shockpad and be comprised of (from top to bottom) a high visibility demarcation layer, 6 inches of dynamic stone base, flat drains, a geotextile liner, 12 inches of dense-graded aggregate (DGA), an HDPE geocomposite, and a 40-mil. LLDPE membrane liner.

  The Engineered Control beneath Field 4 will incorporate a stormwater management system consisting of perforated and solid HDPE piping and a detention system located north of Field 4. A separate system consisting of a geocomposite drain and 4-inch HDPE slotted pipe will be installed beneath the EC to manage groundwater and prevent hydrostatic pressure from building up beneath the impermeable membrane liner.
- The EC beneath restored asphalt will begin at ground surface and be comprised of (from top to bottom) 4 inches of asphalt, 12 inches of DGA, a high visibility demarcation layer, and 56 inches of common fill/unrestricted reuse material.
- The EC beneath grassy areas in RA12 where excavations are proposed will begin at ground surface and be comprised of (from top to bottom) grass, 6 inches of topsoil, a high visibility demarcation layer, 18 inches of common fill/unrestricted reuse material, and a second high visibility demarcation layer. Sprinklers are not located west of Field 4, therefore the only maintenance activity expected to occur in this area is cutting of the grass.
- The EC beneath grassy areas in RA16 where excavations are proposed will begin at 18 inches bgs and consist of (from top to bottom) a high visibility demarcation layer and 54 inches of common fill/unrestricted reuse material.
- In grassy areas where the stormwater detention piping is to be installed, the EC will begin at 12 inches bgs and consist of (from top to bottom) a high visibility demarcation layer, approximately 6 inches of pipe bedding, 24 inches of piping/pipe bedding, approximately 4 inches of pipe bedding, and an 8 oz. geotextile.

A summary of EC conditions is provided in **Table 1**. A plan view showing the locations of the various restoration areas where ECs will be constructed is provided as **Figure 3**. Cross sections depicting the vertical extents of ECs beneath artificial turf, grass, and asphalt are provided as **Figures 4 through 7**.

The Maintenance, and Monitoring (M&M) Plan submitted in conjunction with the Phase II RAP will be updated to reflect these changes. Typical maintenance activities for artificial turf fields include monthly grooming of the turf carpet and raking of the infill, and yearly deep cleaning of the turf carpet, addition of infill, and seam repair. None of these activities will require disturbance of the EC. Every 10 to 15 years, the artificial turf carpet and infill is replaced. The shockpad is meant to last for at least two synthetic turf replacement cycles and only require spot replacement if damaged by turf removal activities. Typically, regrading of the stone beneath the shockpad is not needed during replacement unless the field experiences drainage or sinkhole issues. However, the M&M plan will include provisions for regrading, which will require lifting the Environmental Land Use Restriction (ELUR), if it becomes necessary.

Groundwater Elevation Evaluation

The Groundwater Elevation Evaluation Memo submitted as an appendix to the Phase II RAP has been updated with revised elevation data for MW-AL10, which is located immediately west of Field 4. The top of PVC elevation of MW-AL10 was re-surveyed in April 2021 and measured to be 2.9 feet lower than previous survey data indicated. Based on this lower elevation, groundwater has not been observed at elevations approaching or exceeding the design elevation of the 4-inch slotted PVC pipe associated with the passive groundwater collection underdrain beneath the impermeable liner for Fields 3 or 4. While on one occasion, groundwater elevations were observed to be above this elevation for a few hours at monitoring well MW-Y9, the expectation is that groundwater recovery by the passive groundwater drain system will be minimal. As noted during our conversation of May 13, 2021, while the elevation of this 4-inch slotted PVC drain pipe is a few inches higher than the lowest elevation of the impermeable liner, the limited extent of the liner below this elevation (1.5 feet wide) and presence of the nearby slotted drain pipe will prevent hydrostatic pressure from displacing the liner. The updated groundwater elevation evaluation memo is included as **Attachment 2**.

Administrative Record

An updated administrative record documenting reports submitted to EPA and DEEP regarding the site is provided as **Attachment 3**. This update includes the administrative record provided in conjunction with the Environmental Conditions Assessment Form in May 2017, as well as documents related to PCB investigation and remediation that were submitted to DEEP and EPA since that time.

Please let us know if you have any questions or comments regarding this requested modification.

Kind regards,

Pat Haskell

Patrick Haskell, LEP
Technical Leader

Michael J. Doherty

Michael Doherty, P.E.
VP, Remediation

Attachments:
Table
Figures
Attachment 1 – RA14 Less Than 50 ppm Delineation
Attachment 2 – Updated Groundwater Elevation Evaluation Memo
Attachment 3 – Administrative Record

cc: Jeff Wilcox, CT DEEP
Gary Trombly, CT DEEP
Ray Frigon, CT DEEP
Amy Siebert, Town of Greenwich
Toni Jones, Greenwich Public Schools
Dan Watson, Greenwich Public Schools
Jane Warren, McCarter & English

Table

Table 1 - Summary of Proposed Engineered Controls revised in Addendum #3

Figures

ANSI D 22" x 34"

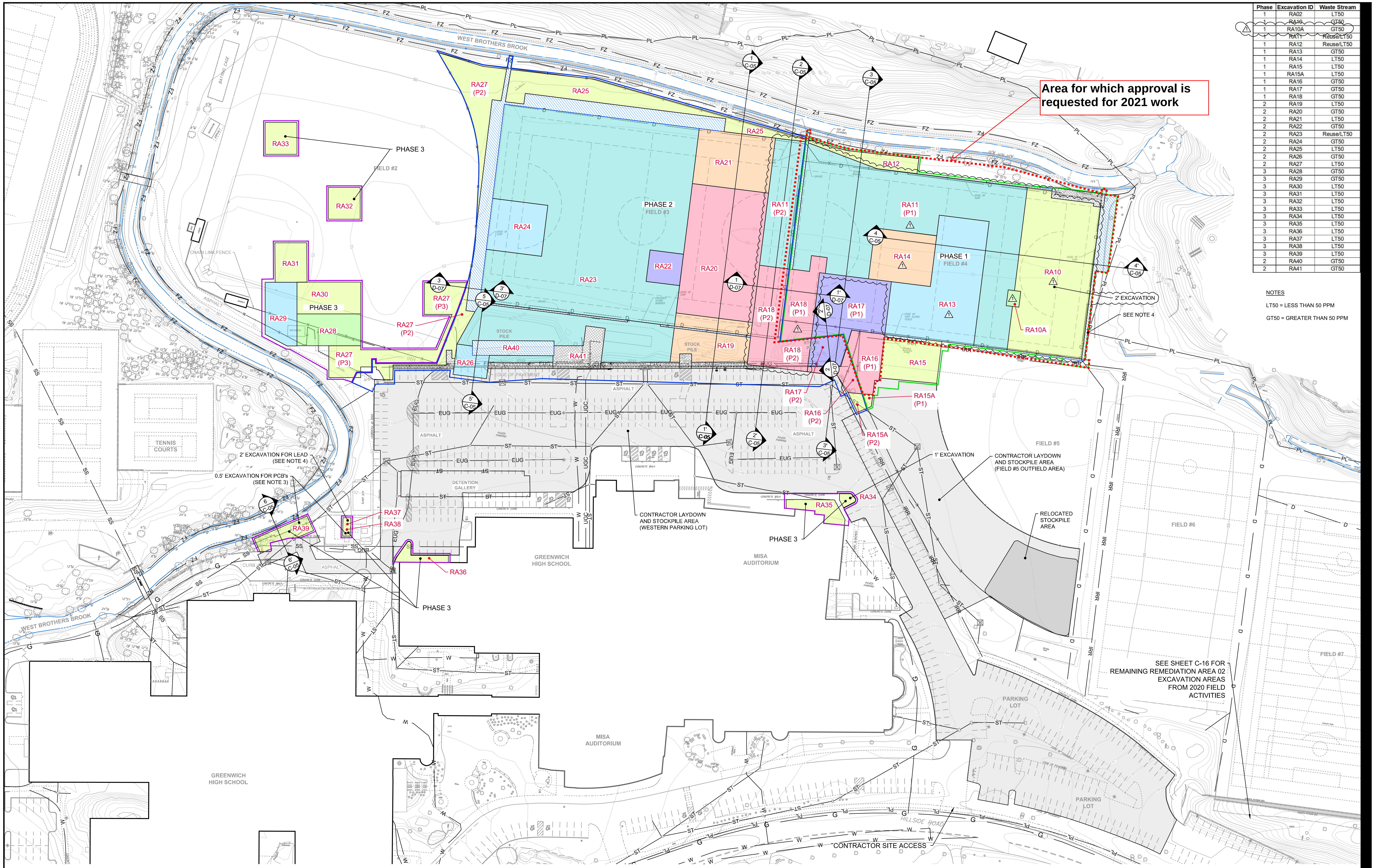
Approved:

Checked:

Designer:

Project Management Initials:

FIGURE 1 - EXCAVATION PLAN



Phase	Excavation ID	Waste Stream
1	RA02	LT50
1	RA10	GT50
1	RA10A	GT50
1	RA11	Reuse/LT50
1	RA12	Reuse/LT50
1	RA13	GT50
1	RA14	LT50
1	RA15	LT50
1	RA15A	LT50
1	RA16	GT50
1	RA17	GT50
1	RA18	GT50
2	RA19	LT50
2	RA20	GT50
2	RA21	LT50
2	RA22	GT50
2	RA23	Reuse/LT50
2	RA24	GT50
2	RA25	LT50
2	RA26	GT50
2	RA27	LT50
3	RA28	GT50
3	RA29	GT50
3	RA30	LT50
3	RA31	LT50
3	RA32	LT50
3	RA33	LT50
3	RA34	LT50
3	RA35	LT50
3	RA36	LT50
3	RA37	LT50
3	RA38	LT50
3	RA39	LT50
2	RA40	GT50
2	RA41	GT50

NOTES

LT50 = LESS THAN 50 PPM

GT50 = GREATER THAN 50 PPM

EXCAVATION KEY

🟦	1.5 FT EXCAVATION AREA (SOIL MAY BE REUSED) SEE NOTE 2
🟧	1.5 FT EXCAVATION AREA (OFFSITE DISPOSAL)
🟨	0.5 - 2 FT EXCAVATION AREA (PORTIONS OF SOIL TO BE REUSED)
🟩	3 FT EXCAVATION AREA
🟦	4 FT EXCAVATION AREA
🟪	5 FT EXCAVATION AREA
🟥	6 FT EXCAVATION AREA
▨	PIPING EXCAVATION BEYOND (HORZ. OR VERT.) ADJACENT REMEDIAL EXCAVATION LIMIT
▨	STRUCTURE EXCAVATION BEYOND (HORZ. OR VERT.) ADJACENT REMEDIAL EXCAVATION LIMIT
RA20	REMEDIAL EXCAVATION DESIGNATION NUMBER

PHASE KEY

(P1)	LIMITS OF PHASE 1 EXCAVATION AND RESTORATION
(P2)	LIMITS OF PHASE 2 EXCAVATION AND RESTORATION
(P3)	LIMITS OF PHASE 3 EXCAVATION AND RESTORATION

NOTES

1. SEE SHEET C-05 FOR EXCAVATION SECTIONS.
2. THIS EXCAVATION IS INTENDED TO ALLOW FOR THE INSTALLATION OF THE MEMBRANE LINER. THIS EXCAVATION MAY BE +/- 1.5 FT. THE EXHUMED MATERIAL FROM THIS EXCAVATION AREA SHALL BE REUSED AS BACKFILL BENEATH THE MEMBRANE LINER AND ABOVE THE GROUNDWATER TABLE TO THE MAXIMUM EXTENT PRACTICABLE. ADDITIONALLY, THE EXISTING STONE LAYER BENEATH THE SYNTHETIC TURF SHALL BE USED AS BACKFILL IN AREAS IDENTIFIED ON DRAWINGS AS SELECT EXCAVATED MATERIAL.
3. SEE SHEET C-05 AND D-07 FOR EXCAVATION SECTIONS.
4. LIMITED ACCESSIBILITY. CONTRACTOR TO DETERMINE MEANS AND METHOD TO EXCAVATE TO THE LIMITS SHOWN.

AECOM

PROJECT

Phase II Remedial Action
Town of Greenwich
Greenwich High School
10 Hillside Road
Greenwich, Connecticut

CLIENT

CONSULTANT

AECOM
500 Enterprose Drive Suite 3B
Rocky Hill, CT 06067-3913
860.529.8882 tel 860.529.3991 fax
www.aecom.com

REGISTRATION

No. 33626
04-12-2021

Date: 04-12-2021

RANDALL TWISS, P.E.
CTPE Lic. No. 33626

ENGINEER'S CERTIFICATION:

THE UNDERSIGNED HEREBY CERTIFIES THIS PLAN TO BE AN APPROPRIATE REPRESENTATION OF THE PROPOSED SITE FEATURES. THE COMPLIANCE OF THE IMPLEMENTATION OF CONTRACT WORK IS THE CONTRACTOR'S SOLE RESPONSIBILITY.

REFERENCE

0 60' 120'

ISSUE/REVISION

I/R	DATE	DESCRIPTION
1	04/20/2021	ADDENDUM 1

PROJECT NUMBER

60432356

SHEET TITLE

REMEDIAL EXCAVATION PLAN

SHEET NUMBER

C-04R1

Printed on ___% Post-Consumer Recycled Content Paper

FIGURE 2 - RESTORATION PLAN

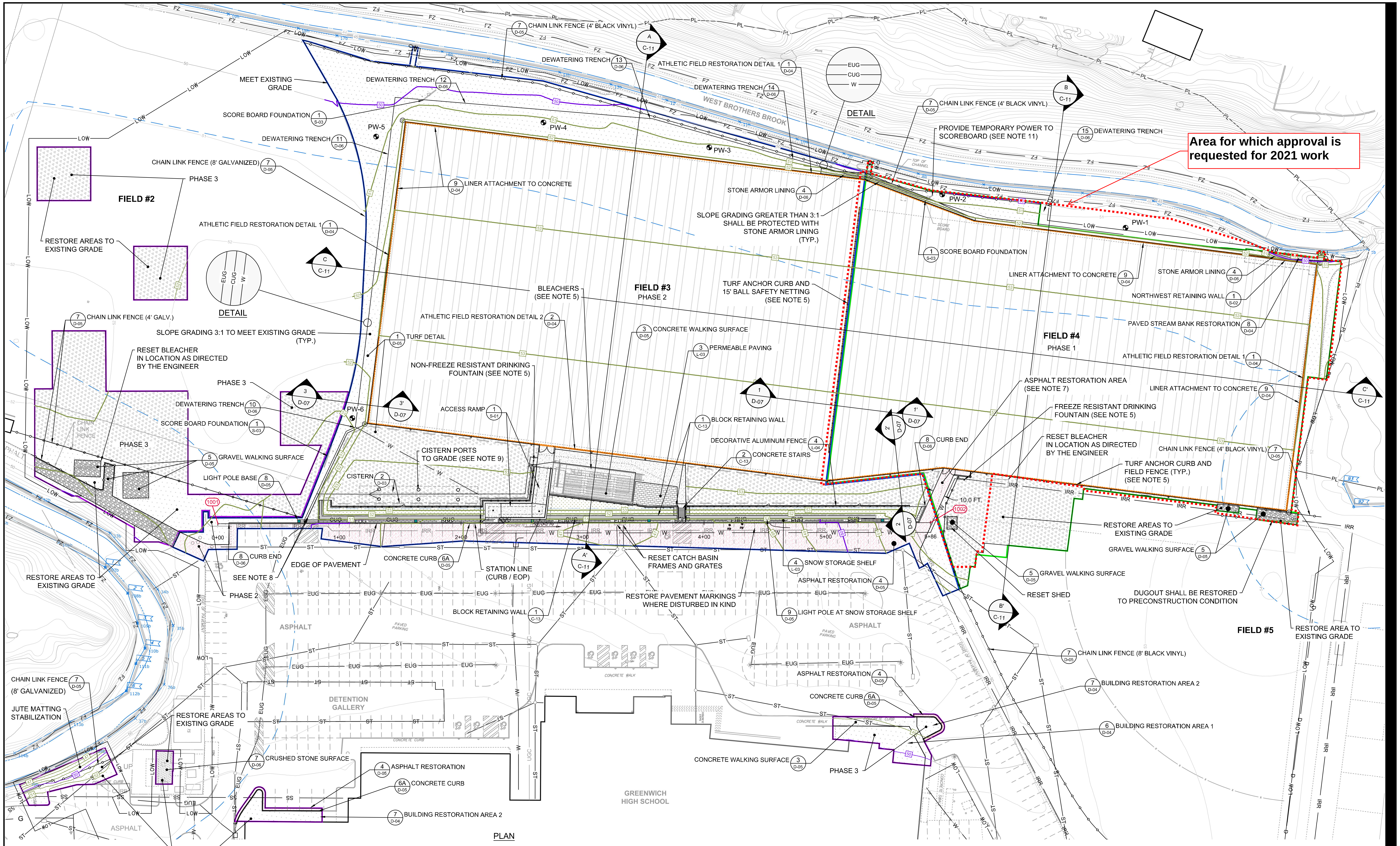
ANSI D 22" x 34"

Approved:

Checked:

Designer:

Project Management Initials:



NOTES

1. RESTORE SURFACES TO EXISTING GRADE IN AREAS INDICATED.
2. SEE SHEET C-15 FOR ADDITIONAL FINAL GRADING INFORMATION.
3. EXISTING SIGNS TO BE REMOVED, STORED AND REPLACED IN LOCATIONS AS DIRECTED BY THE ENGINEER.
4. SEE SHEET C-16 FOR REMEDIATION AREA 02 RESTORATION.
5. SEE REFERENCE DRAWING SET BY MILONE & MACBROOM (SLR) FOR SYNTHETIC TURF, TURF CURB AND FIELD FENCING / GATE, BLEACHERS AND DRINKING FOUNTAIN INFORMATION AND DETAILS.
6. RESTORATION SHALL BE COMPLETED FOR EACH PHASE UNLESS OTHERWISE NOTED.
7. FINAL ASPHALT RESTORATION SHALL BE COMPLETED DURING PHASE 2. CONTRACTOR TO INSTALL BINDER COURSE PAVEMENT FOR THE AREA INDICATED AT THE COMPLETION OF PHASE 1.
8. END OF CONDUITS SHALL BE CAPPED, LEFT BELOW GRADE AND SURVEYED FOR FUTURE CONNECTIONS.
9. TWO 2-INCH SCH80 PVC PIPES SHALL BE INSTALLED THROUGH CISTERN RISERS (LIQUID TIGHT PENETRATIONS) AND WYE INTO A 3-INCH SCH80 PVC PIPE (MIN. 42 INCH BELOW GRADE) FOR FUTURE PUMP DISCHARGE.
10. SEE SHEET C-12 FOR ADDITIONAL FIELD ACCESS AND RETAINING WALL INFORMATION AND PROFILE.
11. CONTRACTOR TO PROVIDE TEMPORARY SOLAR POWER WITH BATTERY BACKUP TO SCOREBOARD AT COMPLETION OF PHASE 1 WORK UNTIL PERMANENT POWER IS PROVIDED AT THE COMPLETION OF PHASE 2.

LEGEND

▨	SYNTHETIC TURF RESTORATION AREA	═	CONCRETE CURB
▨	GRASS TURF RESTORATION AREA	—o—o—o—	CHAIN LINK FENCE
▨	GRASS SOD RESTORATION AREA	—□—□—□—	DECORATIVE ALUMINUM FENCE
▨	BRICK PAVER RESTORATION AREA	▣	LIGHT POLE BASE
▨	ASPHALT RESTORATION AREA	— W —	WATER LINE
▨	CONCRETE RESTORATION AREA	— EUG —	UNDERGROUND ELECTRIC
▨	DGA RESTORATION AREA	— CUG —	UNDERGROUND COMMUNICATION (CCTV / SIGNAL)
▨	STONE RESTORATION AREA	— IRR —	IRRIGATION WATER LINE
▨	STRUCTURE RESTORATION (CONCRETE SLAB)	— — —	IRRIGATION SYSTEM LIMITS
▬	BLOCK RETAINING WALL	— LOW —	LIMITS OF WORK
▭	CONCRETE RETAINING WALL	— 50 —	PROPOSED CONTOURS (1 FT. INTERVAL)

◕ PROPOSED PUMPING WELL LOCATION (FUTURE BY OTHERS)

PHASE KEY

🟩	LIMITS OF PHASE 1 EXCAVATION AND RESTORATION
🟦	LIMITS OF PHASE 2 EXCAVATION AND RESTORATION
🟪	LIMITS OF PHASE 3 EXCAVATION AND RESTORATION

Printed on ___% Post-Consumer
Recycled Content Paper

AECOM

PROJECT

Phase II Remedial Action
Town of Greenwich
Greenwich High School
10 Hillside Road
Greenwich, Connecticut

CLIENT

CONSULTANT

AECOM
500 Enterprose Drive Suite 3B
Rocky Hill, CT 06067-3913
860.529.8882 tel 860.529.3991 fax
www.aecom.com

REGISTRATION

No. 33626
04-12-2021
Randall Twiss

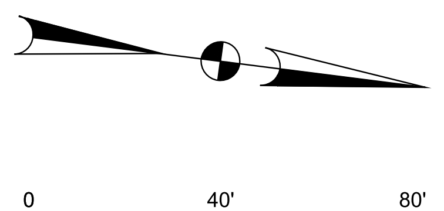
Date: 04-12-2021

RANDALL TWISS, P.E.
CTPE Lic. No. 33626

ENGINEER'S CERTIFICATION:

THE UNDERSIGNED HEREBY CERTIFIES THIS PLAN TO BE AN APPROPRIATE REPRESENTATION OF THE PROPOSED SITE FEATURES. THE COMPLIANCE OF THE IMPLEMENTATION OF CONTRACT WORK IS THE CONTRACTOR'S SOLE RESPONSIBILITY.

