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May 27, 2015

Mr. Paul Apple, Town Administrator
Town of North Hampton
233 Atlantic Avenue, 2nd Floor
North Hampton, NH 03862

Re: Summary of Document Review
Hampton Rod & Gun Club, Atlantic Ave
NHDES Site #201310001 Project #31644

Dear Mr. Apple,

This letter provides a summary of public documents pertaining to the ongoing Site Investigation of lead contamination at the Hampton Rod and Gun Club (HRGC). The documents reviewed include those available from the New Hampshire Department of Environmental Services (NHDES) OneStop website (NHDES Site#201310001), other pertinent documents from state and federal agencies, and journal articles from the scientific literature. A listing of the documents reviewed is provided below. Permission for a site visit was not granted, so this review is based on available documents only.

These comments will focus on a synthesis of available information rather than specific correspondence between parties and the ongoing data collection efforts. As the Site Investigation is ongoing and the Phase I report not yet finalized, these comments are intended to assist the Town of North Hampton in understanding the findings to date in a hydrogeologic context. These comments are not a critique of the investigation or a point-by-point assessment of individual comments.

This summary will address each media of interest (soil, groundwater, surface water, and sediment) in the context of concentration limits and guidelines, as provided by the NHDES. For each media, the results to date are summarized followed by a brief synopsis of issues that remain to be addressed.

## Soil

Delineation of the source of contamination is of utmost importance in assessing the magnitude and extent of contamination as well as determining appropriate remedial actions. There appears to be consensus that the primary source of lead is the spent bullets and shot in and on the soil. The lead from these materials is presumed to be weathering, migrating with water, and moving through the soil into the groundwater and surface water bodies.

Pertinent lead concentration limits in soil are the Soil Remediation Standard (400 mg/kg) and the Upper Concentration Limit (4,000 mg/kg). Consistent with conditions at other shooting ranges, soil concentrations of lead are elevated and exceed the SRS over a large area of the Pistol/Rifle range, with several individual samples exceeding the UCL. These data will not be reviewed in detail here, though efforts should continue to delineate the lateral and vertical extents of lead concentrations exceeding the SRS level.

The most significant omission in the soil sampling to date is that of the Pistol/Rifle Range berm. In a study of five separate shooting ranges in Florida, Cao et al. (2003) found that total lead concentrations in the berm soils were typically an order of magnitude greater than concentrations in soil samples collected between the firing line and the berm. As noted below, soil contamination in the Pistol/Rifle Range berm is a likely source of the elevated concentrations observed at SW-3.

## Groundwater

Contamination of groundwater has been assessed through the sampling of the on-site drinking water well (DW-1) and installation and sampling of four monitoring wells (MW-1 through MW-4) and four shallow groundwater wells (SGW-1 and SGW-4). The applicable contamination limit for lead in groundwater is the Ambient Groundwater Quality Standard (AGQS) of 15 µg/L.

From the well logs available for MW-1 though MW-4, each well is completed to a depth of 17 feet below ground surface. The logs also suggest the presence of a (marine) silt and clay layer at a depth of approximately 8 feet in the southeastern portion of the site. MW-4 appears to bottom out in glacial till though the screen was reportedly set just above the till. Provided that the screens in MW-3 and MW-4 do not fully penetrate the silt-clay layer, the measured water

levels and lead concentrations in those wells should be representative of conditions above the silt-clay layer.

A set of four shallow groundwater wells (SGW-1 through SGW-4) were installed in Pistol/Rifle Range with 5 ft screens extending to approximately 5 feet below the water table. Drilling logs are not available to fully assess installation depth or whether the silt-clay layer was encountered at these locations, though the materials were reported to be a silty-clay soil. Surveyed water levels are also not available for the SGW wells so it is not possible to use them to improve the understanding of groundwater conditions. Based on the description of the shallow groundwater wells as penetrating silty-clay soil and the observed silty-clay layer in MW-3 and MW-4, it is possible that a significant marine silt-clay layer extends as far north as SGW-2. If present, this layer would act as a barrier and prevent lead contamination in the overlying soil to migrate downward into the aquifer.

