HART BROOK WATERSHED MANAGEMENT PLAN 2019

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PUBLIC WORKS
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LEWISTON, MAINE

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ACRONYMS

ACRONYM	DEFINITION
BMPs	Best Management Practices
CBEP	Casco Bay Estuary Partnership
CITY	City of Lewiston, Maine
CCC	Criterion Chronic Concentration
CFUP	Compensation Fee Utilization Plan
CMC	Criterion Maximum Concentration
CSO	Combined Sewer Overflow
CWP	Center for Watershed Protection
DO	Dissolved Oxygen
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
IC	Impervious Cover
IDDE	Illicit Discharge Detection and Elimination
LID	Low Impact Development
MDEP	Maine Department of Environmental Protection
mg/L	milligrams per liter
mS/cm	millisiemens per centimeter
MS4	Municipal Small Separate Stormwater System
Plan	Watershed Management Plan
RHA	Rapid Habitat Assessment
SCA	Stream Corridor Assessment
STEPL	Spreadsheet Tool for Estimating Pollutant Load
TMDL	Total Maximum Daily Load
WHIP	Wildlife Habitat Incentive Program
WMP	Watershed Management Plan

WATERSHED MANAGEMENT PLAN NINE ELEMENTS GUIDE

A watershed management plan (WMP) is an important tool used to protect and restore local lake, river or stream water quality. The purpose of this WMP is focused on Hart Brook, a stream located in Lewiston, Maine, that has been determined to be impaired and does not meet State standards for dissolved oxygen (DO), E coli. Bacteria, aquatic organisms, and habitat and therefore does not meet its water quality classification as a Class B Water.

This Hart Brook WMP is an update combining the original WMP developed by Woodard and Curran, Inc. and Edwards and Kelcey, Inc. with data collected by the City of Lewiston (City) and CES Inc. from 2011-2017. Some portions of the original WMP plan are included in this document. The complete previous plan and supporting documentation are found in the *Hart Brook Watershed Management Plan* (Woodard & Curran, 2008). Funding for the original project was provided by the US EPA through Section 604(b) of the Clean Water Act

The previous WMP for Hart Brook was submitted before creation of the US Environmental Protection Agency's (USEPA) nine element watershed plan guidelines criteria (USEPA, 2013). The Guideline was published in 2013 and requires development of a nine-element watershed-based plan for nonpoint source pollution (NPS) of impaired waters prior to implementing projects using Clean Water Act section 319 funds. This 2018 WMP has been updated to meet the criteria as shown in the **Watershed Management Plan Nine Elements Guide (Guide)** listing the nine required elements and sections of this plan where each criterion are addressed.

WATERSHED MANAGEMENT PLAN NINE ELEMENTS GUIDE

	Required Plan Element	WMP Section
A	Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions.	Section 4: Watershed Analysis and Stream Monitoring Section 5: Identification and Causes of Impairment
B	An estimate of the load reductions expected from management measures.	Section 6: Pollutant Load Reduction
C	A description of the nonpoint source management measures that will need to be implemented to achieve load reductions and a description of the critical areas in which those measures will be needed.	Section 6: Pollutant Load Reduction Section 7: Watershed Action Plan
D	Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.	Section 7: Watershed Action Plan
E	An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.	Section 7: Watershed Action Plan Section 8: Public Outreach
F	Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.	Section 7: Watershed Action Plan Section 10: Measures of Success/ Measurable Interim Milestones
G	A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.	Section 10: Measures of Success/ Measurable Interim Milestones
H	A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.	Section 10: Measures of Success/Measurable Interim Milestones
I	A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under Element Item H above.	Section 9: Monitoring Plan

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

Hart Brook is an urban stream located entirely within the City of Lewiston, Maine and is a tributary to the Androscoggin River. The brook is classified by the State of Maine as a Class B water. As defined by the Maine Revised Statutes (38 M.R.S.A. §464, 1985), Class B waters must meet water quality standards for Dissolved Oxygen (DO), Escherichia coli bacteria (E. coli), and may not cause adverse impacts on habitat for fish and other aquatic life and must be supportive of indigenous aquatic life. However, Hart Brook does not meet Class B standards because it is considered impaired due to not meeting DO, E. coli, or aquatic habitat and life standards. The following document is a watershed management plan (WMP) which is an important tool to improve local lake, river or stream water quality, specifically in Hart Brook. A plan is also required before the City can seek additional grant funding from EPA through Section 319 of the Clean Water Act. This Hart Brook WMP provides project goals, analysis of water quality and habitat data, and provides an action plan for restoring the water quality over the next 10-years, with the ultimate goal of meeting water quality standards.