REFERENCE



ISSUE/REVISION

I/R	DATE	DESCRIPTION

PROJECT NUMBER

60432356

SHEET TITLE

RESTORATION PLAN

SHEET NUMBER

C-10

FIGURE 3 - ENGINEERED CONTROL CROSS SECTION LOCATIONS

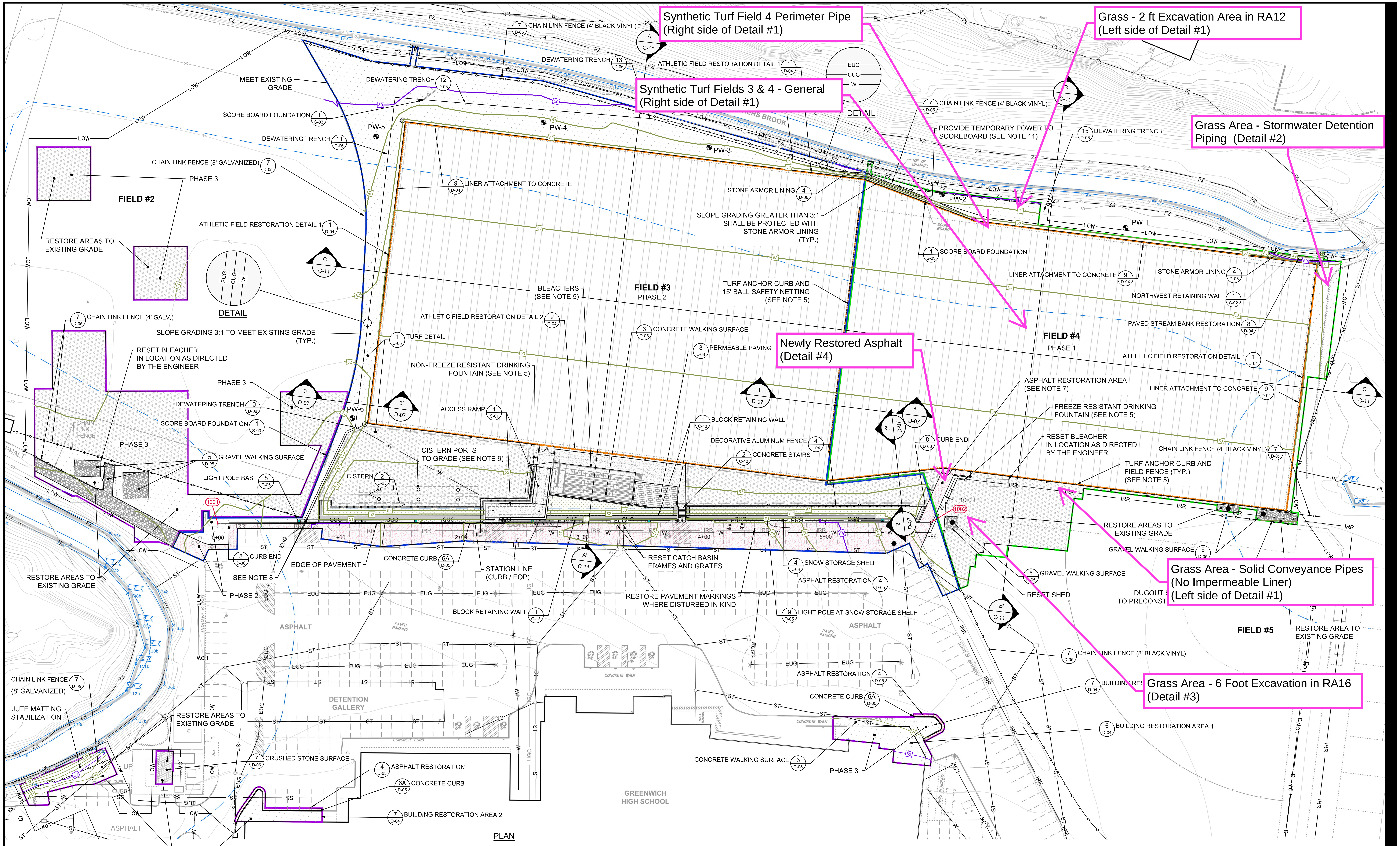
ANSI D 22" x 34"

Approved:

Checked:

Designer:

Project Management Initials:



NOTES

1. RESTORE SURFACES TO EXISTING GRADE IN AREAS INDICATED.
2. SEE SHEET C-15 FOR ADDITIONAL FINAL GRADING INFORMATION.
3. EXISTING SIGNS TO BE REMOVED, STORED AND REPLACED IN LOCATIONS AS DIRECTED BY THE ENGINEER.
4. SEE SHEET C-16 FOR REMEDIATION AREA 02 RESTORATION.
5. SEE REFERENCE DRAWING SET BY MILONE & MACBROOM (SLR) FOR SYNTHETIC TURF, TURF CURB AND FIELD FENCING / GATE, BLEACHERS AND DRINKING FOUNTAIN INFORMATION AND DETAILS.
6. RESTORATION SHALL BE COMPLETED FOR EACH PHASE UNLESS OTHERWISE NOTED.
7. FINAL ASPHALT RESTORATION SHALL BE COMPLETED DURING PHASE 2. CONTRACTOR TO INSTALL BINDER COURSE PAVEMENT FOR THE AREA INDICATED AT THE COMPLETION OF PHASE 1.
8. END OF CONDUITS SHALL BE CAPPED, LEFT BELOW GRADE AND SURVEYED FOR FUTURE CONNECTIONS.
9. TWO 2-INCH SCH80 PVC PIPES SHALL BE INSTALLED THROUGH CISTERN RISERS (LIQUID TIGHT PENETRATIONS) AND WYE INTO A 3-INCH SCH80 PVC PIPE (MIN. 42 INCH BELOW GRADE) FOR FUTURE PUMP DISCHARGE.
10. SEE SHEET C-12 FOR ADDITIONAL FIELD ACCESS AND RETAINING WALL INFORMATION AND PROFILE.
11. CONTRACTOR TO PROVIDE TEMPORARY SOLAR POWER WITH BATTERY BACKUP TO SCOREBOARD AT COMPLETION OF PHASE 1 WORK UNTIL PERMANENT POWER IS PROVIDED AT THE COMPLETION OF PHASE 2.

LEGEND

▨	SYNTHETIC TURF RESTORATION AREA
▨	GRASS TURF RESTORATION AREA
▨	GRASS SOD RESTORATION AREA
▨	BRICK PAVER RESTORATION AREA
▨	ASPHALT RESTORATION AREA
▨	CONCRETE RESTORATION AREA
▨	DGA RESTORATION AREA
▨	STONE RESTORATION AREA
▨	STRUCTURE RESTORATION (CONCRETE SLAB)
▨	BLOCK RETAINING WALL
☐	CONCRETE RETAINING WALL

═	CONCRETE CURB
—○—○—	CHAIN LINK FENCE
—□—□—	DECORATIVE ALUMINUM FENCE
▣	LIGHT POLE BASE
— W —	WATER LINE
— EUG —	UNDERGROUND ELECTRIC
— CUG —	UNDERGROUND COMMUNICATION (CCTV / SIGNAL)
— IRR —	IRRIGATION WATER LINE
▬ ▬ ▬	IRRIGATION SYSTEM LIMITS
— LOW —	LIMITS OF WORK
— 50 —	PROPOSED CONTOURS (1 FT. INTERVAL)
◕	PROPOSED PUMPING WELL LOCATION (FUTURE BY OTHERS)

PHASE KEY

🟩	LIMITS OF PHASE 1 EXCAVATION AND RESTORATION
🟦	LIMITS OF PHASE 2 EXCAVATION AND RESTORATION
🟪	LIMITS OF PHASE 3 EXCAVATION AND RESTORATION

Printed on ___% Post-Consumer
Recycled Content Paper

AECOM

PROJECT

Phase II Remedial Action
Town of Greenwich
Greenwich High School
10 Hillside Road
Greenwich, Connecticut

CLIENT

CONSULTANT

AECOM
500 Enterprise Drive Suite 3B
Rocky Hill, CT 06067-3913
860.529.8882 tel 860.529.3991 fax
www.aecom.com

REGISTRATION

No. 33626
04-12-2021
Randall Twiss

Date: 04-12-2021

RANDALL TWISS, P.E.
CTPE Lic. No. 33626

ENGINEER'S CERTIFICATION:

THE UNDERSIGNED HEREBY CERTIFIES THIS PLAN TO BE AN APPROPRIATE REPRESENTATION OF THE PROPOSED SITE FEATURES. THE COMPLIANCE OF THE IMPLEMENTATION OF CONTRACT WORK IS THE CONTRACTOR'S SOLE RESPONSIBILITY.

REFERENCE

0 40' 80'

ISSUE/REVISION

I/R	DATE	DESCRIPTION

PROJECT NUMBER

60432356

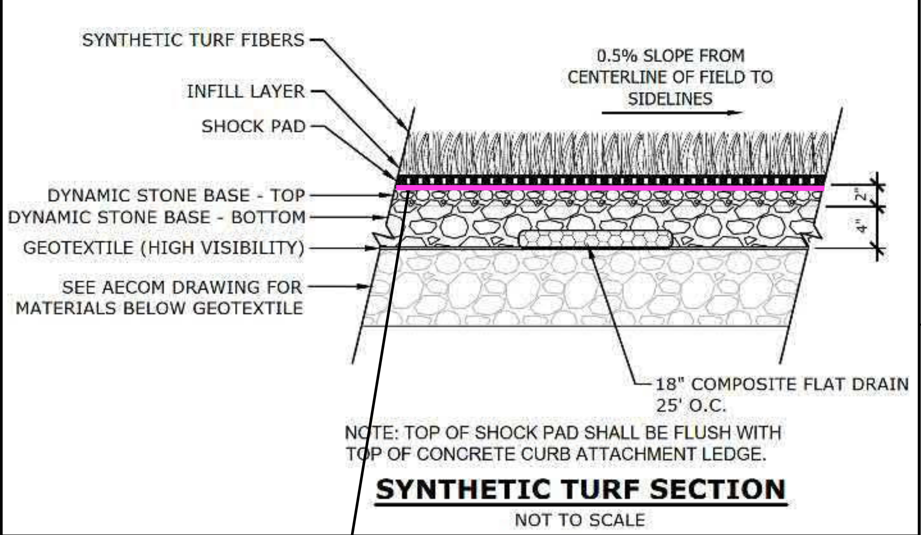
SHEET TITLE

RESTORATION PLAN

SHEET NUMBER

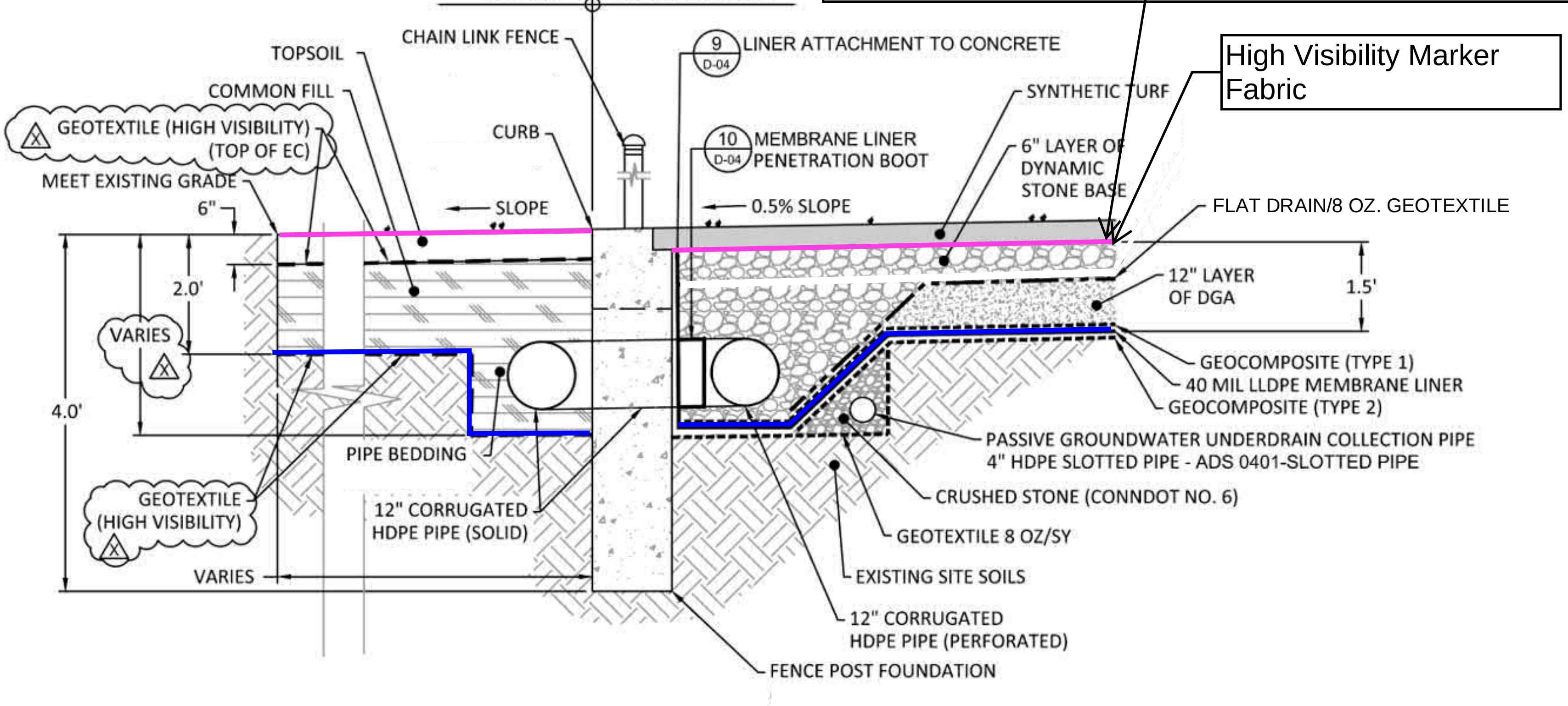
C-10

Detail #1
Synthetic Turf Field 4 - General
Synthetic Turf Field 4 - Perimeter Perforated Piping
Grass Area - Solid Conveyance Pipes (No Impermeable Liner)
Grass Area - 2 foot Excavation in RA12



SYNTHETIC TURF SECTION

NOT TO SCALE



LEGEND:

🟪	TOP OF EC
🟦	BOTTOM OF EC

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

SCALE:

VERTICAL SCALE: NOT TO SCALE

HORIZONTAL SCALE: NOT TO SCALE

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE RD
GREENWICH, CT

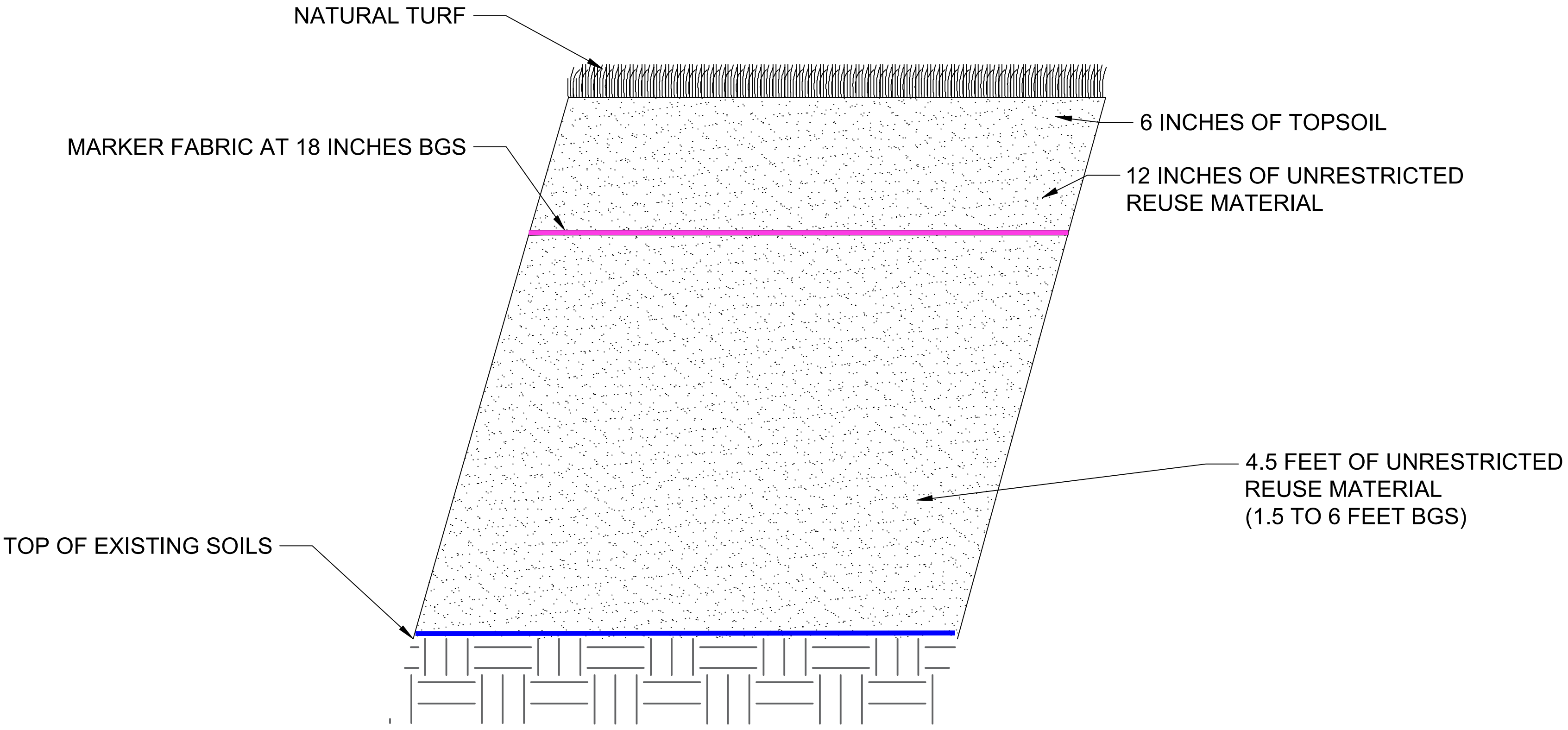
FIGURE 4
DETAIL #1
ENGINEERED CONTROL
CROSS SECTIONS

JOB 60432356
FILE NO.
CAD FILE EC_X_SECTION
SHEET

PATH/FILENAME: \\USRKH2FP001\DATA\EVERYONE\60432356 GREENWICH HIGH SCHOOL REMEDIATION\900-WORK\GIS\CAD\PHASE II RAP\EC_X_SECTION.DWG
LAST UPDATE: Monday, January 04, 2021 12:07:23 PM
PLOT DATE: Tuesday, January 05, 2021 3:30:02 PM
ARCH D – 3-7-05

Figure 5 - Detail #2 Grass Area - Detention Piping North of Field 4: Revised version provided in Addendum #3.

Detail #3
Grass Area - 6 Foot Excavation in RA16



LEGEND:

🟪	TOP OF EC
🟦	BOTTOM OF EC

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

SCALE:

VERTICAL SCALE NOT TO SCALE

HORIZONTAL SCALE: NOT TO SCALE

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE RD
GREENWICH, CT

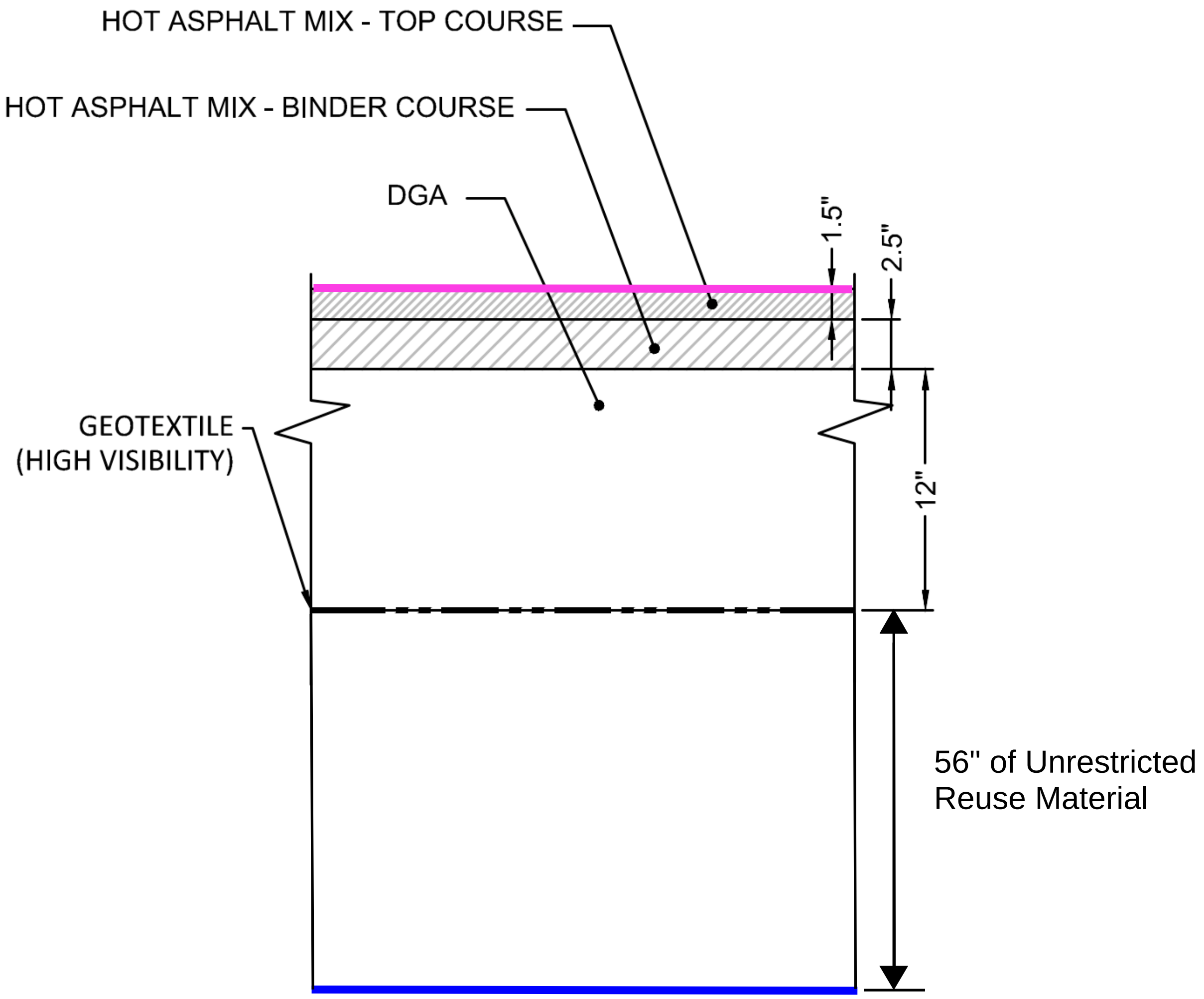
FIGURE 6
DETAIL #3
ENGINEERED CONTROL
CROSS SECTION

JOB 60432356
FILE NO.
CAD FILE [illegible]
SHEET

PATH/FILENAME: \\USRKH2FP001\DATA\EVERYONE\60432356 GREENWICH HIGH SCHOOL REMEDIATION\900-WORK\GIS\CAD\PHASE II RAP\EC_X_SECTION.DWG
LAST UPDATE: Wednesday, January 06, 2021 1:35:58 PM
PLOT DATE: Friday, May 14, 2021 1:08:35 PM

ARCH D - 3-7-05

Detail #4
Newly Restored Asphalt Walkway in RA16



LEGEND:

- 🟪 TOP OF EC
- 🟦 BOTTOM OF EC

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

SCALE:

VERTICAL SCALE: NOT TO SCALE
HORIZONTAL SCALE: NOT TO SCALE

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE RD
GREENWICH, CT

FIGURE 7
DETAIL #4
ENGINEERED CONTROL
CROSS SECTION

JOB 60432356
FILE NO.
CAD FILE EC_X_SECTION
SHEET

PATH/FILENAME: \\USRKH2FP001\DATA\EVERYONE\60432356 GREENWICH HIGH SCHOOL REMEDIATION\900-WORK\GIS\CAD\PHASE II RAP\EC_X_SECTION.DWG
LAST UPDATE: Monday, January 04, 2021 12:07:23 PM
PLOT DATE: Tuesday, January 05, 2021 3:30:02 PM

ARCH D - 3-7-05

Attachment 1

RA14 Less Than 50 ppm Delineation

LEGEND

☐	Not Sampled
🟩	Not Detected
🟦	≤1,000 ug/kg
🟪	>1,000 ug/kg (RDEC) - ≤10,000 ug/kg
🟧	>10,000 ug/kg - ≤50,000 ug/kg
🟥	>50,000 ug/kg - ≤500,000 ug/kg
■	>500,000 ug/kg

Stack charts indicate the maximum detected PCB concentration in the specified depth interval

- 0≤2'
- >2'≤4'
- >4'≤6'
- >6'≤8'
- >8'≤10'
- >10'≤12'
- >12'≤14'
- >14'≤16'

LEGEND

RA	REMEDIATION AREA		
LT50	SOIL TO BE DISPOSED OF AS LESS THAN 50PPM PCB REMEDIATION WASTE	▨	2 FOOT EXCAVATION AREA
GT50	SOIL TO BE DISPOSED OF AS GREATER THAN 50PPM PCB REMEDATION WASTE	▨	3 FOOT EXCAVATION AREA
●	PCB BORING LOCATION	▨	4 FOOT EXCAVATION AREA
▨	1.5 FOOT EXCAVATION AREA (REUSE < 10 PPM)	▨	5 FOOT EXCAVATION AREA
▨	1.5 FOOT EXCAVATION AREA (DISPOSAL > 10 PPM)	▨	6 FOOT EXCAVATION AREA

NOTES:
1. SURFICIAL SOIL SAMPLES ARE SHOWN AS TRIANGLES.
   - PARKING LOT SURFICIAL SAMPLES COLLECTED AT 2 FT BGS.
   - NATURAL GRASS SURFICIAL SOIL SAMPLES COLLECTED FROM 0 TO 0.25 FT OR 0 TO 0.5 FT BGS.
   - SYNTHETIC TURF SURFICIAL SAMPLES COLLECTED FROM 0 TO 0.3 FT BGS.
2. SOME STACK CHARTS SHIFTED TO PREVENT OVERLAP. SAMPLE LOCATIONS DENOTED BY BLACK DOTS.