Given the proximity of the site to the wetlands and the Little River, it is expected that the natural flow of groundwater would tend to be discharging to the surface and the natural flow would inhibit downward movement of water percolating through the soil. However, it is possible that drawdown in the drinking water well may result in periodic downward vertical flow. The presence of the (marine) silt-clay layer in the southeastern part of the site also has the potential to inhibit downward migration of lead into the aquifer. Where the silt-clay layer is present, there is likely a perched water table that receives recharge from precipitation and discharges it locally to nearby surface water bodies.

A set of synoptic surveyed water elevations should be obtained for DW-1 (under static non-pumping conditions), the MW and SGW wells, and the surface water sampling locations. These elevations would improve the ability to determine the presence or absence of perched and/or confined units as well as the horizontal and vertical connectivity of hydrogeologic units.

## Surface Water

Twenty nine surface water samples were collected at 13 locations between April 24 and August 14, 2014 (summarized in Table 1). Lead concentrations in surface water locations up-gradient from the HRGC exhibit relatively low concentrations (<1 to 3 µg/L) and can be assumed to represent background concentrations. The two samples from the down-gradient

location in the Little River (SW-9) also exhibits low concentrations (<1 to 1 µg/L), suggesting that surface water contamination may have a limited down-gradient extent. However, both samples from SW-9 are for 'wet' conditions and may not be representative of concentrations in the Little River under dry conditions.

Surface water samples were collected using different methods and under different environmental conditions. Some samples represent total lead and others dissolved lead. Contamination limits depend on hardness which was not measured for most water samples. When hardness was measured, it ranged from 28 mg/L to 80 mg/L (NH DES 3/4/14 letter). Prevailing meteorological/hydrological conditions also varied between sampling events. Some conditions were reported while others are inferred from streamflow in the nearby Winnicut River (see Figures 1-4). Conditions on 4/24/14 and 5/12/14 are inferred as being relatively dry (Figures 1 and 2, respectively). Conditions on 6/13/14 and 8/14/14 are reported as "low intensity storm" and a "24-hour rain event", respectively. These are consistent with observed conditions in the Winnicut River (Figures 3 and 4, respectively).

While it is often assumed that the water flowing in the streams during and immediately following a storm is dominantly rain water, the water chemistry is most often dominated by "old" water that is being pushed to the surface as rainfall percolates into the ground. Of particular interest is the range of concentrations observed in SW-3, with higher concentrations associated with rain and post-rain sampling. These higher concentrations are inferred to represent shallow (possibly perched) groundwater and suggest that the Pistol/Rifle Range berm may be a source of shallow groundwater contamination flowing to the northeast.

The NH DES recommends additional work to determine surface water drainage network. This will be very important for interpreting surface water chemistry results. Exeter Environmental suggests the possible use of a drone camera. However, this can be done relatively quickly with use of existing LIDAR data that is available through GRANIT (www.granit.unh.edu).

**Table 1.** Summary of Observed Lead (Pb) concentrations (ppb) in surface waters. Blue font denotes concentrations in excess of acute limits for total (16.16 ppb) and dissolved (15.77 ppb) lead for waters with hardness of 28 mg/L. Red denotes concentrations in excess of acute limits for total (61.45 ppb) and dissolved (50.61 ppb) lead for waters with hardness of 80 mg/L. Environmental conditions (Env.) are inferred from reports and USGS hydrographs for Winnicut River (see below). Stations with measured concentrations consistently below limits are shaded gray.