Watershed Description

The Hart Brook watershed is approximately 2,100-acres in size and encompasses areas of commercial, industrial, agricultural, and residential development. Currently over 22% of the watershed consists of impervious surface. These surfaces have resulted in increased stormwater discharge to Hart Brook with resultant impacts to water quality. During development of the original Watershed Management Plan (WMP) in 2008, Hart Brook was subdivided into six smaller sub-watersheds with similar land use or land characteristics including: Lower (376 acres), Valley Section (396 acres), Goff (229 acres), Old Lisbon (279 acres), Interchange (342 acres), and Industry (487 acres) as shown on **Figure 1**.

Watershed Management Plan Update Goals

The goals of the Hart Brook WMP Update are to develop a plan based on the 2008 WMP but with the increased understanding derived from 10-years of new water quality data and observations of macroinvertebrate communities done since the plan was completed. Specific actions identified herein address three goals identified by the first Hart Brook Watershed stakeholders in the original Hart Brook WMP including:

- **Goal #1** – Reduce or regulate stormwater runoff through storage, infiltration or treatment to meet Class B Water Quality Standards.
- **Goal #2** – Restore water quality and stream habitat through stream bank shading, channel and floodplain configuration or stabilization to meet Class B Water Quality Standards.
- **Goal #3** - Build community support for the protection and restoration of the Hart Brook Watershed through education and targeted collaborative projects with public, private and non-profit organizations.

With better understanding on watershed impairments and the latest approaches and technologies, the WMP Action Plan and Monitoring Plan were revised to provide a focused manageable road map for watershed improvements over the next 10-years.

Water Quality and Habitat

Water quality has been monitored since 2011 at between five to ten locations using field parameter and laboratory analytical sampling, continuous data logger monitoring, and macroinvertebrate sampling. Based on these measurements, the brook is considered impaired by the MDEP due to the amount and types of aquatic life present, degraded habitat, high temperatures, low dissolved oxygen (DO), and detection of E. coli bacteria above State standards.

The elevated water temperature limits the amount of DO the water can hold and degradation of excessive organics in the stream can further reduce DO concentrations. There is potential for increased nutrients (phosphorus and nitrogen) in Hart Brook from polluted stormwater, excessive fertilizer use, disposal of yard waste or wastewater leakage, and transport via groundwater. The presence of these nutrients in the surface water can result in excessive algae growth responsible for large diurnal DO swings. DO is lowered during the night when algal consumption of DO during respiration is not compensated for by algal release of DO during photosynthesis. In addition, upon its death, algae can create an excessive organic mass that consumes DO during decomposition. Either or both mechanisms can reduce DO levels and affect the aquatic life habitat in Hart Brook.

E. coli has been observed in Hart Brook throughout the watershed. This may be an indicator of nutrient and bacteria loading from anthropogenic sources to Hart Brook from a combination of underground leakage of sanitary sewer pipes and potential runoff from pet waste especially in the Valley sub watershed residential areas.

Chloride compounds from meltwater runoff of road salt or washing of road salted grit into the stream can be toxic to freshwater stream organisms. In addition, if chloride infiltrates the groundwater supply it can damage stream health at base flow levels as streams are primarily fed by groundwater during low flow periods. If base flow is high in chloride, it can result in a chronic level of chloride in the water since there is minimal dilution effect from rainwater. Conductivity of water is a simple parameter measured in the field to indicate the impact of road salt. Conductivity is the measure of a water's ability to transmit electric current. The higher the dissolved ions such as dissolved salts or other inorganic materials such as chloride from road salt the higher the conductivity. Observed values of conductivity in Hart Brook indicate that road salt contamination levels are not acute enough to cause immediate impact but does border on chronic levels that can have long term effects on aquatic life throughout the watershed.