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

N

SCALE:
0 20 40 80 120 Feet
1" = 40' SCALE
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

SCENARIO 3 EXCAVATION AREAS
PHASE II REMEDIAL ACTION PLAN

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

PROJECT NUMBER:
60432356

FIGURE:
1

Remediation Area 14
Less Than 50 ppm Delineation
Phase II Remediation
Greenwich High School

Location ID	**Unit**	**2013 RES DEC**	**AL13-SB439**	**AL13-SB439**	**AM13**	**AM13**	**AM13**	**AM13-E**
Depth Interval			**2 - 3 ft**	**3 - 4 ft**	**1 - 1.5 ft**	**2 - 4 ft**	**4 - 5 ft**	**0 - 0.5 ft**
Sample ID			**AL13-SB439(2-3)070612-1**	**AL13-SB439(3-4)070612-1**	**AM13 (1-1.5)-1**	**AM13 (2-4)-1**	**AM13 (4-5)-1**	**AM13-E-071118-1**
Sample Date			**7/6/2012**	**7/6/2012**	**9/18/2020**	**9/18/2020**	**9/18/2020**	**7/11/2018**
SDG			**SB52371**	**SB52371**	**20I1051**	**20I1051**	**20I1051**	**18G0509**
PCBs								
Aroclor 1016	ug/kg	NE	< 22.9 U	< 121 U	< 2300	< 4200	< 2100	< 87 U
Aroclor 1221	ug/kg	NE	< 22.9 U	< 121 U	< 2300	< 4200	< 2100	< 87 U
Aroclor 1232	ug/kg	NE	< 22.9 U	< 121 U	< 2300	< 4200	< 2100	< 87 U
Aroclor 1242	ug/kg	NE	< 22.9 U	< 121 U	< 2300	< 4200	< 2100	< 87 U
Aroclor 1248	ug/kg	NE	**2440**	< 121 U	**22000**	**33000**	**13000**	< 87 U
Aroclor 1254	ug/kg	NE	< 22.9 U	< 24.3 U	< 2300	< 4200	< 2100	< 87 U
Aroclor 1260	ug/kg	NE	**133**	< 24.3 U	< 2300	< 4200	< 2100	< 87 U
Aroclor 1262	ug/kg	NE	< 22.9 U	< 24.3 U	< 2300	< 4200	< 2100	< 87 U
Aroclor 1268	ug/kg	NE	< 22.9 U	< 24.3 U	< 2300	< 4200	< 2100	< 87 U
Total PCB Aroclors	ug/kg	1000	**2570**	< 121 U	**22000**	**33000**	**13000**	< 87

Notes:

This is a summary table. Only detected analytes are shown.

<0.010 = Not detected above the laboratory reporting limit

Bold = Detected above reporting limit

Blue highlighted cells exceed the 2013 RES DEC

RES DEC = Residential Direct Exposure Criteria

NE = Criteria has not been established

NS = Not sampled for this constituent

ug/kg = micrograms per kilogram

U = The analyte was not detected above the detection limit

Remediation Area 14
Less Than 50 ppm Delineation
Phase II Remediation
Greenwich High School

Location ID	**Unit**	**2013 RES DEC**	**1-LT50-RA14(0.5-1)_LOC1**	**1-LT50-RA14(1-1.5)_LOC1**	**1-LT50-RA14(0.5-1)_LOC2**	**1-LT50-RA14(1-1.5)_LOC2**
Depth Interval			**0.5 - 1 ft**	**1 - 1.5 ft**	**0.5 - 1 ft**	**1 - 1.5 ft**
Sample ID			**1-LT50-RA14(0.5-1)_LOC1**	**1-LT50-RA14(1-1.5)_LOC1**	**1-LT50-RA14(0.5-1)_LOC2**	**1-LT50-RA14(1-1.5)_LOC2**
Sample Date			**5/11/2021**	**5/11/2021**	**5/11/2021**	**5/11/2021**
SDG			**21E0666**	**21E0666**	**21E0666**	**21E0666**
PCBs						
Aroclor 1016	ug/kg	NE	< 860	< 1900	< 92	< 4500
Aroclor 1221	ug/kg	NE	< 860	< 1900	< 92	< 4500
Aroclor 1232	ug/kg	NE	< 860	< 1900	< 92	< 4500
Aroclor 1242	ug/kg	NE	< 860	< 1900	< 92	< 4500
Aroclor 1248	ug/kg	NE	**6600**	**12000**	**600**	**20000**
Aroclor 1254	ug/kg	NE	< 860	< 1900	< 92	< 4500
Aroclor 1260	ug/kg	NE	< 860	< 1900	< 92	< 4500
Aroclor 1262	ug/kg	NE	< 860	< 1900	< 92	< 4500
Aroclor 1268	ug/kg	NE	< 860	< 1900	< 92	< 4500
Total PCB Aroclors	ug/kg	1000	**6600**	**12000**	**600**	**20000**

Notes:

This is a summary table. Only detected analytes are shown.

<0.010 = Not detected above the laboratory reporting limit

Bold = Detected above reporting limit

Blue highlighted cells exceed the 2013 RES DEC

RES DEC = Residential Direct Exposure Criteria

NE = Criteria has not been established

NS = Not sampled for this constituent

ug/kg = micrograms per kilogram

U = The analyte was not detected above the detection limit

con-test®
A Pace Analytical® Laboratory

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

May 18, 2021

Dan Seremet
AECOM Environment - Rocky Hill, CT
500 Enterprise Drive, Suite 1A
Rocky Hill, CT 06067

Project Location: Greenwich, CT
Client Job Number:
Project Number: 60432356
Laboratory Work Order Number: 21E0666

Enclosed are results of analyses for samples received by the laboratory on May 12, 2021. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Kaitlyn A. Feliciano
Project Manager

Table of Contents

con-test®
A Pace Analytical® Laboratory

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

AECOM Environment - Rocky Hill, CT
500 Enterprise Drive, Suite 1A
Rocky Hill, CT 06067
ATTN: Dan Seremet

REPORT DATE: 5/18/2021

PURCHASE ORDER NUMBER: 99513ACM

PROJECT NUMBER: 60432356

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 21E0666

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Greenwich, CT

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1-LT50-RA14(0.5-1)_LOC2	21E0666-01	Soil		SM 2540G SW-846 8082A	
1-LT50-RA14(1-1.5)_LOC2	21E0666-02	Soil		SM 2540G SW-846 8082A	
1-LT50-RA14(0.5-1)_LOC1	21E0666-03	Soil		SM 2540G SW-846 8082A	
1-LT50-RA14(1-1.5)_LOC1	21E0666-04	Soil		SM 2540G SW-846 8082A	

CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

SW-846 8082A

Qualifications:

MS-21

Matrix spike and/or spike duplicate recovery bias high due to contribution of other Aroclors present in the source sample.

Analyte & Samples(s) Qualified:

Aroclor-1016
B282014-MS1, B282014-MSD1

Aroclor-1016 [2C]
B282014-MS1, B282014-MSD1

Aroclor-1260
B282014-MSD1

Aroclor-1260 [2C]
B282014-MSD1

S-01

The surrogate recovery for this sample is not available due to sample dilution below the surrogate reporting limit required from high analyte concentration and/or matrix interferences.

Analyte & Samples(s) Qualified:

Decachlorobiphenyl
21E0666-02[1-LT50-RA14(1-1.5)_LOC2], 21E0666-03[1-LT50-RA14(0.5-1)_LOC1], 21E0666-04[1-LT50-RA14(1-1.5)_LOC1]

Decachlorobiphenyl [2C]
21E0666-02[1-LT50-RA14(1-1.5)_LOC2], 21E0666-03[1-LT50-RA14(0.5-1)_LOC1], 21E0666-04[1-LT50-RA14(1-1.5)_LOC1]

Tetrachloro-m-xylene
21E0666-02[1-LT50-RA14(1-1.5)_LOC2], 21E0666-03[1-LT50-RA14(0.5-1)_LOC1], 21E0666-04[1-LT50-RA14(1-1.5)_LOC1]

Tetrachloro-m-xylene [2C]
21E0666-02[1-LT50-RA14(1-1.5)_LOC2], 21E0666-03[1-LT50-RA14(0.5-1)_LOC1], 21E0666-04[1-LT50-RA14(1-1.5)_LOC1]

The results of analyses reported only relate to samples submitted to Con-Test, a Pace Analytical Laboratory, for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

Lisa Worthington

Lisa A. Worthington
Technical Representative

Project Location: Greenwich, CT
Sample Description:
Work Order: 21E0666

Date Received: 5/12/2021

Field Sample #: 1-LT50-RA14(0.5-1)_LOC2
Sampled: 5/11/2021 11:10

Sample ID: 21E0666-01

Sample Matrix: Soil

Polychlorinated Biphenyls with 3540 Soxhlet Extraction

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.092	mg/Kg dry	4		SW-846 8082A	5/13/21	5/15/21 17:41	JMB
Aroclor-1221 [1]	ND	0.092	mg/Kg dry	4		SW-846 8082A	5/13/21	5/15/21 17:41	JMB
Aroclor-1232 [1]	ND	0.092	mg/Kg dry	4		SW-846 8082A	5/13/21	5/15/21 17:41	JMB
Aroclor-1242 [1]	ND	0.092	mg/Kg dry	4		SW-846 8082A	5/13/21	5/15/21 17:41	JMB
Aroclor-1248 [1]	0.60	0.092	mg/Kg dry	4		SW-846 8082A	5/13/21	5/15/21 17:41	JMB
Aroclor-1254 [1]	ND	0.092	mg/Kg dry	4		SW-846 8082A	5/13/21	5/15/21 17:41	JMB
Aroclor-1260 [1]	ND	0.092	mg/Kg dry	4		SW-846 8082A	5/13/21	5/15/21 17:41	JMB
Aroclor-1262 [1]	ND	0.092	mg/Kg dry	4		SW-846 8082A	5/13/21	5/15/21 17:41	JMB
Aroclor-1268 [1]	ND	0.092	mg/Kg dry	4		SW-846 8082A	5/13/21	5/15/21 17:41	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	77.5	30-150		5/15/21 17:41
Decachlorobiphenyl [2]	89.7	30-150		5/15/21 17:41
Tetrachloro-m-xylene [1]	85.6	30-150		5/15/21 17:41
Tetrachloro-m-xylene [2]	92.7	30-150		5/15/21 17:41

Project Location: Greenwich, CT
Sample Description:
Work Order: 21E0666

Date Received: 5/12/2021

Field Sample #: 1-LT50-RA14(0.5-1)_LOC2
Sampled: 5/11/2021 11:10

Sample ID: 21E0666-01

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	86.5		% Wt	1		SM 2540G	5/18/21	5/18/21 13:46	SMC

Project Location: Greenwich, CT Sample Description: Work Order: 21E0666

Date Received: 5/12/2021

Field Sample #: 1-LT50-RA14(1-1.5)_LOC2 Sampled: 5/11/2021 11:15

Sample ID: 21E0666-02

Sample Matrix: Soil

Polychlorinated Biphenyls with 3540 Soxhlet Extraction

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	4.5	mg/Kg dry	200		SW-846 8082A	5/13/21	5/16/21 10:26	JMB
Aroclor-1221 [1]	ND	4.5	mg/Kg dry	200		SW-846 8082A	5/13/21	5/16/21 10:26	JMB
Aroclor-1232 [1]	ND	4.5	mg/Kg dry	200		SW-846 8082A	5/13/21	5/16/21 10:26	JMB
Aroclor-1242 [1]	ND	4.5	mg/Kg dry	200		SW-846 8082A	5/13/21	5/16/21 10:26	JMB
Aroclor-1248 [2]	20	4.5	mg/Kg dry	200		SW-846 8082A	5/13/21	5/16/21 10:26	JMB
Aroclor-1254 [2]	ND	4.5	mg/Kg dry	200		SW-846 8082A	5/13/21	5/16/21 10:26	JMB
Aroclor-1260 [1]	ND	4.5	mg/Kg dry	200		SW-846 8082A	5/13/21	5/16/21 10:26	JMB
Aroclor-1262 [1]	ND	4.5	mg/Kg dry	200		SW-846 8082A	5/13/21	5/16/21 10:26	JMB
Aroclor-1268 [1]	ND	4.5	mg/Kg dry	200		SW-846 8082A	5/13/21	5/16/21 10:26	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	*	30-150	S-01	5/16/21 10:26
Decachlorobiphenyl [2]	*	30-150	S-01	5/16/21 10:26
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/16/21 10:26
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/16/21 10:26

Project Location: Greenwich, CT Sample Description: Work Order: 21E0666

Date Received: 5/12/2021

Field Sample #: 1-LT50-RA14(1-1.5)_LOC2 Sampled: 5/11/2021 11:15

Sample ID: 21E0666-02

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	86.5		% Wt	1		SM 2540G	5/18/21	5/18/21 13:46	SMC

Project Location: Greenwich, CT
Sample Description:
Work Order: 21E0666
Date Received: 5/12/2021
Field Sample #: 1-LT50-RA14(0.5-1)_LOC1
Sampled: 5/11/2021 11:20
Sample ID: 21E0666-03
Sample Matrix: Soil

Polychlorinated Biphenyls with 3540 Soxhlet Extraction

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.86	mg/Kg dry	40		SW-846 8082A	5/13/21	5/16/21 10:44	JMB
Aroclor-1221 [1]	ND	0.86	mg/Kg dry	40		SW-846 8082A	5/13/21	5/16/21 10:44	JMB
Aroclor-1232 [1]	ND	0.86	mg/Kg dry	40		SW-846 8082A	5/13/21	5/16/21 10:44	JMB
Aroclor-1242 [1]	ND	0.86	mg/Kg dry	40		SW-846 8082A	5/13/21	5/16/21 10:44	JMB
Aroclor-1248 [1]	6.6	0.86	mg/Kg dry	40		SW-846 8082A	5/13/21	5/16/21 10:44	JMB
Aroclor-1254 [1]	ND	0.86	mg/Kg dry	40		SW-846 8082A	5/13/21	5/16/21 10:44	JMB
Aroclor-1260 [1]	ND	0.86	mg/Kg dry	40		SW-846 8082A	5/13/21	5/16/21 10:44	JMB
Aroclor-1262 [1]	ND	0.86	mg/Kg dry	40		SW-846 8082A	5/13/21	5/16/21 10:44	JMB
Aroclor-1268 [1]	ND	0.86	mg/Kg dry	40		SW-846 8082A	5/13/21	5/16/21 10:44	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	Date/Time Analyzed
Decachlorobiphenyl [1]	*	30-150	S-01	5/16/21 10:44
Decachlorobiphenyl [2]	*	30-150	S-01	5/16/21 10:44
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/16/21 10:44
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/16/21 10:44

Project Location: Greenwich, CT
Sample Description:
Work Order: 21E0666

Date Received: 5/12/2021

Field Sample #: 1-LT50-RA14(0.5-1)_LOC1
Sampled: 5/11/2021 11:20

Sample ID: 21E0666-03

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	87.7		% Wt	1		SM 2540G	5/18/21	5/18/21 13:46	SMC

Project Location: Greenwich, CT
Sample Description:
Work Order: 21E0666
Date Received: 5/12/2021
Field Sample #: 1-LT50-RA14(1-1.5)_LOC1
Sampled: 5/11/2021 11:25
Sample ID: 21E0666-04
Sample Matrix: Soil

Polychlorinated Biphenyls with 3540 Soxhlet Extraction

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	1.9	mg/Kg dry	80		SW-846 8082A	5/13/21	5/16/21 11:02	JMB
Aroclor-1221 [1]	ND	1.9	mg/Kg dry	80		SW-846 8082A	5/13/21	5/16/21 11:02	JMB
Aroclor-1232 [1]	ND	1.9	mg/Kg dry	80		SW-846 8082A	5/13/21	5/16/21 11:02	JMB
Aroclor-1242 [1]	ND	1.9	mg/Kg dry	80		SW-846 8082A	5/13/21	5/16/21 11:02	JMB
Aroclor-1248 [1]	12	1.9	mg/Kg dry	80		SW-846 8082A	5/13/21	5/16/21 11:02	JMB
Aroclor-1254 [1]	ND	1.9	mg/Kg dry	80		SW-846 8082A	5/13/21	5/16/21 11:02	JMB
Aroclor-1260 [1]	ND	1.9	mg/Kg dry	80		SW-846 8082A	5/13/21	5/16/21 11:02	JMB
Aroclor-1262 [1]	ND	1.9	mg/Kg dry	80		SW-846 8082A	5/13/21	5/16/21 11:02	JMB
Aroclor-1268 [1]	ND	1.9	mg/Kg dry	80		SW-846 8082A	5/13/21	5/16/21 11:02	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	*	30-150	S-01	5/16/21 11:02
Decachlorobiphenyl [2]	*	30-150	S-01	5/16/21 11:02
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/16/21 11:02
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/16/21 11:02

Project Location: Greenwich, CT
Sample Description:
Work Order: 21E0666

Date Received: 5/12/2021

Field Sample #: 1-LT50-RA14(1-1.5)_LOC1
Sampled: 5/11/2021 11:25

Sample ID: 21E0666-04

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	83.8		% Wt	1		SM 2540G	5/18/21	5/18/21 13:46	SMC

Sample Extraction Data

Prep Method: % Solids **Analytical Method: SM 2540G**

Lab Number [Field ID]	Batch	Date
21E0666-01 [1-LT50-RA14(0.5-1)_LOC2]	B282242	05/18/21
21E0666-02 [1-LT50-RA14(1-1.5)_LOC2]	B282242	05/18/21
21E0666-03 [1-LT50-RA14(0.5-1)_LOC1]	B282242	05/18/21
21E0666-04 [1-LT50-RA14(1-1.5)_LOC1]	B282242	05/18/21

Prep Method: SW-846 3540C **Analytical Method: SW-846 8082A**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21E0666-01 [1-LT50-RA14(0.5-1)_LOC2]	B282014	10.0	10.0	05/13/21
21E0666-02 [1-LT50-RA14(1-1.5)_LOC2]	B282014	10.2	10.0	05/13/21
21E0666-03 [1-LT50-RA14(0.5-1)_LOC1]	B282014	10.6	10.0	05/13/21
21E0666-04 [1-LT50-RA14(1-1.5)_LOC1]	B282014	10.0	10.0	05/13/21