| Sample ID | Location | Date | Total Pb | Dissolved Pb | pH | Env. |
|---|---|---|---|---|---|---|
| SW-1 | Pistol/Rifle swale (N/A) | 4/24/2014 | 72 | | | Dry |
| | | 8/14/2014 | | 55 | 5.0 | Post Rain |
| SW-2 | Pistol/Rifle (N/A) | 4/24/2014 | 63 | | | Dry |
| | | 6/13/2014 | 60 | | | Dry |
| | | 8/14/2014 | | 76 | 5.1 | Post Rain |
| SW-3 | Downgradient of PR-SW-1, TR-SW-1, and PR berm | 4/24/2014 | 3 | | | Dry |
| | | 5/12/2014 | 21 | | | Dry |
| | | 6/13/2014 | 210 | | | Rain |
| | | 8/14/2014 | | 310 | 5.1 | Post Rain |
| SW-4 | Trap range (middle) | 5/12/2014 | 5 | | | Dry |
| | | 8/14/2014 | | 29 | 6.2 | Post Rain |
| SW-5 | Trap range (up-gradient) | 5/12/2014 | 3 | | | Dry |
| | | 8/14/2014 | | 3 | 5.0 | Post Rain |
| SW-6 | Trap range (up-gradient) | 5/12/2014 | 3 | | | Dry |
| | | 8/14/2014 | | 2 | 5.0 | Post Rain |
| SW-7 | Little River (up-gradient) | 6/6/2014 | 3 | | | Wet |
| | | 8/14/2014 | | 3 | 5.7 | Post Rain |
| SW-8 | Little River (middle) | 6/6/2014 | 76 | | | Wet |
| | | 8/14/2014 | | 37 | 5.1 | Post Rain |
| SW-9 | Little River (down-gradient) | 6/6/2014 | <1 | | | Wet |
| | | 8/14/2014 | | 1 | 5.1 | Post Rain |
| PR-SW-1 | Pistol/Rifle (down-gradient) | 6/13/2014 | 89 | | | Rain |
| | | 8/14/2014 | | 62 | 4.6 | Post Rain |
| PR-SW-2 | Pistol/Rifle (middle) | 6/13/2014 | 76 | | | Rain |
| | | 8/14/2014 | | 45 | 4.6 | Post Rain |
| PR-SW-3 | Pistol/Rifle (mid-gradient) | 6/13/2014 | 55 | | | Rain |
| | | 8/14/2014 | | 37 | 4.8 | Post Rain |
| TR-SW-1 | Trap range (down-gradient) | 6/13/2014 | 67 | | | Rain |
| | | 8/14/2014 | | 59 | 4.7 | Post Rain |

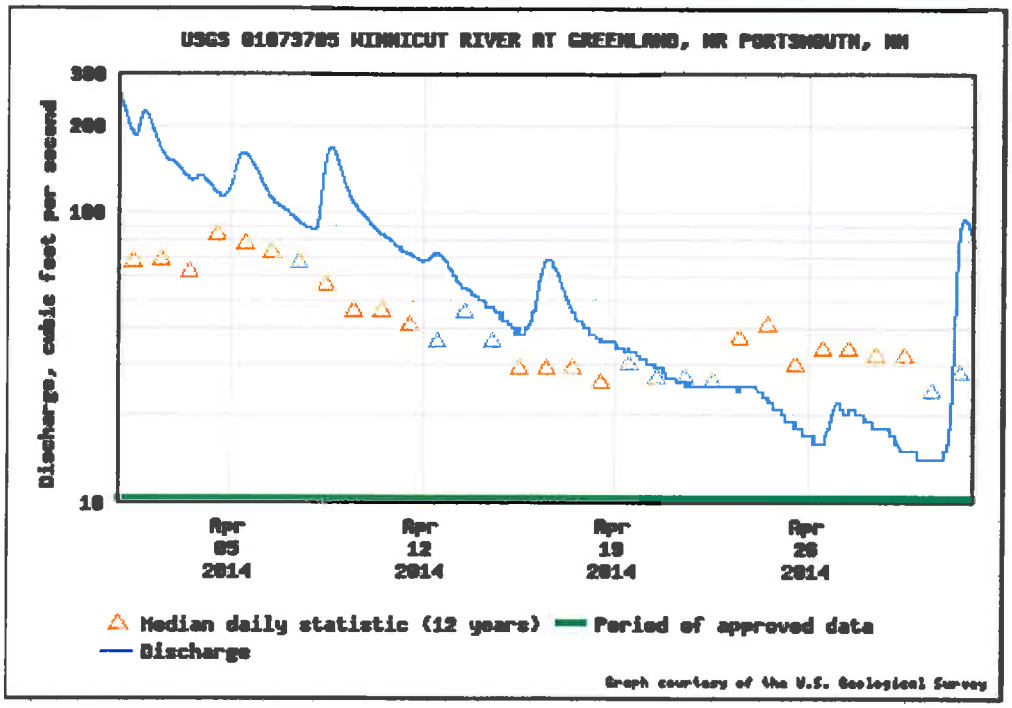


Figure 1. April 2014 hydrograph for Winnicut River near Portsmouth NH. Surface water sampling at HRGC occurred on 4/24/2014.