Impervious Surface and Channel Alterations

Impervious cover consists of hardened surfaces that limit precipitation infiltration including but not limited to roads, parking lots, driveways, sidewalks, and building roofs. These types of surfaces prevent precipitation and snow melt infiltration into the ground and result in increased stormwater runoff into nearby stream channels and surface water bodies. The decreased infiltration affects the groundwater reserves which are the water supply for summer stream base flows. Studies have shown that water quality and aquatic habitat can begin to show signs of stress when impervious cover in a watershed reaches 8-10%. The current impervious cover for Hart Brook was estimated in 2007 by MDEP at 22%. Recent research completed at Bates College did not indicate a measurable change in impervious surface from 2008 to 2018 (Slattery, 2018).

Historical stream alterations to Hart Brook and increased stormwater runoff from impervious cover over the past 100 years have changed the natural alignment and flow of the brook. These changes have resulted in unnatural erosion and deposition within the Hart Brook channel. These alterations have included manmade stream relocation and alignments (e.g. channelizing) for infrastructure improvements such as the section of Hart Brook from Lisbon Street to the Maine Turnpike where the stream was moved and straightened to accommodate the new sanitary sewer (Lewiston, 1958). In several cases these modifications have isolated the stream from natural floodplains because the stream channels become deep from erosion or from berm construction. In areas where the brook has been unable to access the natural floodplain, flows that would have otherwise spread to the floodplain and reduced momentum, have instead created high velocities that accelerate rates of erosion and create deeper channels that can then deposit too much sediment in some areas (deposition that can smother some aquatic life) and too much coarse gravel with no fine sediment in others (armoring) which can limit aquatic habitat and fish spawning habitat.

Improperly designed stream crossings can limit aquatic populations if a natural substrate is not utilized and a lack of water depth or perched water conditions can prevent aquatic passage. In addition, the sizing and alignment of structures within the stream can cause unnatural erosion and deposition upstream and downstream of the crossing. The concrete channels such as found at the industrial park create an unnatural habitat where stream temperatures become elevated. The stormwater runoff velocities are also increased causing habitat impairment and downstream erosion in the natural channels.

Structural and Non-Structural Solutions and Restoration Actions

The overall purpose of the 2018 WMP is to identify specific actions to restore Hart Brook's water quality and aquatic habitat to attain Class B standards by reducing impacts from temperature increases, nutrients, sediment, salt, high velocities, or channel alterations. This WMP outlines specific steps needed to achieve plan goals by reducing impacts and threats to water quality within the Hart Brook Watershed. The 10-year plan (2019-2029) consists of three phases and includes plans for four structural solutions, six non-structural solutions and three stream restoration projects. The structural solutions consist of structural retrofit sites for stormwater treatment and detention systems, shoulder improvements adjacent to stream crossings, improved stream crossings, and sanitary sewer inspection and repairs adjacent Hart Brook. The non-structural solutions consist of salt reduction strategies, street sweeping, roadway maintenance, education and outreach programs and policy, ordinance, and development standard reviews. The stream restoration goals over the next 10-years include stream channel restoration of concrete channels to a natural state, shade tree plantings, and floodplain restoration.

The WMP includes the summarized Action Plan in **Section 7** and Restoration Strategy and Timeline and Table and Timeline in **Section 10** describing the actions in detail, which address these primary areas of focus:

- Stormwater Treatment Detention – The effect of existing impervious surfaces can be minimized by requiring redevelopment upgrades to stormwater management systems.

- Stream Crossing Sites – Habitat and water quality degradation associated with improperly sized and/or placed roadway culverts could be addressed by pursuing culvert upgrade projects throughout the watershed. As funding and other project parameters allow, culvert size and types will be upgraded to meet standards, such as hydraulic requirements and aquatic organism passage standards. In addition, erodible shoulders adjacent to stream crossings should be stabilized, and stormwater runoff managed to prevent stream impacts.
- Stream Restoration – Reestablishing a more natural flow regime and reducing stormwater runoff in the Hart Brook Watershed should help reduce erosion. However, additional geomorphologic analysis and reduction in runoff through storage or infiltration are needed first to minimize peak flows. The restoration efforts should be focused on restoring brook access to floodplains, providing additional floodplain storage, removal of concrete channel sections and/or conversion to a more natural stream state along with shade tree plantings to reduce solar temperature increases to stream water.
- Impervious Cover Reduction – Through non-structural solutions focusing on municipal ordinance language and design standards, the impact of impervious cover from future development should be reduced by holding stormwater planning and management to a higher, more protective standard than current practices.
- Nutrient Reduction – Redevelopment and new development should be encouraged to employ stormwater management practices such as vegetated filter strips and bioretention systems which directly address nutrient (i.e., phosphorus) inputs. Replacement or lining of sewer lines at leaking or at risk of leaking should prevent nutrient impacts from sanitary sewers. Education and outreach efforts will also help address residential nutrient sources from fertilizers and yard waste.
- Citizen Outreach – Education and outreach plans should be considered throughout the watershed including stream crossing or watershed improvement project signs to highlight sensitive areas and/or high-visibility projects as well as storm drain stenciling.