Table of Contents

QUALITY CONTROL

Polychlorinated Biphenyls with 3540 Soxhlet Extraction - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B282014 - SW-846 3540C										
Blank (B282014-BLK1)				Prepared: 05/13/21 Analyzed: 05/15/21						
Aroclor-1016	ND	0.019	mg/Kg wet							
Aroclor-1016 [2C]	ND	0.019	mg/Kg wet							
Aroclor-1221	ND	0.019	mg/Kg wet							
Aroclor-1221 [2C]	ND	0.019	mg/Kg wet							
Aroclor-1232	ND	0.019	mg/Kg wet							
Aroclor-1232 [2C]	ND	0.019	mg/Kg wet							
Aroclor-1242	ND	0.019	mg/Kg wet							
Aroclor-1242 [2C]	ND	0.019	mg/Kg wet							
Aroclor-1248	ND	0.019	mg/Kg wet							
Aroclor-1248 [2C]	ND	0.019	mg/Kg wet							
Aroclor-1254	ND	0.019	mg/Kg wet							
Aroclor-1254 [2C]	ND	0.019	mg/Kg wet							
Aroclor-1260	ND	0.019	mg/Kg wet							
Aroclor-1260 [2C]	ND	0.019	mg/Kg wet							
Aroclor-1262	ND	0.019	mg/Kg wet							
Aroclor-1262 [2C]	ND	0.019	mg/Kg wet							
Aroclor-1268	ND	0.019	mg/Kg wet							
Aroclor-1268 [2C]	ND	0.019	mg/Kg wet							
Surrogate: Decachlorobiphenyl	*0.160*		mg/Kg wet	0.192		83.1	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.182*		mg/Kg wet	0.192		94.4	30-150			
Surrogate: Tetrachloro-m-xylene	*0.139*		mg/Kg wet	0.192		72.1	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.152*		mg/Kg wet	0.192		79.0	30-150			
LCS (B282014-BS1)				Prepared: 05/13/21 Analyzed: 05/15/21						
Aroclor-1016	0.16	0.019	mg/Kg wet	0.192		85.1	40-140			
Aroclor-1016 [2C]	0.17	0.019	mg/Kg wet	0.192		90.2	40-140			
Aroclor-1260	0.15	0.019	mg/Kg wet	0.192		77.0	40-140			
Aroclor-1260 [2C]	0.16	0.019	mg/Kg wet	0.192		82.5	40-140			
Surrogate: Decachlorobiphenyl	*0.165*		mg/Kg wet	0.192		85.6	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.188*		mg/Kg wet	0.192		97.5	30-150			
Surrogate: Tetrachloro-m-xylene	*0.155*		mg/Kg wet	0.192		80.7	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.167*		mg/Kg wet	0.192		86.8	30-150			
LCS Dup (B282014-BSD1)				Prepared: 05/13/21 Analyzed: 05/15/21						
Aroclor-1016	0.17	0.020	mg/Kg wet	0.200		86.8	40-140	5.99	30	
Aroclor-1016 [2C]	0.18	0.020	mg/Kg wet	0.200		90.8	40-140	4.64	30	
Aroclor-1260	0.15	0.020	mg/Kg wet	0.200		77.3	40-140	4.29	30	
Aroclor-1260 [2C]	0.17	0.020	mg/Kg wet	0.200		83.2	40-140	4.84	30	
Surrogate: Decachlorobiphenyl	*0.173*		mg/Kg wet	0.200		86.5	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.197*		mg/Kg wet	0.200		98.3	30-150			
Surrogate: Tetrachloro-m-xylene	*0.169*		mg/Kg wet	0.200		84.6	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.182*		mg/Kg wet	0.200		91.0	30-150			

QUALITY CONTROL

Polychlorinated Biphenyls with 3540 Soxhlet Extraction - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC		%REC Limits	RPD		RPD Limit	Notes
Batch B282014 - SW-846 3540C												
Matrix Spike (B282014-MS1)	**Source: 21E0666-01**		Prepared: 05/13/21 Analyzed: 05/15/21									
Aroclor-1016	0.67	0.089	mg/Kg dry	0.222	ND	**300**	*	40-140				MS-21
Aroclor-1016 [2C]	0.74	0.089	mg/Kg dry	0.222	ND	**334**	*	40-140				MS-21
Aroclor-1260	0.28	0.089	mg/Kg dry	0.222	ND	125		40-140				
Aroclor-1260 [2C]	0.30	0.089	mg/Kg dry	0.222	ND	134		40-140				
Surrogate: Decachlorobiphenyl	*0.193*		mg/Kg dry	0.222		87.0		30-150				
Surrogate: Decachlorobiphenyl [2C]	*0.224*		mg/Kg dry	0.222		101		30-150				
Surrogate: Tetrachloro-m-xylene	*0.208*		mg/Kg dry	0.222		93.7		30-150				
Surrogate: Tetrachloro-m-xylene [2C]	*0.224*		mg/Kg dry	0.222		101		30-150				
Matrix Spike Dup (B282014-MSD1)	**Source: 21E0666-01**		Prepared: 05/13/21 Analyzed: 05/15/21									
Aroclor-1016	0.58	0.090	mg/Kg dry	0.224	ND	**259**	*	40-140	13.4		50	MS-21
Aroclor-1016 [2C]	0.65	0.090	mg/Kg dry	0.224	ND	**288**	*	40-140	13.7		50	MS-21
Aroclor-1260	0.53	0.090	mg/Kg dry	0.224	ND	**237**	*	40-140	**62.3**	*	50	MS-21
Aroclor-1260 [2C]	0.60	0.090	mg/Kg dry	0.224	ND	**266**	*	40-140	**66.8**	*	50	MS-21
Surrogate: Decachlorobiphenyl	*0.188*		mg/Kg dry	0.224		83.7		30-150				
Surrogate: Decachlorobiphenyl [2C]	*0.216*		mg/Kg dry	0.224		96.2		30-150				
Surrogate: Tetrachloro-m-xylene	*0.205*		mg/Kg dry	0.224		91.2		30-150				
Surrogate: Tetrachloro-m-xylene [2C]	*0.221*		mg/Kg dry	0.224		98.3		30-150				

IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

1-LT50-RA14(0.5-1)_LOC2

Lab Sample ID: 21E0666-01

Date(s) Analyzed: 05/15/2021 05/15/2021

Instrument ID (1):

Instrument ID (2):

GC Column (1): ID: (mm)

GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1248	1	0.000	-0.030	0.030	0.60	
	2	0.000	-0.030	0.030	0.57	6.8

IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

1-LT50-RA14(1-1.5)_LOC2

Lab Sample ID: 21E0666-02

Date(s) Analyzed: 05/16/2021 05/16/2021

Instrument ID (1):

Instrument ID (2):

GC Column (1): ID: (mm)

GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1248	1	0.000	-0.030	0.030	18	
	2	0.000	-0.030	0.030	20	10.5

IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

1-LT50-RA14(0.5-1)_LOC1

Lab Sample ID: 21E0666-03

Date(s) Analyzed: 05/16/2021 05/16/2021

Instrument ID (1):

Instrument ID (2):

GC Column (1): ID: (mm)

GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1248	1	0.000	-0.030	0.030	6.6	
	2	0.000	-0.030	0.030	6.6	0.0

IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

1-LT50-RA14(1-1.5)_LOC1

Lab Sample ID: 21E0666-04

Date(s) Analyzed: 05/16/2021 05/16/2021

Instrument ID (1):

Instrument ID (2):

GC Column (1): ID: (mm)

GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1248	1	0.000	-0.030	0.030	12	
	2	0.000	-0.030	0.030	12	0.0

FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
ND	Not Detected
RL	Reporting Limit is at the level of quantitation (LOQ)
DL	Detection Limit is the lower limit of detection determined by the MDL study
MCL	Maximum Contaminant Level
	Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.
	No results have been blank subtracted unless specified in the case narrative section.
MS-21	Matrix spike and/or spike duplicate recovery bias high due to contribution of other Aroclors present in the source sample.
S-01	The surrogate recovery for this sample is not available due to sample dilution below the surrogate reporting limit required from high analyte concentration and/or matrix interferences.

CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8082A in Soil	
Aroclor-1016	CT,NH,NY,ME,NC,VA,PA
Aroclor-1016 [2C]	CT,NH,NY,ME,NC,VA,PA
Aroclor-1221	CT,NH,NY,ME,NC,VA,PA
Aroclor-1221 [2C]	CT,NH,NY,ME,NC,VA,PA
Aroclor-1232	CT,NH,NY,ME,NC,VA,PA
Aroclor-1232 [2C]	CT,NH,NY,ME,NC,VA,PA
Aroclor-1242	CT,NH,NY,ME,NC,VA,PA
Aroclor-1242 [2C]	CT,NH,NY,ME,NC,VA,PA
Aroclor-1248	CT,NH,NY,ME,NC,VA,PA
Aroclor-1248 [2C]	CT,NH,NY,ME,NC,VA,PA
Aroclor-1254	CT,NH,NY,ME,NC,VA,PA
Aroclor-1254 [2C]	CT,NH,NY,ME,NC,VA,PA
Aroclor-1260	CT,NH,NY,ME,NC,VA,PA
Aroclor-1260 [2C]	CT,NH,NY,ME,NC,VA,PA
Aroclor-1262	NY,NC,VA,PA
Aroclor-1262 [2C]	NY,NC,VA,PA
Aroclor-1268	NY,NC,VA,PA
Aroclor-1268 [2C]	NY,NC,VA,PA

Con-Test, a Pace Environmental Laboratory, operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	AIHA-LAP, LLC - ISO17025:2017	100033	03/1/2022
MA	Massachusetts DEP	M-MA100	06/30/2021
CT	Connecticut Department of Publilc Health	PH-0165	12/31/2022
NY	New York State Department of Health	10899 NELAP	04/1/2022
NH-S	New Hampshire Environmental Lab	2516 NELAP	02/5/2022
RI	Rhode Island Department of Health	LAO00112	12/30/2021
NC	North Carolina Div. of Water Quality	652	12/31/2021
NJ	New Jersey DEP	MA007 NELAP	06/30/2021
FL	Florida Department of Health	E871027 NELAP	06/30/2021
VT	Vermont Department of Health Lead Laboratory	LL720741	07/30/2021
ME	State of Maine	MA00100	06/9/2021
VA	Commonwealth of Virginia	460217	12/14/2021
NH-P	New Hampshire Environmental Lab	2557 NELAP	09/6/2021
VT-DW	Vermont Department of Health Drinking Water	VT-255716	06/12/2021
NC-DW	North Carolina Department of Health	25703	07/31/2021
PA	Commonwealth of Pennsylvania DEP	68-05812	06/30/2021
MI	Dept. of Env, Great Lakes, and Energy	9100	09/6/2021

21E0406

con-test ANALYTICAL LABORATORY

Phone: 413-525-2332
Fax: 413-525-6405
Email: info@contestlabs.com

http://www.contestlabs.com

CHAIN OF CUSTODY RECORD

39 Spruce Street
East Longmeadow, MA 01028

Doc # 381 Rev 2_06262019

Page 1 of 1

Company Name: AECOM
Address: 500 Enterprise Dr, Suite 1A, Rocky Hill CT 06067
Phone:
Project Name: GHS
Project Location: Greenwich, CT
Project Number: 60432356
Project Manager: Dan Seremet
Con-Test Quote Name/Number:
Invoice Recipient: Dan Seremet
Sampled By: M. Meadows

Requested Turnaround Time
7-Day ☑ 10-Day ☐
PFAS 10-Day (std) ☐ Due Date:

Rush-Approval Required
1-Day ☐ 3-Day ☐
2-Day ☐ 4-Day ☐

Dissolved Metals Samples
○ Field Filtered
○ Lab to Filter

Orthophosphate Samples
○ Field Filtered
○ Lab to Filter

Data Delivery
Format: PDF ☑ EXCEL ☑
Other: equis
CLP Like Data Pkg Required: ☐
Email To: dan.seremet@aecom.com; elizabeth.doerfler@aecom.com
Fax To #:

ANALYSIS REQUESTED

Con-Test Work Order#	Client Sample ID / Description	Beginning Date/Time	Ending Date/Time	COMP/GRAB	¹Matrix Code	Conc Code	VIALS	GLASS	PLASTIC	BACTERIA	ENCORE	PCBs (8082)
² Preservation Code												I
01	1-LTSO-RA14 (0.5-1) L0C2	5/11/21	1110	GRAB	S			1				X
02	1-LTSO-RA14 (1-1.5) L0C2	|	1115	|	|			1				X
03	1-LTSO-RA14 (0.5-1) L0C1	|	1120	|	|			1				X
04	1-LTSO-RA14 (1-1.5) L0C1	|	1125	|	|			1				X

Courier Use Only

Total Number Of:
VIALS
GLASS 4
PLASTIC
BACTERIA
ENCORE

Glassware in the fridge? Y / N
Glassware in freezer? Y / N
Prepackaged Cooler? Y / N
*Contest is not responsible for missing samples from prepacked coolers

¹ Matrix Codes:
GW = Ground Water
WW = Waste Water
DW = Drinking Water
A = Air
S = Soil
SL = Sludge
SOL = Solid
O = Other (please define)

² Preservation Codes:
I = Iced
H = HCL
M = Methanol
N = Nitric Acid
S = Sulfuric Acid
B = Sodium Bisulfate
X = Sodium Hydroxide
T = Sodium Thiosulfate
O = Other (please define)

Relinquished by: (signature)	Date/Time:
M. Meadows	5/11/21 1637
Received by: (signature)	Date/Time:
AECOM Refrigerator	5/11/21 1437
Relinquished by: (signature)	Date/Time:
AECOM Refrigerator	5/12/21
Received by: (signature)	Date/Time:
	5/12/21 10:30
Relinquished by: (signature)	Date/Time:
	5/12/21 1750
Received by: (signature) 3.0°	Date/Time:
	5/12/21 1950
Relinquished by: (signature)	Date/Time:
Received by: (signature)	Date/Time:

Client Comments:

Detection Limit Requirements
MA:
CT: RSR, RDEC
GA PMC
Other:

Special Requirements
☐ MA MCP Required
MCP Certification Form Required
☑ CT RCP Required
RCP Certification Form Required
☐ MA State DW Required
PWSID #

Please use the following codes to indicate possible sample concentration within the Conc Code column above:
H - High; M - Medium; L - Low; C - Clean; U - Unknown

NELAC and AIHA-LAP, LLC Accredited

Project Entity
Government ☐ Municipality ☐ MWRA ☐ WRTA ☐
Federal ☐ 21 J ☐ School ☑
City ☐ Brownfield ☐ MBTA ☐

Other
☐ Chromatogram
☐ AIHA-LAP,LLC

PCB ONLY
☑ Soxhlet
☐ Non Soxhlet

Comments:

Disclaimer: Con-Test Labs is not responsible for any omitted information on the Chain of Custody. The Chain of Custody is a legal document that must be complete and accurate and is used to determine what analyses the laboratory will perform. Any missing information is not the laboratory's responsibility. Con Test values your partnership on each project and will try to assist with missing information, but will not b held accountable.

I Have Not Confirmed Sample Container Numbers With Lab Staff Before Relinquishing Over Samples______________

con-test®
ANALYTICAL LABORATORY

Doc# 277 Rev 5 2017

Login Sample Receipt Checklist - (Rejection Criteria Listing - Using Acceptance Policy) Any False Statement will be brought to the attention of the Client - State True or False

Client AECOM

Received By ______ Date 5/12/01 Time 1950

How were the samples received? In Cooler T No Cooler ______ On Ice T No Ice ______

Direct from Sampling ______ Ambient ______ Melted Ice ______

Were samples within Temperature? 2-6°C T By Gun # 2 Actual Temp - 3.2

By Blank # ______ Actual Temp - ______

Was Custody Seal Intact? NA Were Samples Tampered with? NA

Was COC Relinquished ? T Does Chain Agree With Samples? T

Are there broken/leaking/loose caps on any samples? F

Is COC in ink/ Legible? T Were samples received within holding time? T

Did COC include all pertinent Information? Client T Analysis T Sampler Name T

Project T ID's T Collection Dates/Times T

Are Sample labels filled out and legible? T

Are there Lab to Filters? F Who was notified? ______

Are there Rushes? F Who was notified? ______

Are there Short Holds? F Who was notified? ______

Is there enough Volume? T

Is there Headspace where applicable? NA MS/MSD? F

Proper Media/Containers Used? T Is splitting samples required? F

Were trip blanks received? F On COC? F

Do all samples have the proper pH? NA Acid ______ Base ______

Vials	**#**	**Containers:**	**#**		**#**		**#**
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz [✓ Amb]/Clear	9
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Flashpoint		Col./Bacteria		2oz Amb/Clear	
DI-		Other Glass		Other Plastic		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Unused Media

Vials	**#**	**Containers:**	**#**		**#**		**#**
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Col./Bacteria		Flashpoint		2oz Amb/Clear	
DI-		Other Plastic		Other Glass		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Comments:

REASONABLE CONFIDENCE PROTOCOL
LABORATORY ANALYSIS QA/QC CERTIFICATION FORM

Laboratory Name: Con-Test, a Pace Analytical Laboratory

Client: AECOM Environment - Rocky Hill, CT

Project Location: Greenwich, CT

Project Number: 21E0666

Laboratory Sample ID(s):
21E0666-01 thru 21E0666-04

Sample Date(s):
05/11/2021

List RCP Methods Used:

SW-846 8082A

1	For each analytical method referenced in this laboratory report package, were all specified QA/QC performance criteria followed, including the requirement to explain any criteria falling outside of acceptable guidelines, as specified in the CTDEP method-specific Reasonable Confidence Protocol documents?	☑ Yes ☐ No
1A	Were the method specified preservation and holding time requirements met?	☑ Yes ☐ No
1B	VPH and EPH Methods only: Was the VPH and EPH method conducted without significant modifications (see Section 11.3 of respective RCP methods)?	☐ Yes ☐ No ☑ N/A
2	Were all samples received by the laboratory in a condition consistent with that described on the associated chain-of-custody document(s)?	☑ Yes ☐ No
3	Were samples received at an appropriate temperature (< 6 degrees C.)?	☑ Yes ☐ No ☐ N/A
4	Were all QA/QC performance criteria specified in the CTDEP Reasonable Confidence Protocol documents achieved?	☐ Yes ☑ No
5A	Were reporting limits specified or referenced on the chain-of-custody?	☑ Yes ☐ No
5B	Were these reporting limits met?	☐ Yes ☑ No
6	For each analytical method referenced in this laboratory report package, were results reported for all constituents identified in the method-specific analyte lists presented in the Reasonable Confidence Protocol documents?	☑ Yes ☐ No
7	Are project-specific matrix spikes and laboratory duplicates included in this data set?	☑ Yes ☐ No

Notes: For all questions to which the response was "No" (with the exception of question #7), additional information must be provided in an attached narrative. If the answer to question #1, #1A, or #1B is "No", the data package does not meet the requirements for "Reasonable Confidence."
This form may not be altered and all questions must be answered.

Lisa A. Worthington

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete.

Authorized Signature: Lisa Worthington

Position: **Technical Representative**

Printed Name: **Lisa A. Worthington**

Date: **05/18/21**

Name of Laboratory: **Con-Test, a Pace Analytical Laboratory**

This certification form is to be used for RCP methods only.

Attachment 2

Updated Groundwater Elevation Evaluation Memo

Revised version included in Addendum #3

Attachment 3

Document Record

Greenwich High School
Document Record
May 2021

Title	Date	Consultant
Phase I Environmental Site Assessment	08/2011	DTC
Significant Environmental Hazard Report	11/2011	DTC
IRM Completion Report, Fields 6 & 7	01/2012	DTC
IRM Completion Report, Field 1	01/2012	DTC
MISA Investigation Report	01/2013	AECOM
Soil RAP, MISA Phase IIB	01/2012	AECOM
IRM Completion Report, Fields 3 & 4	01/2012	DTC
IRM Completion Report, Fields 2 & 5	01/2012	DTC
Soil RAP Addendum, MISA Phase IIB	04/2012	AECOM
MISA Response to Comments	08/2012	AECOM
MISA Soil RAP Phase IIA Construction Schedule	09/2012	AECOM
MISA: Email regarding waterproofing	11/2012	AECOM
Remedial Investigation Report	02/2013	AECOM
Arsenic Background Determination	03/2013	AECOM
Screening Level Ecological RA	02/2013	AECOM
Human Health RA	04/2013	AECOM
Arsenic Background Study	04/2013	AECOM
Focused Feasibility Study	04/2013	AECOM
Annual Groundwater Results	11/2013	AECOM
Remedial Action Plan	11/2013	AECOM
MISA Modification Request	12/2013	AECOM
Soil Re-use Request	01/2014	AECOM
Response to Comments, RAP	02/2014	AECOM
Response to Comments, RAP	10/2014	AECOM
MISA Soil RAP Addendum	02/2015	AECOM
Modification to Approved IRMs	05/2015	AECOM
Groundwater Monitoring Results	07/2016	AECOM
Response to Comments, RAP	07/2016	AECOM
Western Parking Lot Completion Report	12/2016	AECOM
Environmental Conditions Assessment Form	05/2017	AECOM
Screening Level Ecological RA Addendum	10/2017	AECOM
Data Gaps Investigation Work Plan	02/2018	AECOM

Greenwich High School
Document Record
May 2021

Title	Date	Consultant
Annual Progress Report – June 2017 to May 2018	07/2018	AECOM
Turf Sampling Summary Memo	06/2018	AECOM
Turf Sampling Summary Memo	08/2018	AECOM
Turf Remedial Action Report	01/2019	AECOM
Artificial Turf Field and Hydrogeologic Investigation Report	03/2019	AECOM
Completion of Investigation Report	05/2019	AECOM
Interim Remedial Action Plan (resubmitted as the Phase I Remedial Action in 12/2019)	05/2019	AECOM
Engineered Control Variance Application	05/2019	AECOM
Annual Progress Report – June 2018 to May 2019	07/2019	AECOM
Remedial Action Completion Report – MISA Construction Project	07/2019	AECOM
Response to Agency Comments and Revised Phase I Remedial Action Plan	12/2019	AECOM
Revised Phase I RAP Addendum	04/2020	AECOM
LUST Closure Report	03/2020	Big East Environmental
Application for Groundwater Classification Change	05/2020	AECOM
Annual Progress Report – June 2019 to May 2020	09/2020	AECOM
Phase II Remedial Action Plan	01/2021	AECOM
Application for Engineered Control Variance	01/2021	AECOM
Request for Approval of Criteria for Additional Polluting Substances and Certain Alternative Criteria	01/2021	AECOM
Phase I Remedial Action Plan Modification Request	02/2021	AECOM
Request for Reuse of Polluted Soil	02/2021	AECOM
Fields 6 & 7 Engineered Control Groundwater Monitoring Update	02/2021	AECOM
Field 2 Scoreboard Notification	03/2021	AECOM
Phase II Remedial Action Plan Addendum #1	04/2021	AECOM
Phase II Remedial Action Plan Addendum #2	05/2021	AECOM

Notes:

Submitted after entrance to the Voluntary Program

Addendum #3

AECOM Imagine it. Delivered.

AECOM
500 Enterprise Drive
Rocky Hill, CT 06067
aecom.com

June 2, 2021

Ms. Kimberly Tisa
PCB Coordinator – Region 1
United States Environmental
Protection Agency
1 Congress Street, Suite 1100
Boston, MA 02114-2023

Phase II RAP Addendum #3
Greenwich High School
10 Hillside Road
Greenwich, Connecticut

Dear Ms. Tisa,

On behalf of the Town of Greenwich, AECOM has prepared this addendum to the Phase II Remedial Action Plan (RAP) for the Greenwich High School property (the site) to address questions raised by DEEP and EPA via telephone subsequent to the submittal of Addendum #2 on May 19, 2021. This addendum presents additional detail of the Engineered Controls (ECs) to be constructed in conjunction with the installation of stormwater detention piping north of Field 4, a revised plan for post-excavation sampling, and clarification regarding the proposed reuse of onsite soils.

Engineered Controls

Based on discussions with DEEP, the vertical limits of ECs to be constructed north of Field 4 in 2021 have been updated as follows:

- In grassy areas where the stormwater detention piping is to be installed north of Field 4, the EC will begin at 6 inches bgs and consist of (from top to bottom) a high-visibility demarcation layer, approximately a minimum of 12 inches of common fill, 6 inches of pipe bedding, 24 inches of piping/pipe bedding, 4 inches of pipe bedding, and an 8 oz. geotextile.
- In grassy areas north of RA10, where detention piping is not installed, the need for an EC will be dependent upon the results of verification sampling. Where verification samples indicate the presence of constituents at concentrations exceeding Residential Direct Exposure Criteria (R DEC), excavations to a depth of two feet below ground surface will be extended laterally from the Field 4 construction area, as needed, and an EC constructed. This EC will begin at ground surface and be comprised of (from top to bottom) grass, 6 inches of topsoil, a high visibility demarcation layer, 18 inches of common fill/unrestricted reuse material, and a second high-visibility demarcation layer.