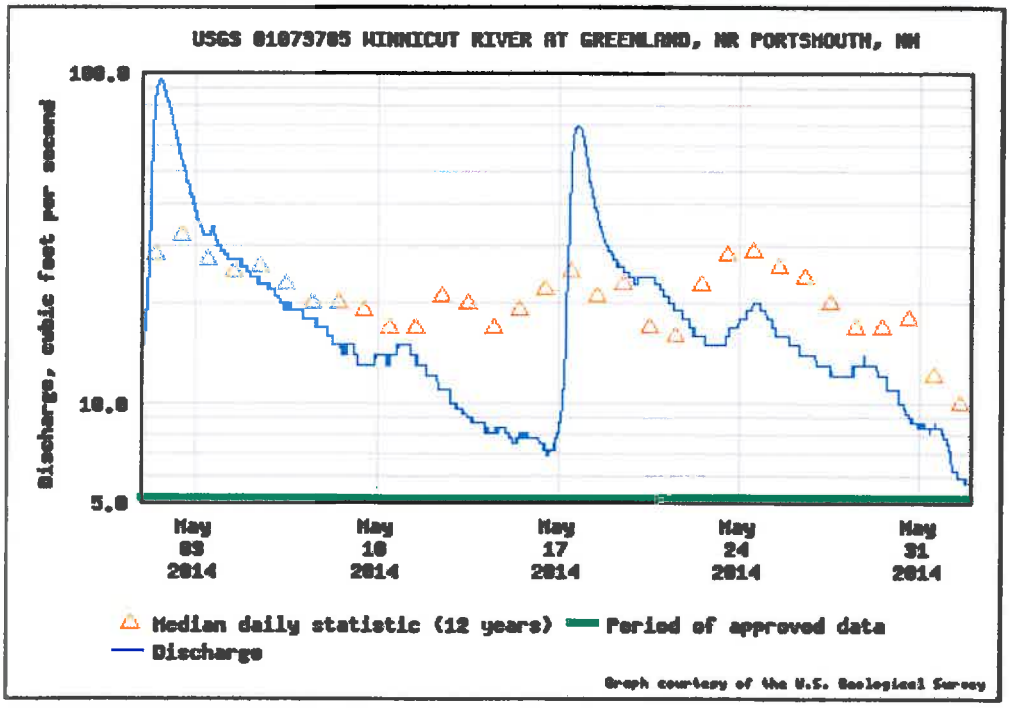


Figure 2. May 2014 hydrograph for Winnicut River near Portsmouth NH. Surface water sampling at HRGC occurred on 5/12/2014.