A cross section depicting the updated vertical extents of ECs beneath grass is provided as **Figure 1**. A summary of EC conditions, revised from RAP Addendum #2 for these two areas, is provided in **Table 1**.

Post-Excavation Sample Plan

The Phase II RAP proposed verification sampling of PCBs at excavation sidewalls at the edges of proposed ECs and supplemental sampling of PCBs at excavation bottoms in areas beneath ECs to document concentrations left in place. At the request of DEEP, additional post-excavation soil sampling will be performed to document concentrations on the base of the excavation and to ensure that soil in grassy areas located west and north of Field 4 do not contain constituent concentrations above R DEC. In addition, in locations north and west of portions of Field 4 (RA10 and RA11), where limited investigation data was collected, three additional verification sidewall samples will be analyzed for pesticides, CT15 metals, volatile organic compounds, semi-volatile organic compounds, and extractable total petroleum hydrocarbons, in addition to PCBs. A revised version of **Figure 7-1** from the RAP, depicting post-excavation sampling activities, is attached.

Soil Reuse

Site soils are proposed for reuse as backfill of Phase II remedial excavations. The various reuse situations proposed include:

1. Reuse of approximately 4,000 cubic yards of polluted soils excavated during the construction of the Music Instructional Space and Auditorium (MISA) from 2014 to 2015. Polluted soils from the MISA footprint contain ETPH, PAHs, metals, and PCBs at concentrations above laboratory reporting limits but below the R DEC. These soils will be utilized as backfill either beneath the impermeable liner and above the water table. A reuse request for this soil was submitted to DEEP on February 11, 2021.
2. Reuse of approximately 750 cubic yards of clean soil excavated during the renovation of Cardinal Stadium in 2021. Analytical data indicate that no compounds were detected above laboratory reporting limits. These soils will be utilized as backfill either beneath the impermeable liner and above the water table or beneath a top cover of 6 inches of topsoil in grassy areas.
3. Reuse of approximately 800 cubic yards of soil containing trace amounts of pesticides excavated during the renovation of Cardinal Stadium in 2021. Analytical data indicate that chlordane is present at a concentration of 0.042 milligrams per kilogram (mg/kg). No other COCs were detected at concentrations above background levels. These soils will be utilized as backfill either beneath the impermeable liner and above the water table or beneath a top cover of 6 inches of topsoil in grassy areas.

Locations where reuse soils were excavated from the Cardinal Stadium area are shown on **Figure 3**.

Groundwater Elevation Evaluation

The updated groundwater elevation evaluation memo included in Addendum #2 was missing page #8. A revised version is included herein as **Attachment A**.

Please let us know if you have any questions or comments regarding this addendum.

Kind regards,

Patrick Haskell, LEP
Technical Leader

Michael Doherty, P.E.
VP, Remediation

Attachments:

Table 1 – Summary of Proposed Engineered Controls (Revised from Addendum #2)
Figure 1 - Grass Area Engineered Controls Near Detention Piping North of Field 4
Figure 2 – Cardinal Stadium Soil Excavation Areas
Revised RAP Figure 7-1
Attachment A – Updated Groundwater Elevation Evaluation Memo

cc: Jeff Wilcox, CT DEEP
Gary Trombly, CT DEEP
Ray Frigon, CT DEEP
Amy Siebert, Town of Greenwich
Toni Jones, Greenwich Public Schools
Dan Watson, Greenwich Public Schools
Jane Warren, McCarter & English

Table

Revised 6/1/2021

Table 1
Summary of Proposed Engineered Controls
For 2021 Work
Greenwich High School

Restoration Area	EC Description	Depth to Top of EC (inches bgs)	Thickness of EC (inches bgs)	Detail Number
Synthetic Turf Field 4 - General	1. High Visibility Marker Fabric 2. 6" Dynamic Stone Base 3. Flat Drains/8 oz. Geotextile 4. 12" DGA 5. HDPE Geocomposite 6. LLDPE Membrane Liner	Below the turf field shockpad	18 inches	1
Synthetic Turf Field 4 - Perimeter Perforated Stormwater Piping	1. High Visibility Marker Fabric 2. Approx. 18" Dynamic Stone Base 3. 12" HDPE Perforated Pipe 4. HDPE Geocomposite 5. LLDPE Membrane	Below the turf field shockpad	30 inches	1
Grass Area - Solid Stormwater Conveyance Pipes (No Impermeable Liner)	1. 6" Topsoil 2. High Visibility Geotextile 3. Approx. 18" Common Fill/Pipe Bedding 4. 12" HDPE Pipe 5. High Visibility Geotextile	Surface	30 inches	1
Grass Area - 2 foot Excavation in RA12 and north of RA10 (if excavation is necessary)	1. 6" Topsoil 2. High Visibility Geotextile 3. 18" common fill/unrestricted reuse material 4. High Visibility Geotextile	Surface	24 inches	1 & 2
Grass Area - Detention Piping North of Field 4	1. 6" Topsoil 2. Geotextile 3. Min. 12" Common Fill 4. 6" Pipe Bedding 5. 24" Pipe/Pipe Bedding 6. 4" Pipe Bedding 7. 8 oz. Geotextile	Surface	52 inches (min.)	2
Grass Area - 6 foot Excavation in RA16	1. High Visibility Geotextile 2. 54" of common fill/unrestricted reuse material	18 inches	54 inches	3
Newly Restored Asphalt Walkway in RA16	1. 4" Asphalt 2. 12" Subgrade 3. High visibility geotextile 4. 56" of common fill/unrestricted reuse material	Surface	72 inches	4

Notes:
Details #1, 3 and 4 included in RAP Addendum #2.
Detail #2 revised 6/1/21 and included in RAP Addendum #3. Revisions shown as red text.

Figures

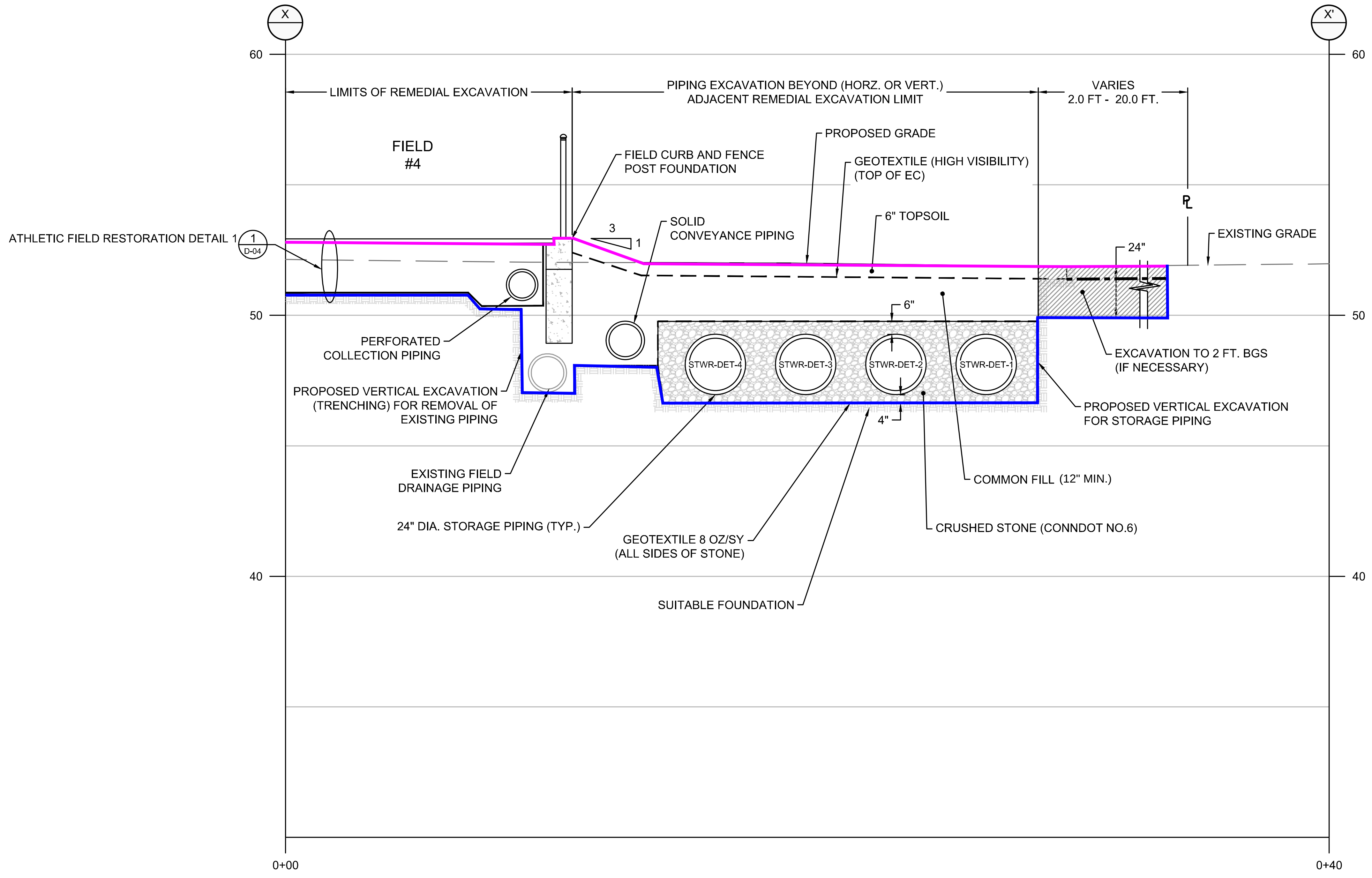
ANSI D 22" x 34"

Approved:

Checked:

Designer:

Project Management Initials:



X SECTION X - X'

0 4' 8'

NOTE: Detail depicts a selected cross-section of detention piping at the north end of Field 4. The final depth of piping varies to meet sloping requirements, and the thickness of common fill varies accordingly.

TOP OF EC

BOTTOM OF EC

AECOM

PROJECT

Phase II Remedial Action
Town of Greenwich
Greenwich High School
10 Hillside Road
Greenwich, Connecticut

CLIENT

CONSULTANT

AECOM
500 Enterprise Drive Suite 3B
Rocky Hill, CT 06067-3913
860.529.8882 tel 860.529.3991 fax
www.aecom.com

REGISTRATION

REFERENCE

ISSUE/REVISION

I/R	DATE	DESCRIPTION

PROJECT NUMBER

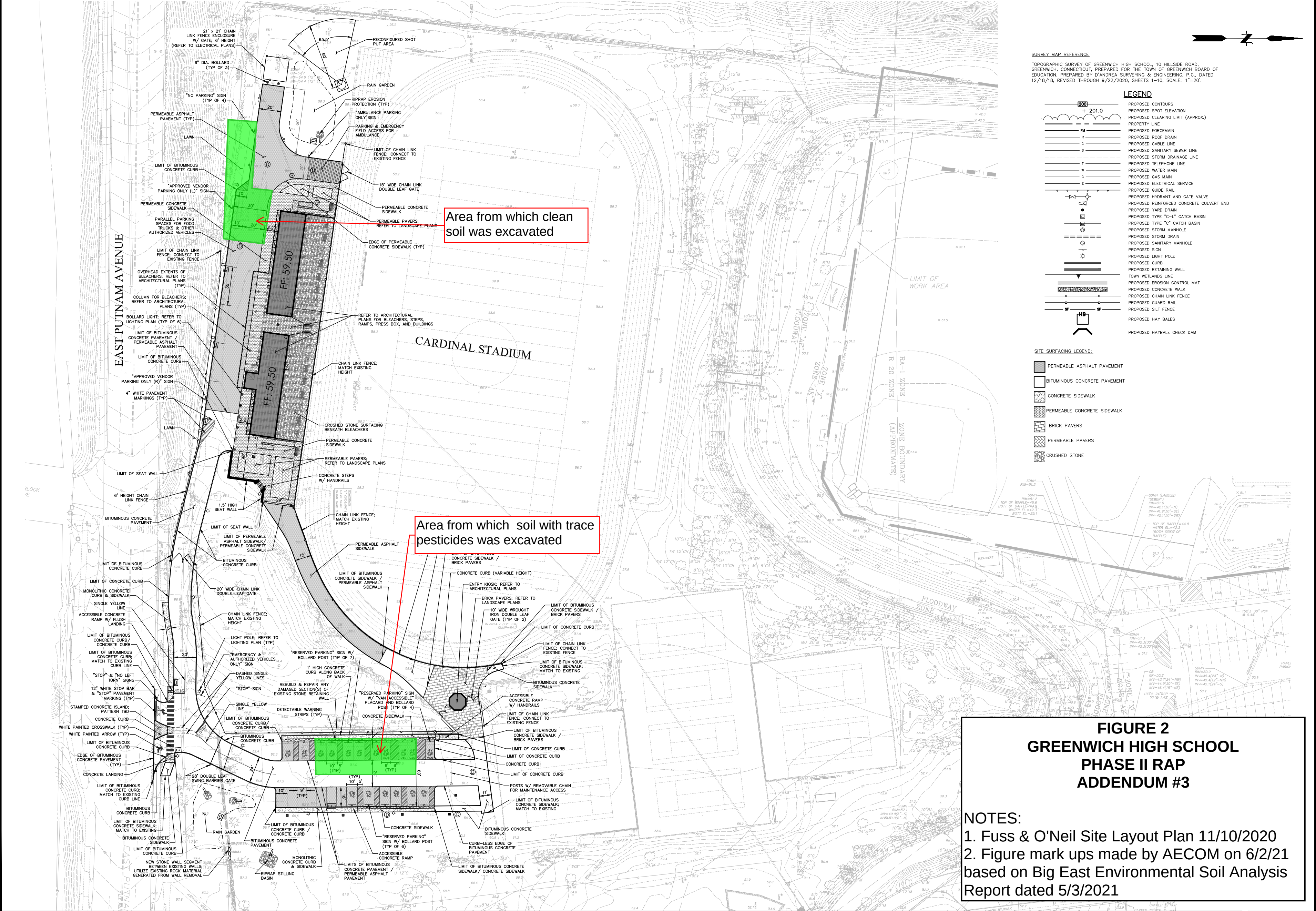
60432356

FIGURE 1

ENGINEERED CONTROLS NEAR
DETENTION PIPING NORTH OF FIELD 4

SHEET NUMBER

D-0X



SURVEY MAP REFERENCE

TOPOGRAPHIC SURVEY OF GREENWICH HIGH SCHOOL, 10 HILLSIDE ROAD, GREENWICH, CONNECTICUT, PREPARED FOR THE TOWN OF GREENWICH BOARD OF EDUCATION, PREPARED BY D'ANDREA SURVEYING & ENGINEERING, P.C., DATED 12/18/18, REVISED THROUGH 9/22/2020, SHEETS 1–10, SCALE: 1"=20'.

LEGEND

- PROPOSED CONTOURS
- PROPOSED SPOT ELEVATION
- PROPOSED CLEARING LIMIT (APPROX.)
- PROPERTY LINE
- PROPOSED FORCEMAIN
- PROPOSED ROOF DRAIN
- PROPOSED CABLE LINE
- PROPOSED SANITARY SEWER LINE
- PROPOSED STORM DRAINAGE LINE
- PROPOSED TELEPHONE LINE
- PROPOSED WATER MAIN
- PROPOSED GAS MAIN
- PROPOSED ELECTRICAL SERVICE
- PROPOSED GUIDE RAIL
- PROPOSED HYDRANT AND GATE VALVE
- PROPOSED REINFORCED CONCRETE CULVERT END
- PROPOSED YARD DRAIN
- PROPOSED TYPE "C–L" CATCH BASIN
- PROPOSED TYPE "C" CATCH BASIN
- PROPOSED STORM MANHOLE
- PROPOSED STORM DRAIN
- PROPOSED SANITARY MANHOLE
- PROPOSED SIGN
- PROPOSED LIGHT POLE
- PROPOSED CURB
- PROPOSED RETAINING WALL
- TOWN WETLANDS LINE
- PROPOSED EROSION CONTROL MAT
- PROPOSED CONCRETE WALK
- PROPOSED CHAIN LINK FENCE
- PROPOSED GUARD RAIL
- PROPOSED SILT FENCE
- PROPOSED HAY BALES
- PROPOSED HAYBALE CHECK DAM

SITE SURFACING LEGEND:

- PERMEABLE ASPHALT PAVEMENT
- BITUMINOUS CONCRETE PAVEMENT
- CONCRETE SIDEWALK
- PERMEABLE CONCRETE SIDEWALK
- BRICK PAVERS
- PERMEABLE PAVERS
- CRUSHED STONE

FIGURE 2
GREENWICH HIGH SCHOOL
PHASE II RAP
ADDENDUM #3

NOTES:
1. Fuss & O'Neil Site Layout Plan 11/10/2020
2. Figure mark ups made by AECOM on 6/2/21 based on Big East Environmental Soil Analysis Report dated 5/3/2021

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SEAL

SEAL

SCALE:
HORZ.: 1" = 30'
VERT.:
DATUM:
HORZ.:
VERT.:
30 15 0 30
GRAPHIC SCALE

FUSS & O'NEILL
56 QUARRY ROAD
TRUMBULL, CONNECTICUT 06611
203.374.3748
www.fando.com

GREENWICH PUBLIC SCHOOLS

SITE LAYOUT PLAN

GHS CARDINAL STADIUM
PHASE 1 CONSTRUCTION DOCUMENTS

GREENWICH CONNECTICUT

PROJ. No.: 20110944.S10
DATE: 11/10/2020

CS-101

File Path: J:\DWG\P2011\0944\S10\Civil\Plan\20110944S10_STP01.dwg Layout: CS-101 Plotted: Mon, November 09, 2020 - 11:46 AM User: tgriffing
Plotter: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 CTB File: FO.STB
MS VIEW:
LAYER STATE:

LEGEND:

PROPOSED PHASE II EXCAVATIONS:

🟦	1.5 FT EXCAVATION AREA (SOIL TO BE REUSED)
🟧	1.5 FT EXCAVATION AREA (OFFSITE DISPOSAL)
🟨	2 FT EXCAVATION AREA
🟩	3 FT EXCAVATION AREA
🟦	4 FT EXCAVATION AREA
🟪	5 FT EXCAVATION AREA
🟥	6 FT EXCAVATION AREA

PROPOSED POST-EXCAVATION SAMPLING AREAS:

🟥	PCB SUBPART O SAMPLING
🟩	BOTTOM SAMPLING: 40-FT GRID FOR PCBS
🟦	SIDEWALL SAMPLING: EVERY 20 FT FOR PCBS & EVERY 80 FT FOR SELECT COCS (SEE TABLE 7-1 OF RAP)
🟦	LEAD SIDEWALL + BOTTOM SAMPLING
🟪	ETPH SIDEWALL + BOTTOM SAMPLING
●	ADDITIONAL SIDEWALL SAMPLE FOR VOCS, SVOCS, CT 15 METALS, ETPH, AND PESTICIDES
●	ADDITIONAL BOTTOM SAMPLE FOR VOCS, SVOCS, CT 15 METALS, ETPH, AND PESTICIDES

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

SCALE:
1" = 40'
0 40 80 120
SCALE FEET
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

GREENWICH HIGH SCHOOL
10 HILLSIDE RD
GREENWICH, CT

FIGURE 7-1
VERIFICATION SAMPLING PLAN
PHASE II REMEDIAL ACTION PLAN

REVISED JUNE 2021

JOB 60432356
FILE NO.
CAD FILE PROPOSED_EXCAVATIONS-PREF
SHEET 7-1

PATH/FILENAME: \\USRKH2FP001\DATA\EVERYONE\60432356 GREENWICH HIGH SCHOOL REMEDIATION\900-WORK\GIS\CAD\PHASE II RAP\PROPOSED_EXCAVATIONS-PREF.DWG
LAST UPDATE: Wednesday, June 02, 2021 11:52:17 AM
PLOT DATE: Wednesday, June 02, 2021 1:46:47 PM

ARCH D - 3-7-05

Attachment A – Updated Groundwater Elevation Evaluation Memo

AECOM
500 Enterprise Drive
Rocky Hill, CT 06067
aecom.com

Project name:
Greenwich High School

Project ref:
60432356

From:
AECOM

Date:
January 8, 2021
Revised May 10, 2021

Memorandum

Subject: **Groundwater Elevation Evaluation**
Phase II Remediation Design
Greenwich High School

1. Introduction

AECOM has prepared this technical memorandum to evaluate the elevation of groundwater over time in the area where the installation of an impermeable liner is proposed as part of an Engineered Control overlying contaminated soil beneath Fields 3 and 4 and the area located between the fields and the western parking lot at Greenwich High School.

The existing drainage system below Fields 3 and 4 consists of 12-inch perforated drains present at elevations ranging from approximately 50.1 feet to 48.2 feet under Field 3 and 49.0 feet to 48.0 feet (NAVD 88) under Field 4. Field observations and analytical data indicate that groundwater occasionally enters the perforated drains under Field 3 and, less often, enters the perforated drains under Field 4. The proposed remediation design will utilize an impermeable liner to prevent stormwater from entering the field drains which discharge to West Brothers Brook.

The impermeable liner will be installed at elevations ranging from 51.0 feet (NAVD 88), along the perimeter of the fields to 56.1 feet (NAVD 88), where the impermeable liner meets the retaining wall along the western edge of the Western Parking Lot. A geocomposite field drain will be installed directly beneath the impermeable liner and will drain to six-inch slotted groundwater collection pipes installed at the edges of the impermeable barrier. The bottom of the 6-inch slotted collector pipes will be at an elevation of approximately 50.5 feet. As shown in **Figure 1**, the groundwater collector pipes are only located at the eastern and western edges of Fields 3 and 4. Groundwater that approaches the bottom of the impermeable liner will be collected through the geocomposite drainage blanket and underdrains to prevent hydraulic pressure from damaging the liner during high water table periods. Groundwater collected will be routed to a series of tanks that are expected to be pumped-off via tanker truck for treatment and disposal. The purpose of this evaluation is to determine whether a groundwater treatment system is required to more frequently manage groundwater recovered by the field drain network, based on groundwater elevation data previously collected at the site.

2. Background

A detailed evaluation of the artificial turf field layers was performed in 2017 and 2018 as part of the Artificial Turf Field and Site Hydrogeological Investigation (AECOM, 2019). It was concluded that while the layers of the artificial turf fields allow infiltration, they reduce the amount of it directly below the fields by allowing precipitation to flow to the edges of the fields through a permeable drainage blanket, which discharges into perforated drainage pipe and stone trenches that surround Field 4 and three sides of Field 3. The compact stone base is also in communication with the gravel trenches, allowing water to drain from this layer to the trenches when the infiltration capacity of the underlying fill material is exceeded. Water that flows horizontally to the drainage trenches and does not infiltrate there is directed to two outfalls on West Brothers Brook via the perforated pipe (AECOM, 2019).

3. Methods

Solinst© Levelogger pressure transducers have been used at the site to continuously record water levels and temperature in select monitoring wells since 2017. The pressure transducer network has been reconfigured multiple times. Pressure transducers are currently installed at eight shallow monitoring wells located around Fields 3 and 4 including wells MW-Y9, MW-AA12, MW-AJ13, MW-AM16, MW-Y15, MW-AG10, MW-AL10, and MW-AE8. When pressure transducers are installed in the monitoring wells, the top of the PVC is left open to allow for the Levelogger to measure atmospheric pressure and thereby determine the changes in water table elevation, corrected for barometric pressure changes.

The existing pressure transducer network and footprint of the proposed impermeable barrier are shown on **Figure 1**. Continuous groundwater elevation measurements are plotted and compared to groundwater temperature and total daily rain amounts in the attached **Figures 2 through 10**. Data for total daily rain amounts for the Stamford 4.2 Station were obtained from the National Oceanic and Atmospheric Administration (NOAA).

4. Data Summary

Table 1 summarizes the relevant groundwater elevation statistics for each of the eight monitoring wells in or near Fields 3 and 4. All groundwater elevations inside the subject area were converted from the 1929 National Geodetic Vertical Data (NVGD 29), to which the monitoring well measuring points are reference, to the 1988 North American Vertical Datum (NAVD 88), in which the engineering design was developed, by subtracting 1.1 feet. A 99.9th percentile upper value of groundwater elevations measured at each monitoring well was also calculated to filter out transient spikes in water level due to rainwater entering the well casing during precipitation events. The 99.9th percentile groundwater elevations are also shown on **Figure 1**. The following sections describe the long-term patterns and anomalies observed at each monitoring well. All elevations are given in NAVD 88. It is noted that elevations shown in **Figures 2 through 10** are given in NVGD 29 and a conversion factor is provided. The propose of **Figures 2 through 10** are to show the relative increases and decreases in groundwater elevations alongside rainfall and temperature measurements.

These figures provide a means of evaluating which groundwater elevations measurements are transient in response to rainfall and also indicate when changes are the result of stormwater directly entering the well casing rather than infiltrating through the subsurface. Rapid temperature changes that correlate with rainfall are indicative of rainwater entering the well directly, rather than infiltrating. When rainwater infiltrates through the ground down to the water table, it has a temperature proximate to the ground temperature, as opposed to stormwater directly entering the well, which has a temperature proximate to the air temperature. Observations of changes in water level that are indicative of rainwater directly entering the well are noted below, along with observations of changes in actual groundwater elevation observed in the data.

4.1.1 MW-AA12

MW-AA12 is located under Field 3, towards the southern end of the field. Relevant information for MW-AA12 is summarized below:

- The top of PVC elevation is 52.55 feet.
- The average groundwater elevation is 47.21 feet.
- The maximum groundwater elevation is 52.6 feet, which is at the top of PVC elevation and indicative of direct rainwater infiltration.
- The 99.9th percentile groundwater elevation is 50.15 feet.
- MW-AA12 is heavily influenced by rain events. Data points approaching or exceeding 50.5 feet correspond to increases or decreases in groundwater temperature and elevated daily rain totals, indicating these spikes are caused by rainwater entering the well through the top of the PVC. An example of an event where rainwater directly entered the well casing is summarized below:
  - 4/16/2018 through 4/17/2018 (total of 2.68 inches rain recorded)

  - Starting elevation (EL) = 46.64 feet on 4/16/2018 @ 1:08 AM
  - Max EL = 51.37 feet on 4/16/2018 @ 10:53 AM. Elevation exceeds 50.5 feet for approximately 5 hours.
  - Return to stable EL (48.05 feet) on 4/18/18 @ 2:23 PM
- The water level at MW-AA12 did not approach or rise above 50.5 feet except when rainwater directly infiltrated the well casing.
- A slug test performed in April 2018 indicated that the water level responded too rapidly to quantify, indicating that the local formation is highly permeable.
- PCBs are present in groundwater at MW-AA12 at concentrations exceeding the GWPC and SWPC. The average PCB concentration is 3.1 µg/L and the maximum is 16.1 µg/L.

These data indicate that the groundwater elevation in the vicinity of well MW-AA12 has not approached the level of the proposed passive groundwater drain beneath Field 3, indicating that this area is unlikely to contribute flow to the passive groundwater collection system.

4.1.2 MW-AJ13

MW-AJ13 is located under Field 4, towards the southern end of the field. Relevant information for MW-AJ13 is summarized below:

- The top of PVC elevation is 52.69 feet .
- The average groundwater elevation is 44.36 feet.
- The minimum groundwater elevation is 42.64 feet.
- The maximum groundwater elevation is 49.02 feet.
- The 99.9th percentile groundwater elevation is 47.64 feet.
- MW-AJ13 is approximately 30 feet north of a field drain running east to west between Fields 3 and 4.
- Peaks in groundwater elevation correspond to rain events. Peak groundwater elevations do not approach the impermeable barrier design elevation.
- A slug test performed in April 2018 determined an average hydraulic conductivity (K) of 1.52E-03 cm/s or 4.3 ft/day.
- PCBs are present in groundwater at MW-AJ13 at concentrations exceeding the GWPC and SWPC. The average PCB concentration is 3.5 µg/L and the maximum is 15.1 µg/L.

These data indicate that the groundwater elevation in the vicinity of well MW-AJ13 has not approached the level of the proposed passive groundwater drain beneath Fields 3 and 4, indicating that this area is unlikely to contribute flow to the passive groundwater collection system.

4.2 MW-AM16

MW-AM16 is located in natural grass in Field 5. MW-AM16 is 27 feet east of Field 4. Relevant information for MW-AM16 is summarized below:

- The top of PVC elevation is 52.36 feet.
- The average groundwater elevation is 45.16 feet.
- The minimum groundwater elevation is 42.10 feet.
- The maximum groundwater elevation is 48.71 feet.

- The 99.9th percentile groundwater elevation is 48.10 feet.
- Peaks in groundwater elevation correspond to rain events. Peak groundwater elevations do not approach the impermeable barrier design elevation.
- A slug test performed in April 2018 determined an average hydraulic conductivity (K) of 1.04E-02 cm/s or 29.5 ft/day.
- PCBs are typically detected in groundwater at concentrations less than the GWPC and SWPC. The average PCB concentration is 0.1 µg/L and the maximum is 0.54 µg/L.

These data indicate that the groundwater elevation in the vicinity of well MW-AM16 has not approached the level of the proposed passive groundwater drain beneath Field 4, indicating that this area is unlikely to contribute flow to the passive groundwater collection system.

4.3 MW-Y9

MW-Y9 is located in natural grass 50 feet south of Field 3. Relevant information for MW-Y9 is summarized below:

- The top of PVC elevation is 50.37 feet.
- The average groundwater elevation is 48.52 feet.
- The minimum groundwater elevation is 40.41 feet. Sudden drops in groundwater elevations at this well are a result of drawdown during low flow sampling.
- The maximum groundwater elevation is 50.57 feet (which is greater than the top of PVC elevation).
- The 99th percentile groundwater elevation is 50.15 feet.
- A slug test performed in April 2018 determined an average hydraulic conductivity (K) of 7.23E-03 cm/s or 20.5 ft/day.
- As evaluated in the 2017 Hydrogeologic study, the water level in well MW-Y9 exceeded the reference top of PVC elevation on March 2018 (3/3/2018) for about 10 hours during a precipitation event before continued infiltration of rainwater allowed the water table to decline. Well MW-Y9 is located in an area where ponded rainwater has been observed in the past, and this high groundwater elevation is indicative of the ponded water having reached the local infiltration capacity and generated saturated conditions throughout the subsurface in that area (AECOM, 2019). At no other time between 3/3/2018 and 4/6/2020 did the groundwater elevation exceed the reference elevation.
- Prior to filling of the wetlands, the area of MW-Y9 formed a headwater of a stream, which may be indicative of groundwater discharge from bedrock uplands in this area.
- There is no artificial turf field drain running east to west at the southern end of Field 3.
- PCB concentrations in groundwater at MW-Y9 are generally not detectable. The maximum PCB concentration detected is 0.026 µg/L, which is well below the SWPC and GWPC.

These data indicate that the groundwater elevation in the vicinity of well MW-Y9 has approached the level of the proposed passive groundwater drain beneath Field 3 on one occasion in the past three years, indicating that there is the potential for this area to contribute flow to the passive groundwater collection system but that it will only occur episodically for short periods of time.

4.4 MW-Y15

MW-Y15 is located in natural grass within a soil berm between Field 3 and the Western Parking Lot. MW-Y15 is approximately 45 feet southeast of Field 3. Relevant information for MW-Y15 is summarized below:

- The top of PVC elevation is 56.48 feet. MW-Y15 casing was raised above the height of the surrounding soil stockpile in 2015.
- The average groundwater elevation is 45.07 feet.
- The minimum groundwater elevation is 42.78 feet. Sudden drops in groundwater elevations at this well are a result of drawdown during low flow sampling.
- The maximum groundwater elevation is 46.20 feet.
- The 99.9th percentile groundwater elevation is 45.93 feet.
- Peaks in groundwater elevation correspond to rain events although impacts from rainwater are minimal. Peak groundwater elevations do not approach the impermeable barrier design elevation.
- A slug test performed in April 2018 determined an average hydraulic conductivity (K) of 5.39E-03 cm/s or 15.3 ft/day.
- PCBs are present in groundwater at MW-Y15 at concentrations exceeding the GWPC and SWPC. The average PCB concentration is 11.6 µg/L and the maximum is 21 µg/L.

These data indicate that the groundwater elevation in the vicinity of well MW-Y15 has not approached the level of the proposed passive groundwater drain beneath Field 3, indicating that this area is unlikely to contribute flow to the passive groundwater collection system.

4.5 MW-AH16R

MW-AH16R is located on the western edge of the Western Parking Lot. Relevant information for MW-AH16R is summarized below:

- The top of PVC elevation is 47.47 feet.
- The average groundwater elevation is 46.40 feet.
- The minimum groundwater elevation is 40.46 feet. Sudden drops in groundwater elevations at this well are a result of drawdown during low flow sampling.
- The maximum groundwater elevation is 48.33 feet (which is greater than the top of PVC elevation).
- The 99.9th percentile groundwater elevation is 48.01 feet.
- MW-AH16R is located below the soil berm between Field 4 and the Western Parking Lot (outside the footprint of the impermeable barrier). MW-AH16R receives runoff from the soil berm. This runoff is likely the cause of the high groundwater elevations observed at this well. Peak groundwater elevations do not approach the impermeable barrier design elevation, which is higher in this area due to the retaining wall.
- PCBs are present in groundwater at MW-AH16R at concentrations exceeding the GWPC and SWPC. The average PCB concentration is 13.5 µg/L and the maximum is 37.6 µg/L.

These data indicate that the groundwater elevation in the vicinity of well MW-AH16R has not approached the level of the proposed passive groundwater drain beneath Fields 3 and 4, indicating that this area is unlikely to contribute flow to the passive groundwater collection system.

4.6 MW-AG10

MW-AG10 is located under Field 3, towards the northern end of the field. Relevant information for MW-AG10 is summarized below:

- The top of PVC elevation is 51.77 feet.
- The average groundwater elevation is 47.04 feet.

- The minimum groundwater elevation is 45.30 feet. Sudden drops in groundwater elevations at this well are a result of drawdown during low flow sampling.
- The maximum groundwater elevation is 47.66 feet.
- The 99.9th percentile groundwater elevation is 47.63 feet.
- Based on temperature readings, rainwater does not enter MW-AG10 through the top of the PVC (road box does not fill up with rainwater).
- Groundwater elevations at MW-AG10 do not approach the impermeable barrier design elevation.
- PCBs are typically detected in groundwater at concentrations less than the GWPC and SWPC. The average PCB concentration is 0.1 μg/L and the maximum is 0.52 μg/L.

These data indicate that the groundwater elevation in the vicinity of well MW-AG10 has not approached the level of the proposed passive groundwater drain beneath Field 3, indicating that this area is unlikely to contribute flow to the passive groundwater collection system.

4.7 MW-AL10

MW-AL10 is located in the grass area, approximately 10 feet to the west of Field 4. Relevant information for MW-AL10 is summarized below:

- The top of PVC elevation is 51.45 feet.
- The average groundwater elevation is 45.45 feet.
- The minimum groundwater elevation is 40.30 feet. Sudden drops in groundwater elevations at this well are a result of drawdown during low flow sampling.
- The maximum groundwater elevation is 48.75 feet.
- The 99.9th percentile groundwater elevation is 48.25 feet.
- A perforated drain runs along the western edge of Field 4, approximately 10 feet to the east of MW-AL10. Stormwater which falls on turf Field 4 is redirected to the perimeter of the field.
- The concrete lined channel west of MW-AL10 prevents discharge of groundwater to the West Brothers Brook.
- PCB concentrations in groundwater at MW-AL10 have not exceeded the GWPC or SWPC. The average PCB concentration is 0.008 μg/L and the maximum is 0.03 μg/L.

These data indicate that the groundwater elevation in the vicinity of well MW-AL10 does not reach the level of the proposed passive groundwater drain beneath Field 4.

4.8 MW-AE8

MW-AE8 is located in the grass area, approximately 28 feet to the west of Field 3. Relevant information for MW-AE8 is summarized below:

- The top of PVC elevation is 50.89 feet.
- The average groundwater elevation is 44.77 feet.
- The minimum groundwater elevation is 43.81 feet.
- The maximum groundwater elevation is 47.83 feet.
- The 99.9th percentile groundwater elevation is 47.75 feet.

- Peaks in groundwater elevation correspond to rain events. Peak groundwater elevations do not approach the impermeable barrier design elevation.
- PCB concentrations in groundwater at MW-AE8 have not exceeded the GWPC or SWPC. The average PCB concentration is 0.04 µg/L and the maximum is 0.19 µg/L.

These data indicate that the groundwater elevation in the vicinity of well MW-AM16 has not approached the level of the proposed passive groundwater drain beneath Field 4, indicating that this area is unlikely to contribute flow to the passive groundwater collection system.

5. Summary and Recommendations

At one monitoring well, MW-Y9, maximum groundwater elevations have approached or exceeded the proposed impermeable barrier design elevation in the past three years of water level monitoring. On each occasion, the rise in groundwater levels was a temporary response to rainfall that quickly attenuated. These data suggest that the proposed passive groundwater collection drain with intercept groundwater rarely.

A summary table providing key information for each well where maximum groundwater elevations approach or exceed 50.5 ft is shown below.

Table 2: Summary Table of Design Elevation Exceedances

Monitoring Well	Location of Well	Average PCB Concentrations in Groundwater	Number of Times Groundwater Elevation Exceeded 50.5 ft	Time groundwater Elevation Exceeded 50.5 ft	Considerations
MW-AA12	Under artificial turf Field 3	3.1 ppb	8 events	Varies from 0.25 to 5 hours	PVC fills up with rainwater. Evident from exceedance durations, water temperatures, and field observations. Actual groundwater elevation does not exceed lowest elevation of field drainage system
MW-Y9	In natural grass southwest of Field 3	Non-detect (maximum = 0.026 ppb)	1 event – 2.00 inches rainfall	3/2/2018 – 4 hrs	~40 feet south of proposed liner and field drainage

Based on the evaluation of groundwater elevations at monitoring wells in and surrounding the area of the proposed impermeable liner, it is assumed that insignificant groundwater collection by the membrane liner and associated groundwater underdrain will occur. Since groundwater may rise to elevations greater than 50.5 feet during intense rainfall events, subsurface groundwater storage vessels will be incorporated into the remediation design and monitored via a telemetry system. Collected groundwater will be analyzed for waste characterization parameters and pumped-off via tanker truck for treatment, if necessary.

Following installation of the impermeable liner, episodic response to rainfall events is expected to decrease, due to the reduction of infiltration. However, groundwater levels may be affected by the removal of the field drains, which currently appear to intercept groundwater during high water-level conditions and may therefore have a moderating influence on groundwater levels. The passive drain beneath the impermeable liner will serve a similar function. If it intercepts more groundwater than anticipated based on this analysis, a groundwater treatment system can be installed near the groundwater collection tanks to treat and discharge groundwater to the sanitary sewer.

6. References

AECOM, 2019. Artificial Turf Field and Site Hydrogeological Investigation Report. Greenwich High School, Greenwich, CT. Rocky Hill, CT: AECOM. February 2019.

Table

Table 1
Groundwater Elevation Summary Statistics
December 2020
Revised May 2021

Well ID	Summary Data Start Date	Summary Data End Date	Well Reference Elevation (feet)	Average Groundwater Elevation (feet)	Minimum Groundwater Elevation (feet)	Maximum Groundwater Elevation (feet)	99th Percentile Groundwater Elevation (feet)	99.9th Percentile Groundwater Elevation (feet)	Average PCB Concentration (µg/L)
MW-AA12	3/1/2018	4/6/2020	52.55	47.21	45.10	52.60	48.81	50.16	3.12
MW-AJ13	4/12/2017	4/6/2020	52.69	44.36	42.64	49.02	47.06	47.64	3.52
MW-AM16	4/12/2017	4/6/2020	52.36	45.16	42.10	48.71	47.53	48.10	0.10
MW-Y9	4/12/2017	4/6/2020	50.37	48.52	40.41	50.57	49.91	50.15	0.02
MW-Y15	4/12/2017	4/6/2020	56.48	45.07	42.78	46.20	45.70	45.93	11.60
MW-AH16R	2/26/2019	4/6/2020	47.47	46.40	40.46	48.33	47.69	48.01	13.34
MW-AG10	2/26/2019	4/6/2020	51.77	47.04	45.30	47.66	47.54	47.63	0.10
MW-AL10	2/26/2019	4/6/2020	51.45	45.45	40.30	48.75	47.00	48.25	0.008
MW-AE8	10/22/2019	4/6/2020	50.89	44.77	43.81	47.83	46.74	47.75	0.04

Notes
1. Groundwater elevations are in NAVD 88 datum.
2. MW-AL10 reference elevation revised from 54.45 feet to 51.48 feet based on survey data collected in April 2021.

Figures

NOTES:
1. GROUNDWATER ELEVATIONS REPRESENT THE 99.9TH PERCENTILE.
2. ELEVATION DATA IN NAVD 88.

LEGEND

- Outfall Pipe Location
- Shallow Monitoring Well
- Surface Water Gauging Station
- Piezometer
- Proposed Membrane Liner Surface Contours
- Transducer Well

Path: \\usrkh2fp001\data\EVERYONE\60432356 Greenwich High School Remediation\900-Work\GIS\MXDs\Prop_Liner_Monitoring_Well_9-14-19.mxd

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

SOURCE:
2010 AERIAL ORTHOPHOTO FROM STATE OF CONNECTICUT
DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION.

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

N

SCALE:
1" = 50'
0 25 50 100 150 Feet
SCALE
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

FIGURE 1
PROPOSED MEMBRANE LINER ELEVATIONS
COMPARED TO 99.9th PERCENTILE
GROUNDWATER ELEVATIONS

JOB 60225155
FILE NO.
CAD FILE
SHEET

Figure 2
MW-AA12 & MW-AA12D Shallow/Deep Groundwater Temperature and Elevation
Greenwich High School

Note: Elevations shown in NGVD 29.
Site conversion factor: NGVD 29 - 1.1 = NAVD 88