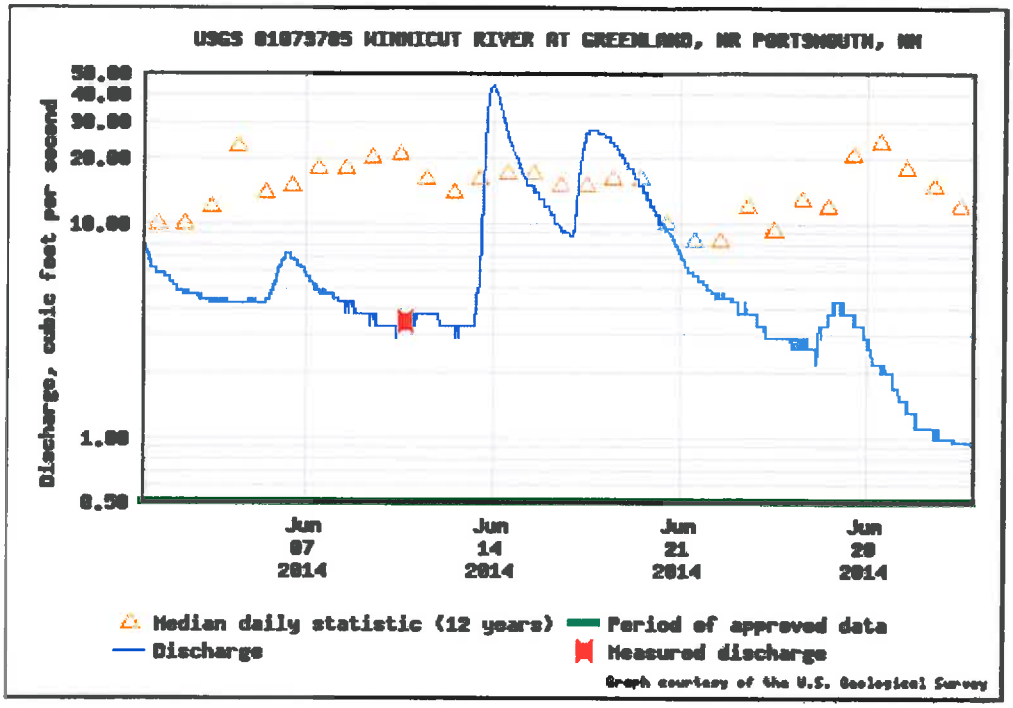


Figure 3. June 2014 hydrograph for Winnicut River near Portsmouth NH. Surface water sampling at HRGC occurred on 6/6/2014 (Little River) and 6/13/2014 (Pistol/Rifle Range, Trap Range, and drainage tributaries).

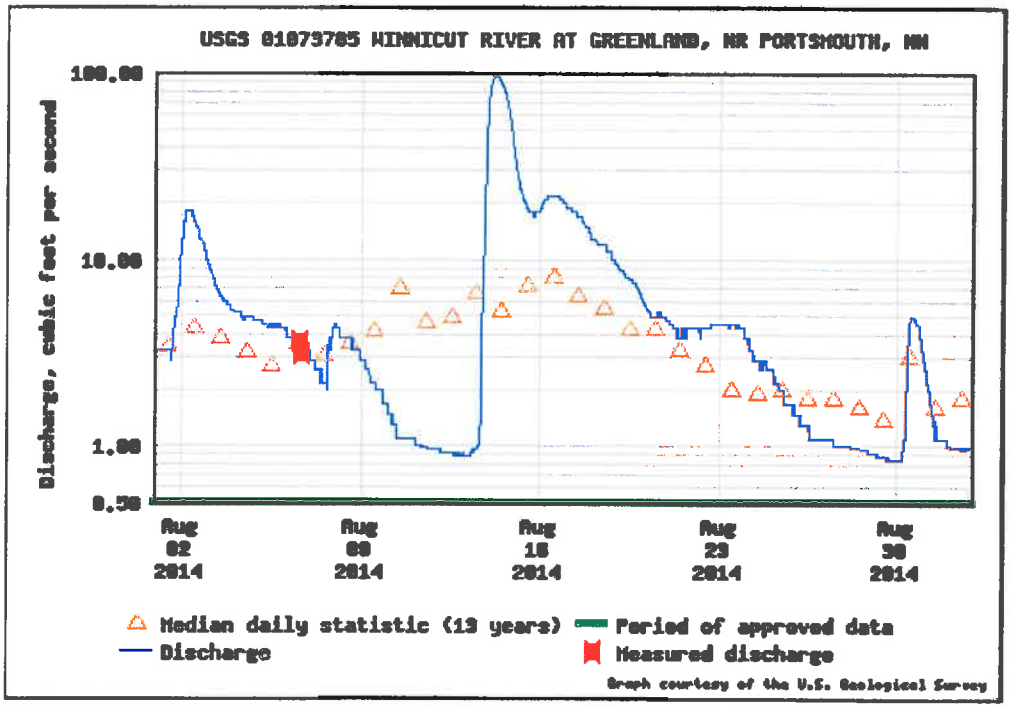


Figure 4. August 2014 hydrograph for Winnicut River near Portsmouth NH. Surface water sampling at HRGC occurred on 8/14/2014 (all locations).

## Sediment

The documents report results for three sediment samples (SED-1, SED-2, SED-3), all samples were collected on April 1, 2014 in the upper 6" of swale in front of the Pistol/Rifle range berm. Total lead concentrations range from 440 to 1,000 mg/kg.