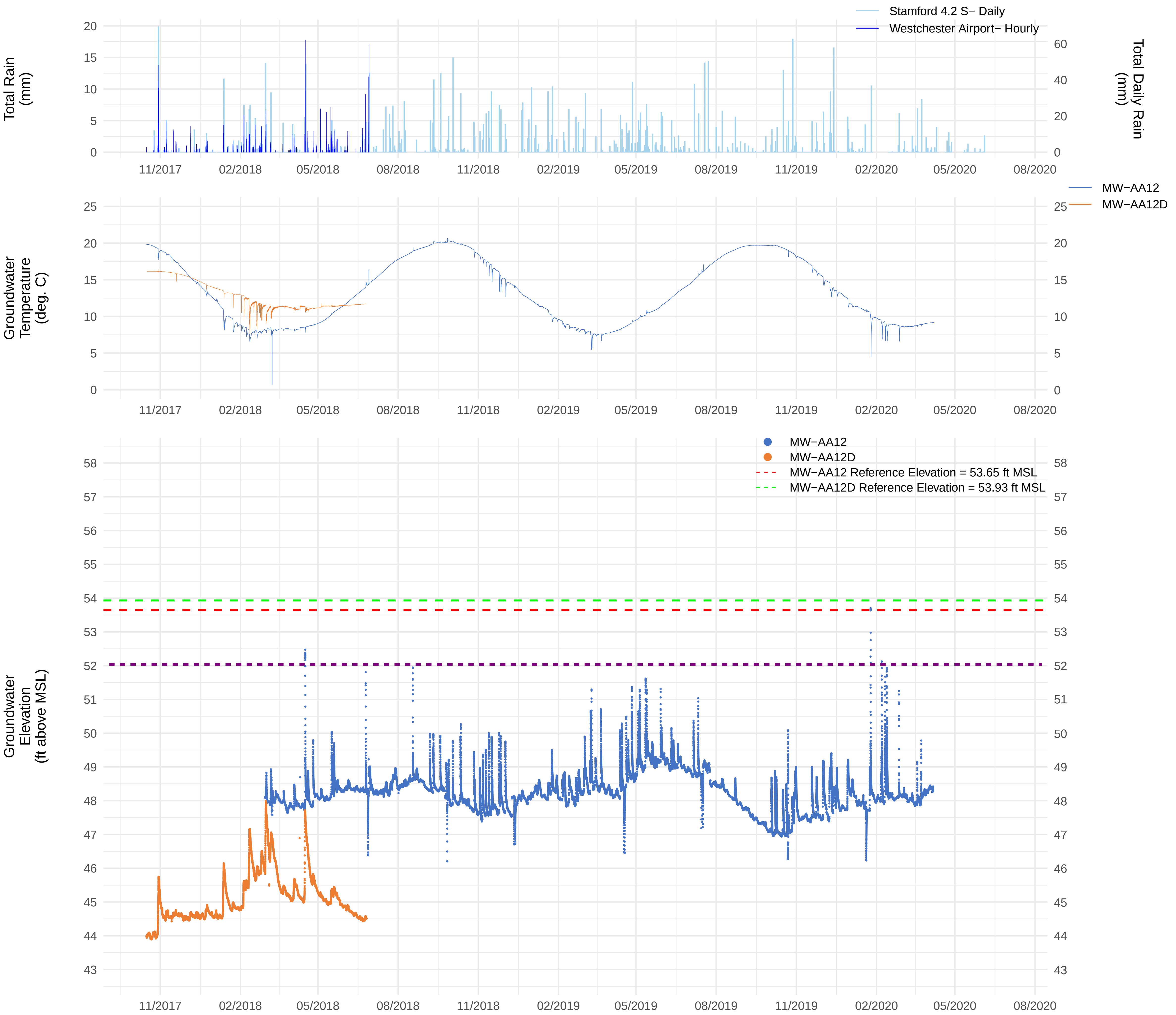
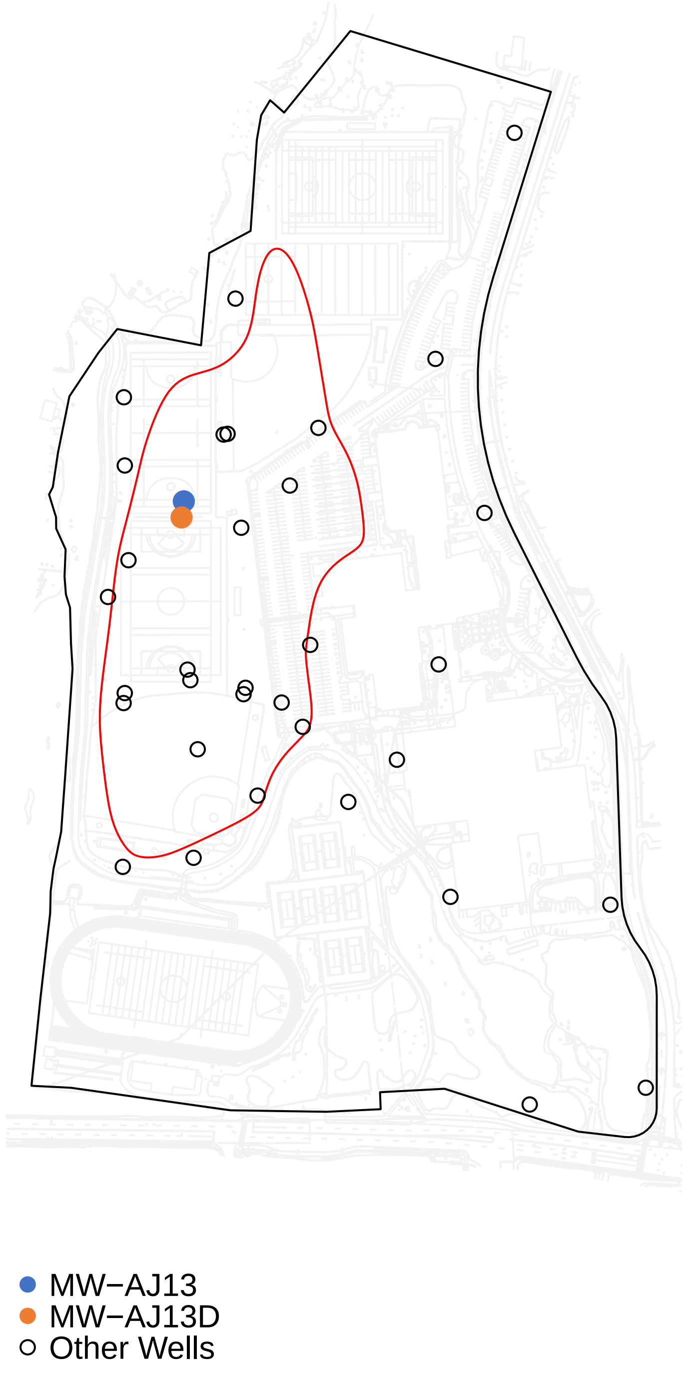
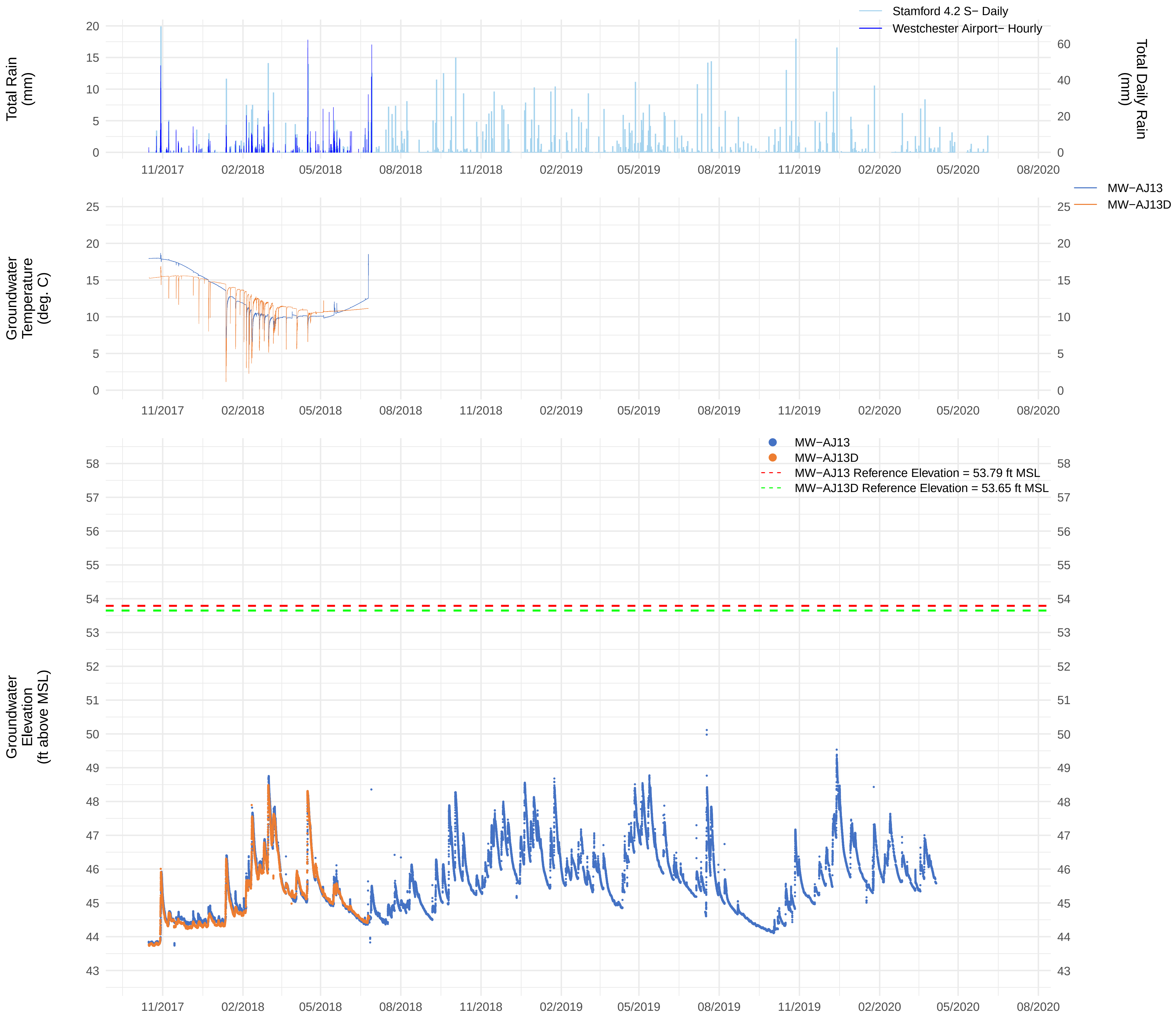


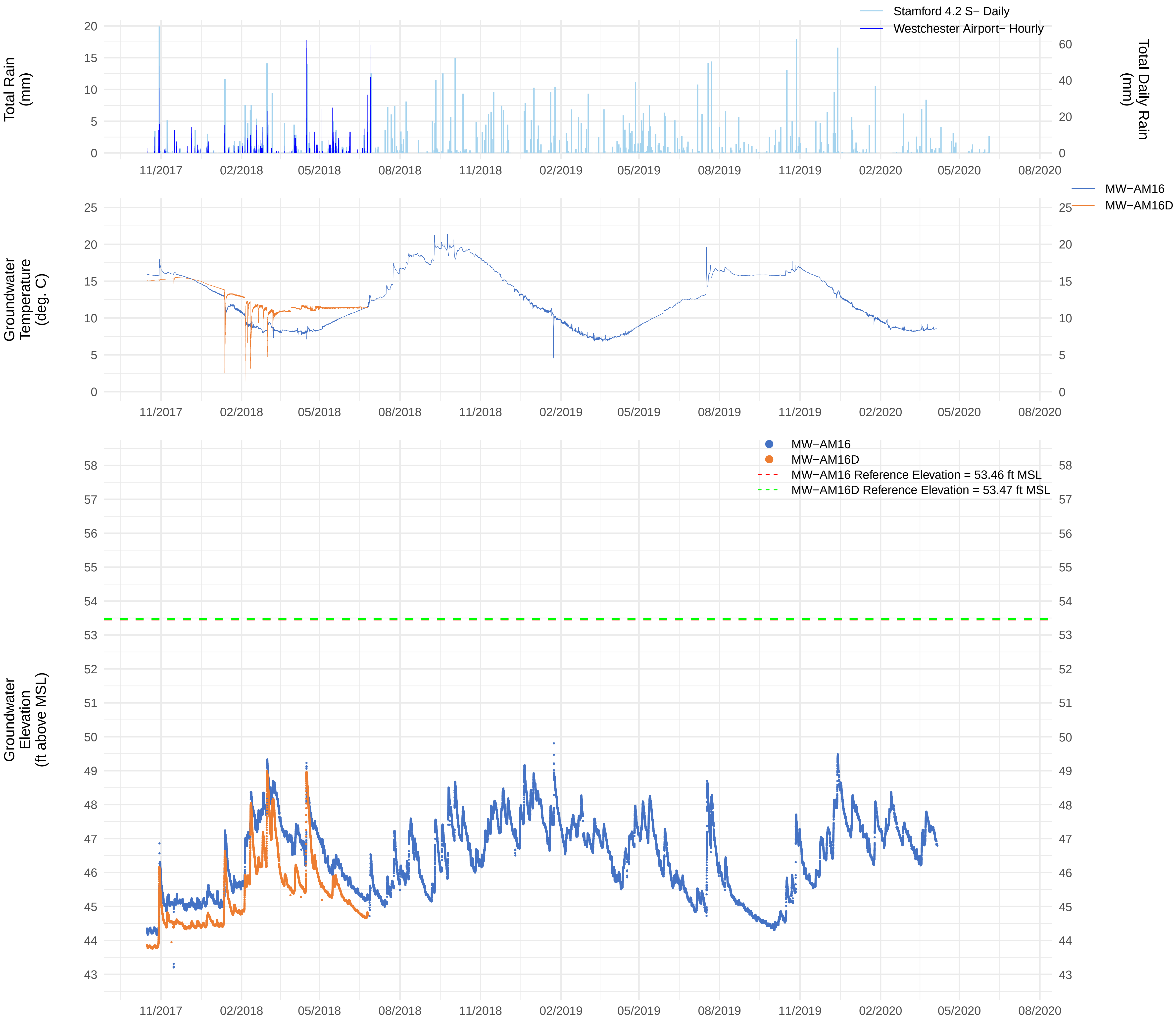
Figure 3
MW-AJ13 & MW-AJ13D Shallow/Deep Groundwater Temperature and Elevation
Greenwich High School





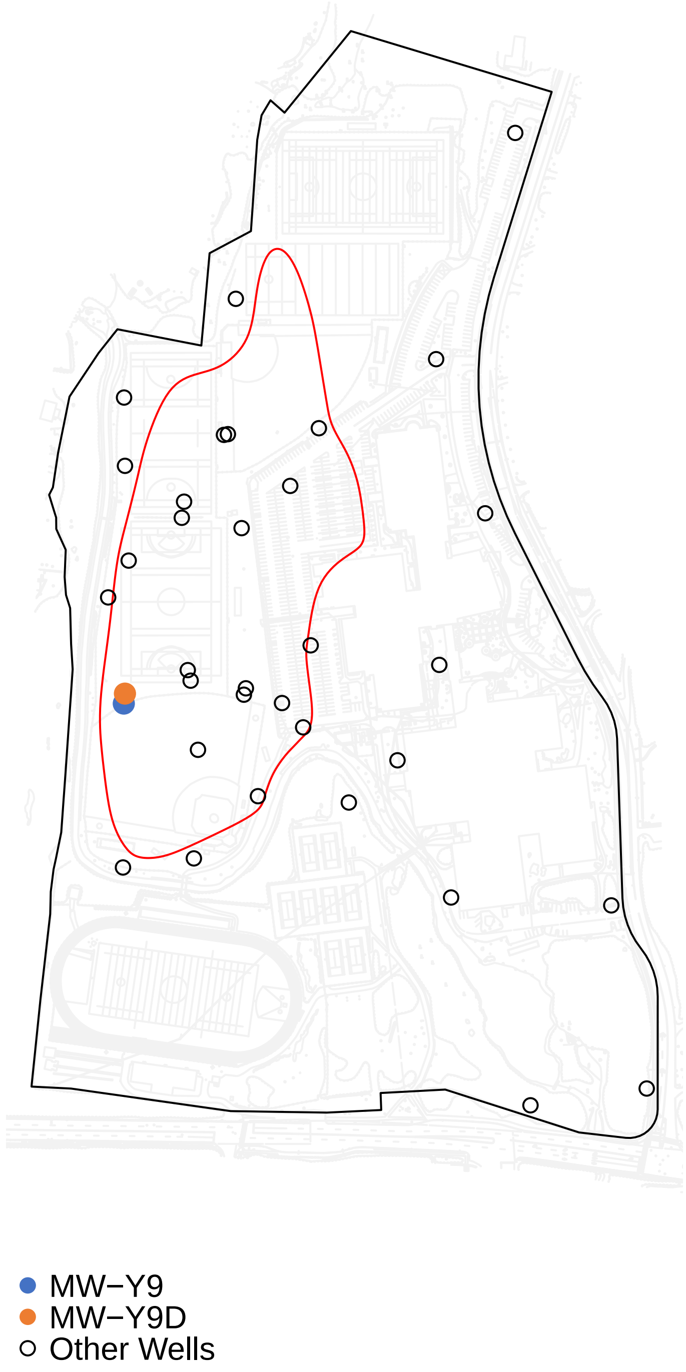
Note: Elevations shown in NGVD 29.
Site conversion factor: NGVD 29 - 1.1 = NAVD 88

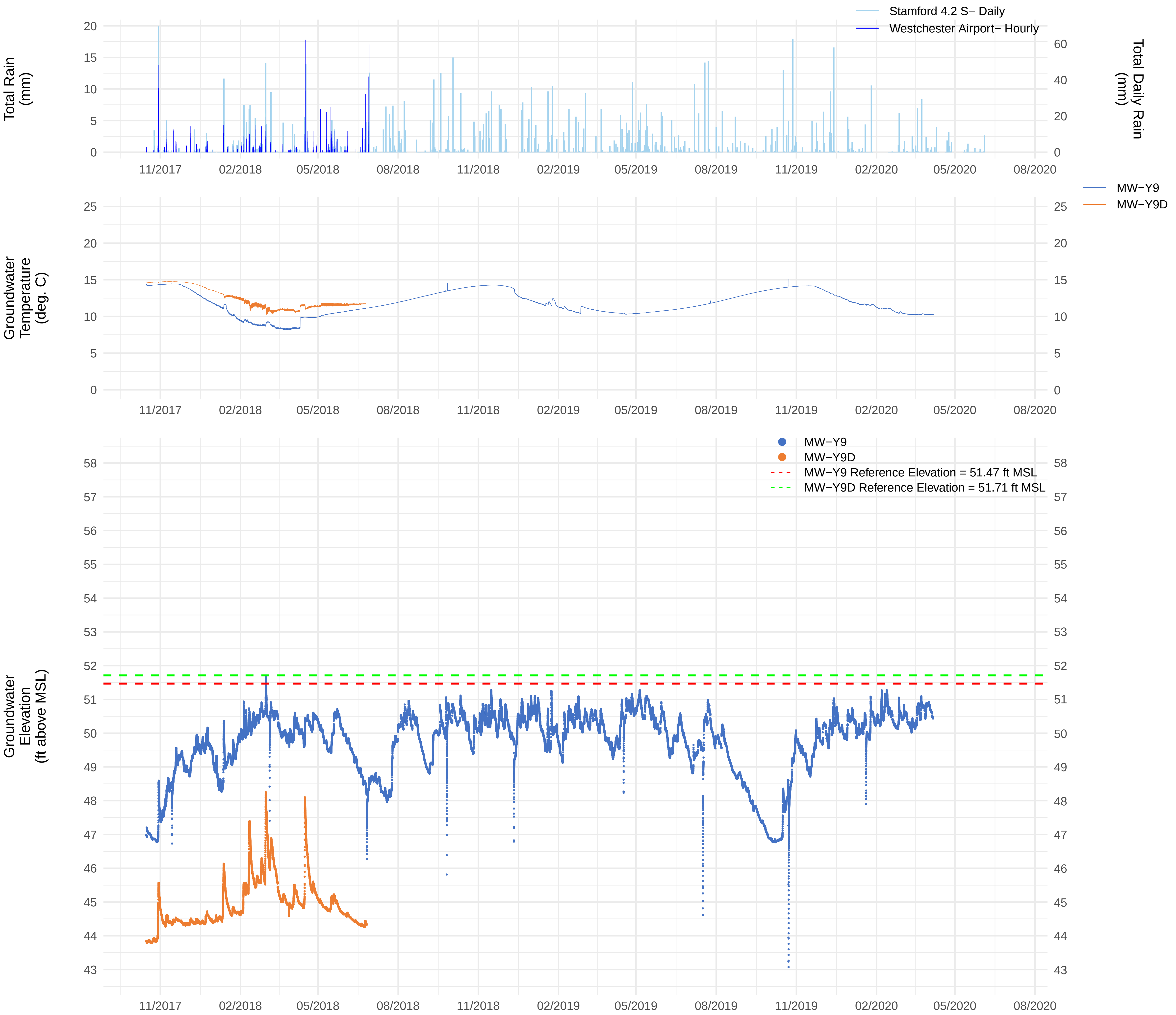
Figure 4
MW-AM16 & MW-AM16D Shallow/Deep Groundwater Temperature and Elevation
Greenwich High School



Note: Elevations shown in NGVD 29.
Site conversion factor: NGVD 29 - 1.1 = NAVD 88

Figure 5
MW-Y9 & MW-Y9D
Shallow/Deep Groundwater Temperature and Elevation
Greenwich High School





Note: Elevations shown in NGVD 29.
Site conversion factor: NGVD 29 - 1.1 = NAVD 88

Figure 6
MW-Y15 & MW-Y15D
Shallow/Deep Groundwater Temperature and Elevation
Greenwich High School

Note: Elevations shown in NGVD 29.
Site conversion factor: NGVD 29 - 1.1 = NAVD 88

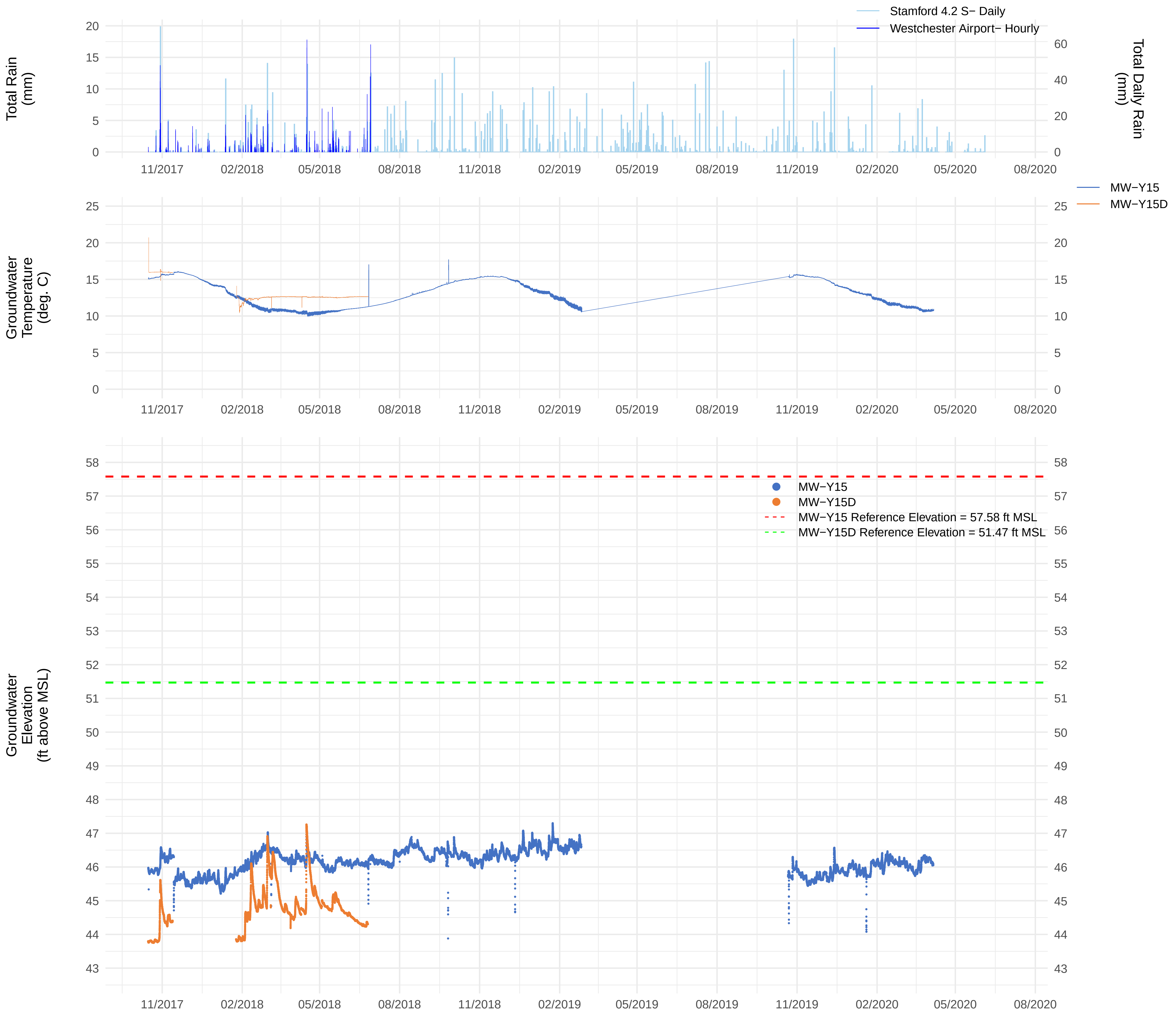
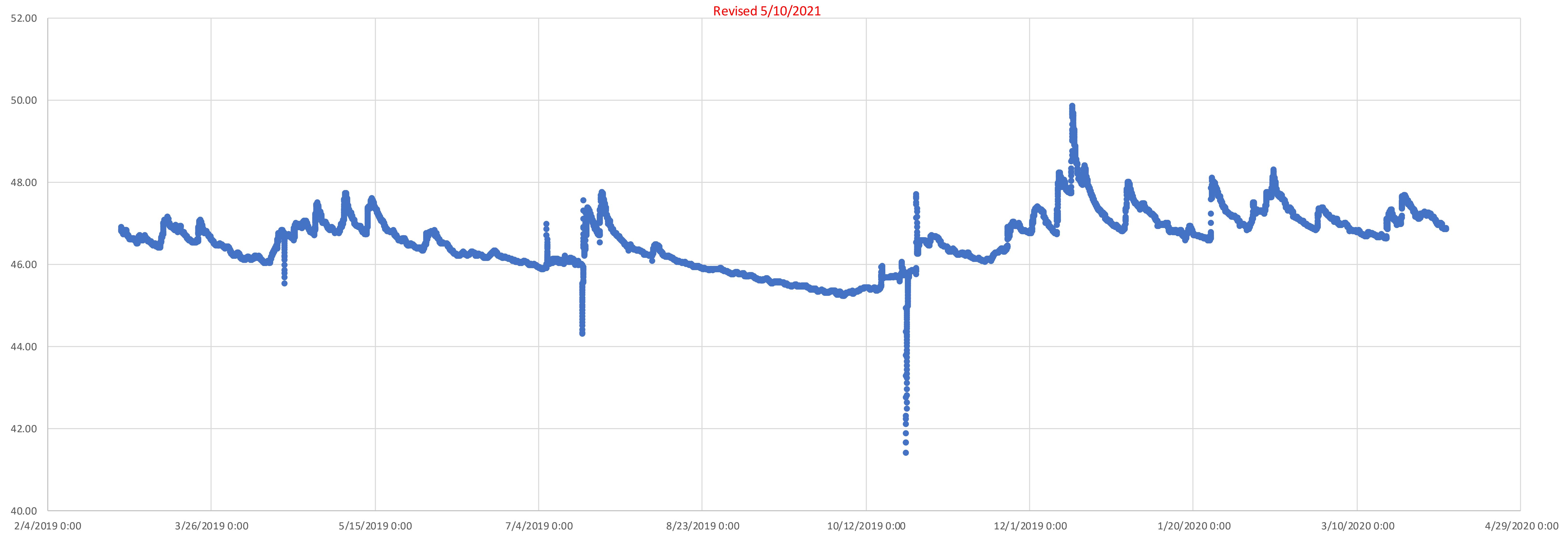