In a letter from NH DES (dated 3/4/2015), they state (p. 6) that nine *sediment* samples were collected on 10/3/14 and they identify the locations of samples previously reported as *soil* sample locations (S-16 through S-23, S-25). NH DES then goes on to evaluate lead concentrations of these locations in the context of the sediment limits for threshold effect concentration (TEC) and probable effect concentration (PEC) rather than soil limits such as the soil remediation standard (SRS) of 400mg/kg and upper concentration limit (UCL) of 4,000 mg/kg. In Exeter Environmental's response of 4/9/2015, they do not comment on this difference. If NH DES is treating hydric soils as sediments, it is not clear that the findings of MacDonald et al (2000) that set the TEC and PEC limits are applicable to hydric soils. The TEC and PEC limits determined in MacDonald et al. (2000) represent a compilation of studies on a number of compounds throughout the United States. The freshwater environments were typically larger rivers and/or water bodies. The applicability of the state PEC and TEC limits to lead contamination in hydric soils in the Northeast is unclear.

## Summary

Phase I of the HRGC Site Investigation is moving closer to providing sufficient information for the delineation of the source and understanding pathways of contaminant movement through the environment and the geographic extent of impact. Investigation of the Trap Range (Phase II) should move more quickly and efforts should be made to better resolve the spatial extent of the silt-clay layer and the hydrologic connectivity of the contaminated soil areas with the shallow groundwater. Detailed and synoptic water level measurements will be important as will a thorough mapping of the surface water drainage network through the wetland. The one area that appears to have received insufficient attention to date is the shallow groundwater between the Pistol/Rifle Range berm and surface water location SW-3.

Thank you for the opportunity to comment on these materials and if you have any questions about this summary, please do not hesitate to contact me.

Sincerely,

J. Matthew Davis, PhD

## Listing of Documents Reviewed

### NH DES OneStop documents

| Date | Document |
|---|---|
| 2/8/2013 | Letter to NH DES from attorney representing citizens |
| 12/3/2013 | NHDES reports findings of site inspection on 8/15/2013 |
| 12/10/2013 | Hinkley Allen on behalf of HRGC |
| 1/16/2014 | Exeter Environmental notifying NHDES of being hired by HRGC |
| 2/14/2014 | West Environmental delineation of wetlands at HRGC |
| 3/10/2014 | Exeter Environmental Scope of Work |
| 3/18/2014 | NHDES response to Exeter Env. Scope of Work |
| 5/12/2014 | Terracon review of Exeter Env. Scope of Work |
| 5/22/2014 | Exeter Environmental - Report of Site Investigation Phase I |
| 6/11/2014 | Terracon review of Exeter Env. Phase I Site Investigation |
| 6/18/2014 | Exeter Environmental proposes addition Phase I sampling |
| 7/10/2014 | Town of North Hampton minutes with statements regarding liming |
| 7/17/2014 | NHDES response to Exeter Env. Phase I Site Investigation and Proposed Addendum |
| 9/08/2014 | Exeter Environmental Addendum to Phase I Environmental Sampling Report |
| 10/20/2014 | Exeter Environmental reports additional soil samples |
| 10/28/2014 | North Hampton Water Commission letter to NHDES with concerns |
| 11/12/2014 | HRGC notifies Town of resumed activities |
| 3/4/2015 | NHDES response to Exeter Environmental Addendum and additional soil sampling |
| 4/9/2015 | Exeter Environmental responds to NHDES' letter of 3/4. |

### Other State and Federal Documents

- NH DES, Evaluation of Sediment Quality Guidance Document, DRAFT, NHDES-WD-04-9, April 2005
- Sanborn Head & Associates, 1998, Background metal concentrations in New Hampshire Soils. 95pp.
- EPA Method 6020A, Inductively couple plasma mass spectroscopy, Rev 1, February 2007
- EPA Method 9045D, Soil and Waste pH, Rev 4, November 2004

### Scientific Journal Articles

- MacDonald, D.D. C.G. Ingersoll, and T.A. Berger, 2000, Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems, Archives of Environmental Contamination and Toxicology, vol. 39, p. 20-31.
- Jorgensen, S.S. and M. Willems, 1987, The fate of lead in soils: The transformation of lead pellets in shooting range soils, Ambio, vol 16, p 11-15.
- Cao, X. and others, 2003, Weathering of lead bullets and their environmental effects at outdoor shooting ranges, Journal of Environmental Quality, vol. 32, p. 526-534.