Figure 7 - MW-AL10 Groundwater Elevation and Temperature



Note: Elevations shown in NGVD 29.
Site conversion factor: NGVD 29 - 1.1 = NAVD 88

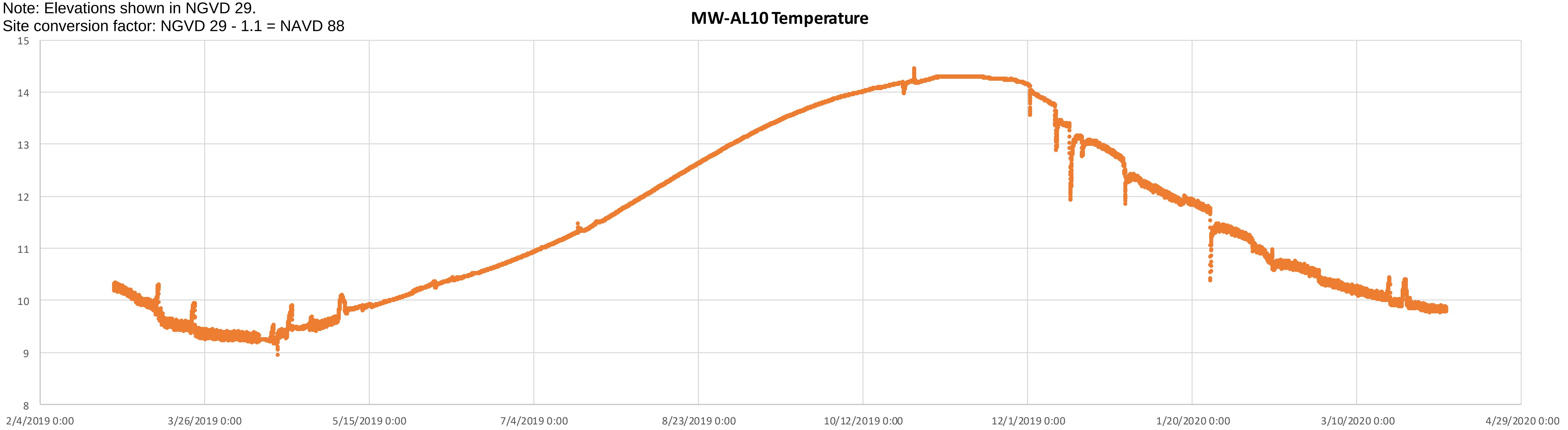
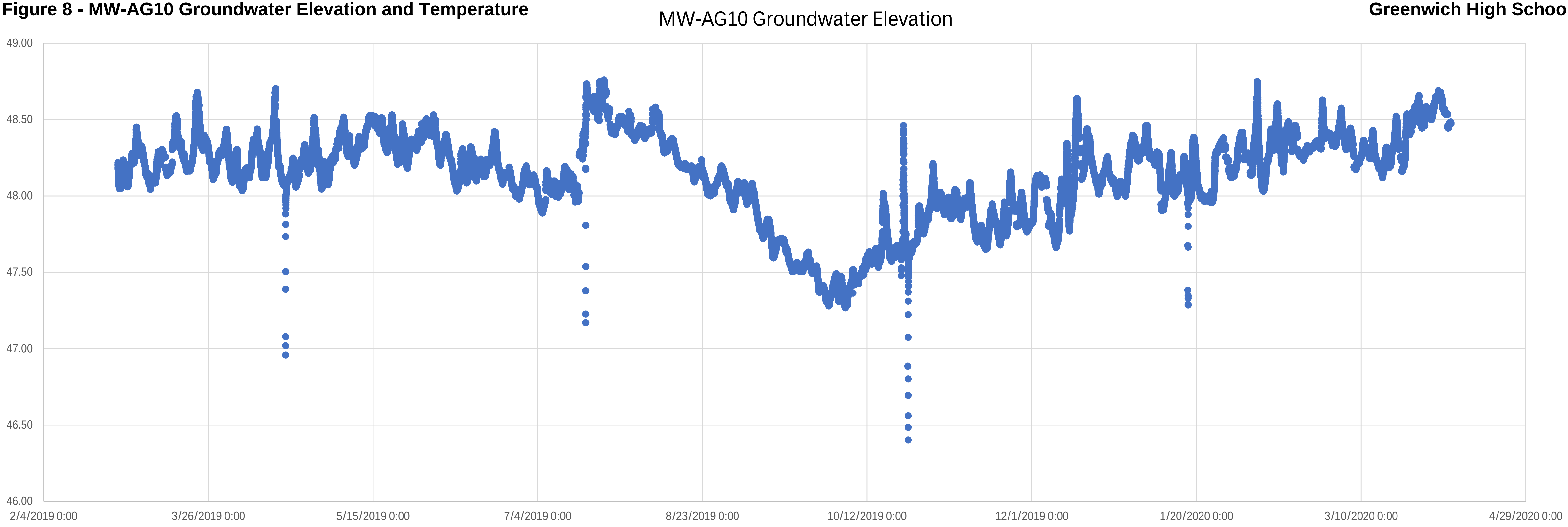


Figure 8 - MW-AG10 Groundwater Elevation and Temperature



Note: Elevations shown in NGVD 29.
Site conversion factor: NGVD 29 - 1.1 = NAVD 88

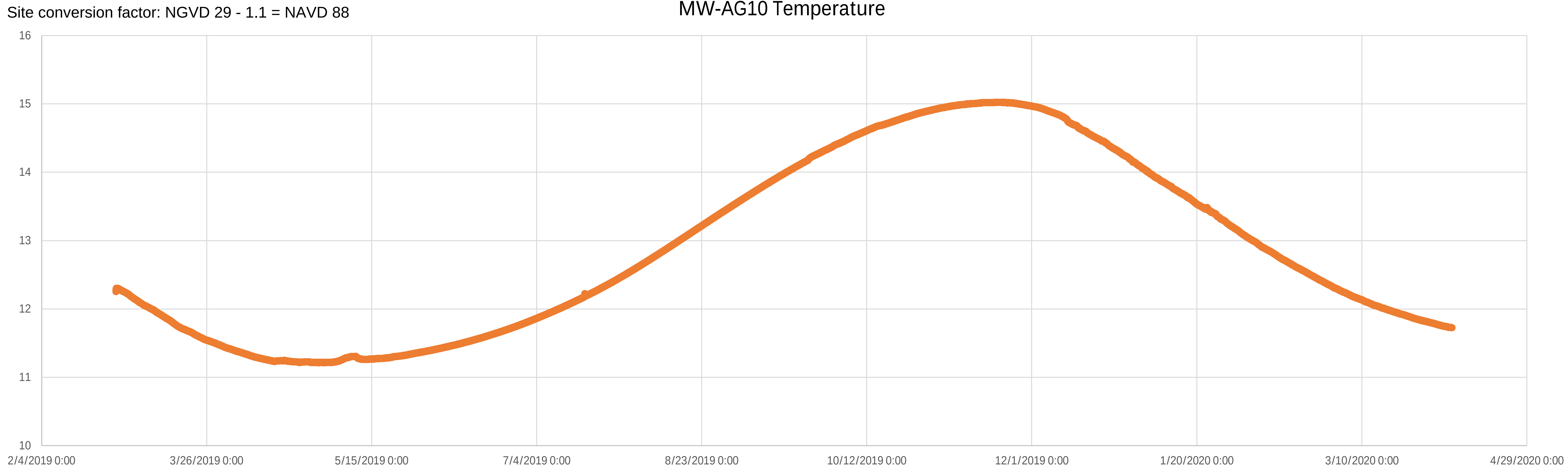
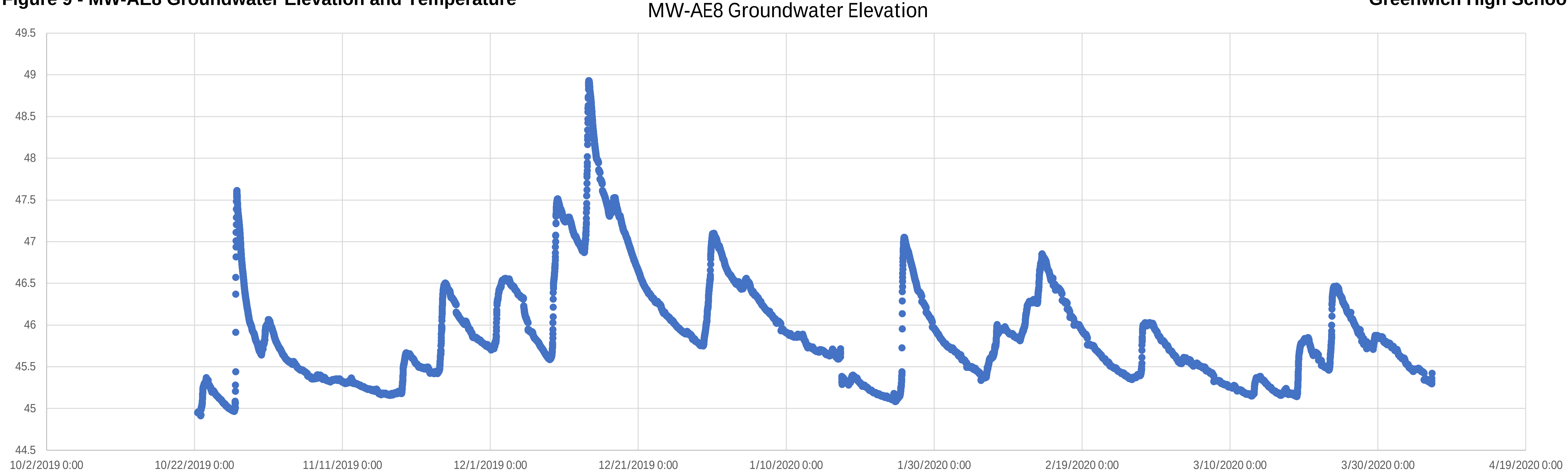


Figure 9 - MW-AE8 Groundwater Elevation and Temperature



Note: Elevations shown in NGVD 29.
Site conversion factor: NGVD 29 - 1.1 = NAVD 88

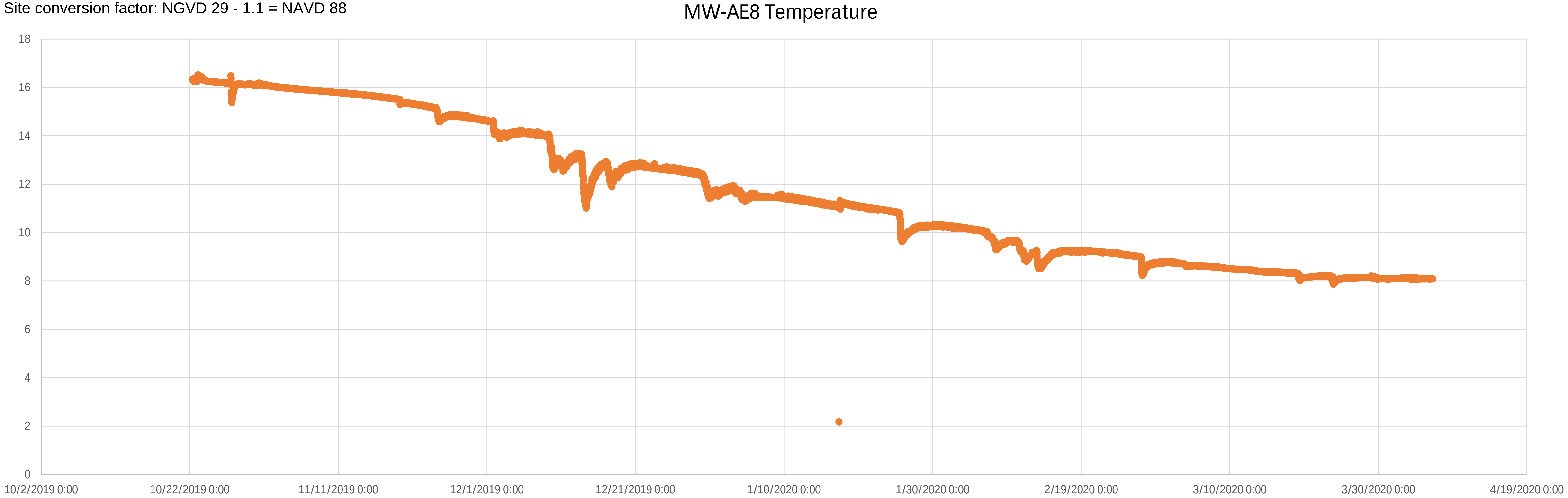
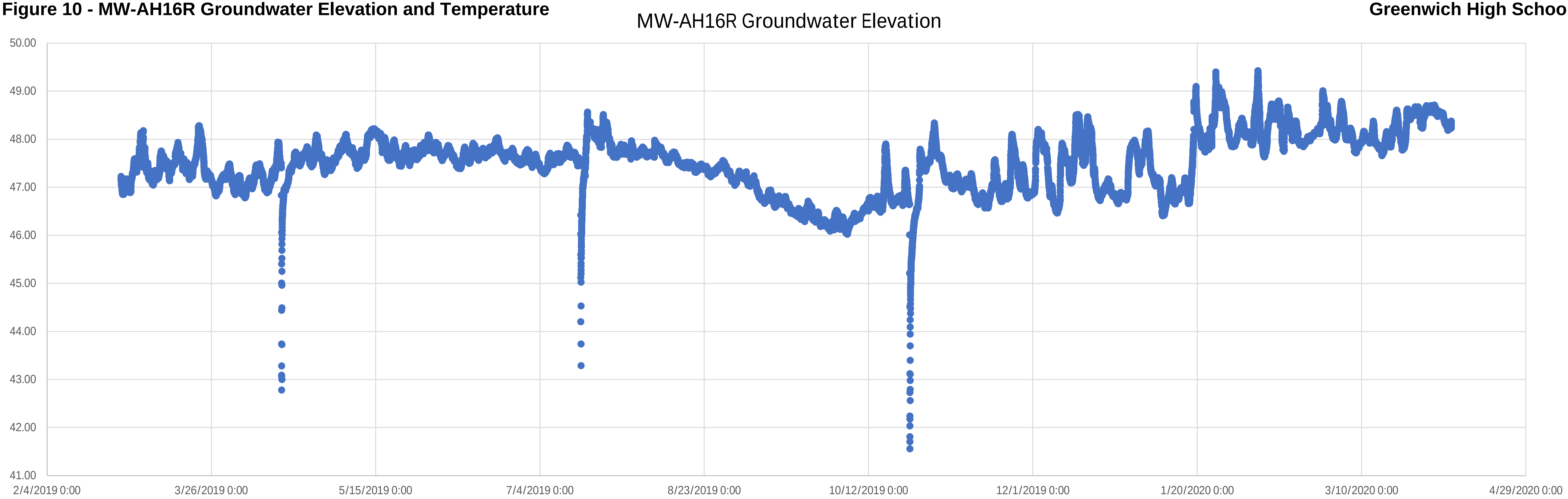
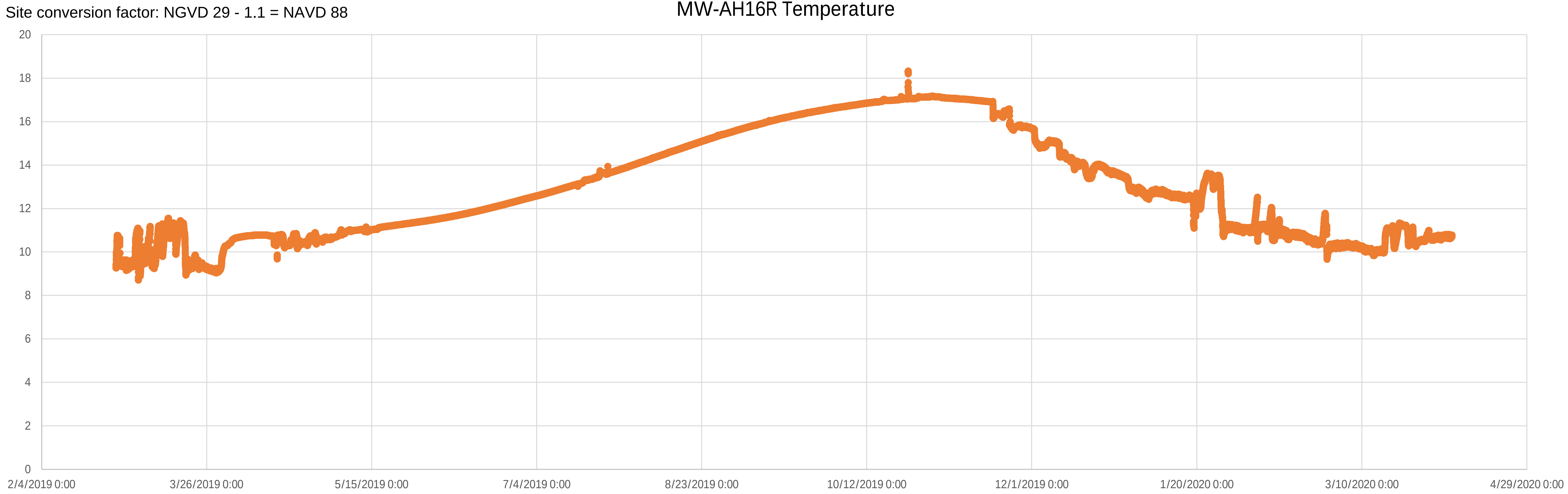


Figure 10 - MW-AH16R Groundwater Elevation and Temperature



Note: Elevations shown in NGVD 29.
Site conversion factor: NGVD 29 - 1.1 = NAVD 88



Addendum #4

LEGEND

☐	Not Sampled
🟩	Not Detected
🟦	≤1,000 ug/kg
🟪	>1,000 ug/kg (RDEC) - ≤10,000 ug/kg
🟧	>10,000 ug/kg - ≤50,000 ug/kg
🟥	>50,000 ug/kg - ≤500,000 ug/kg
■	>500,000 ug/kg

Stack charts indicate the maximum detected PCB concentration in the specified depth interval

0≤2'
>2'≤4'
>4'≤6'
>6'≤8'
>8'≤10'
>10'≤12'
>12'≤14'
>14'≤16'

LEGEND

RA	REMEDIATION AREA		
LT50	SOIL TO BE DISPOSED OF AS LESS THAN 50PPM PCB REMEDIATION WASTE	▢	2 FOOT EXCAVATION AREA
GT50	SOIL TO BE DISPOSED OF AS GREATER THAN 50PPM PCB REMEDATION WASTE	🟩	3 FOOT EXCAVATION AREA
●	PCB BORING LOCATION	▢	4 FOOT EXCAVATION AREA
▢	1.5 FOOT EXCAVATION AREA (REUSE < 10 PPM)	🟪	5 FOOT EXCAVATION AREA
🟧	1.5 FOOT EXCAVATION AREA (DISPOSAL > 10 PPM)	▢	6 FOOT EXCAVATION AREA

NOTES:
1. SURFICIAL SOIL SAMPLES ARE SHOWN AS TRIANGLES.
 - PARKING LOT SURFICIAL SAMPLES COLLECTED AT 2 FT BGS.
 - NATURAL GRASS SURFICIAL SOIL SAMPLES COLLECTED FROM 0 TO 0.25 FT OR 0 TO 0.5 FT BGS.
 - SYNTHETIC TURF SURFICIAL SAMPLES COLLECTED FROM 0 TO 0.3 FT BGS.
2. SOME STACK CHARTS SHIFTED TO PREVENT OVERLAP. SAMPLE LOCATIONS DENOTED BY BLACK DOTS.

AECOM Environment
500 ENTERPRISE DR, STE 1A
ROCKY HILL, CT 06067
(860) 263-5800
www.aecom.com

AECOM

N

SCALE:
0 20 40 80 120 Feet
1" = 40' SCALE

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

SCENARIO 3 EXCAVATION AREAS
PHASE II REMEDIAL ACTION PLAN

GREENWICH HIGH SCHOOL
10 HILLSIDE ROAD
GREENWICH, CT

REVISED 6/3/2021

PROJECT NUMBER:
60432356

FIGURE:
4-3