Adaptive Management Strategies

An adaptive management approach is recommended for restoring urban watersheds (Center for Watershed Protection, 2003) and is critical to ensuring watershed management plans stay current and relevant. This relevance is subject to the analysis of future development within the watershed as demands on existing infrastructure are likely to change over time. Adaptive management is used in conservation and natural resource management by evaluating the latest data to test plan hypothesis, measure progress in a plan and then adapt the plan as needed to meet outlined goals.

A Hart Brook Working Group (Working Group) should be formed to oversee the WMP by reviewing schedule progress, latest data and employing adaptive management strategies to manage plan implementation. The Hart Brook Working Group may include members of the Lewiston Public Works, Engineering and Planning Staff, MDEP, Bates College faculty and students, members of the public, and private facility or landholders. Through regular review of the WMP schedule progress and recorded data every three years, adjustments can be made to the project through its life cycle to meet the 10-year WMP goals.

Funding Strategies

Phased implementation is planned for many of the structural and restoration projects identified in the plan. Most of the listed actions should be implemented by the City of Lewiston (City); however, it also provides opportunities to engage interested landowners leading to cooperative projects. It is anticipated that some restoration efforts identified in this plan will be implemented using funding provided by the US EPA through Section 319 of the Clean Water Act (CWA) as funds are made available through the MDEP Non-Point Source program competitive process.

The WMP recognizes that grants alone cannot address the entire restoration process for Hart Brook. The City has developed standards for new development and redevelopment that over time, should help minimize further impact and help alleviate existing problems to help realize restoration goals. If milestones and goals are not met as anticipated, alternative funding sources or partnerships will be explored to provide additional funds to implement additional projects.

1.0 | INTRODUCTION

Hart Brook is an urban stream located entirely within the City of Lewiston, Maine (City) and is a tributary to the Androscoggin River. The brook is classified by the State of Maine as a Class B water. As defined by the Maine Revised Statutes (38 M.R.S.A. §464, 1985), Class B waters must meet water quality standards for Dissolved Oxygen (DO), Escherichia coli bacteria (E. coli), may not cause adverse impact on Habitat for fish and other aquatic life, and must support indigenous aquatic life. However, Hart Brook does not meet Class B standards because it is considered impaired due to not meeting DO, E. coli or aquatic habitat and life standards. The following document is a watershed management plan (WMP) which is an important tool to restore stream water quality in the impaired Hart Brook and open up eligibility for future grant funding by EPA through CWA Section 319. The Hart Brook WMP provides project goals, analysis of water quality and habitat data, and provides an action plan for improving the water quality over the next 10-years.

Intended Audience

The intended audience for this plan includes public or private entities that influence or are affected by water quality, habitat management, and land use decisions in the Hart Brook (Brook) Watershed.

Background

During the original WMP development, Hart Brook was subdivided into six smaller sub watersheds with similar land use or land characteristics including: Lower (376 acres), Valley Section (396 acres), Goff (229 acres), Old Lisbon (279 acres), Interchange (342 acres), and Industry (487 acres) as shown on **Figure 1**. The WMP considers the unique conditions specific to the six sub watersheds of the Hart Brook WMP and identifies suitable approaches to minimize future impacts to the brook due to human activities or development.

The original Hart Brook WMP was developed in 2008 with limited information on water quality and habitat. Since that time, changes and improvements have increased the knowledge of, and condition of, the Hart Brook Watershed including:

- Water Quality Monitoring Analytical Data,
- Water Quality Continuous Monitoring Data,
- Improved Roadway and Impervious Surface Replacement and Maintenance,
- Improved Stream Crossings,
- Installation of Stormwater Treatment and Detention Structures; and,
- Citizen Outreach and Education.

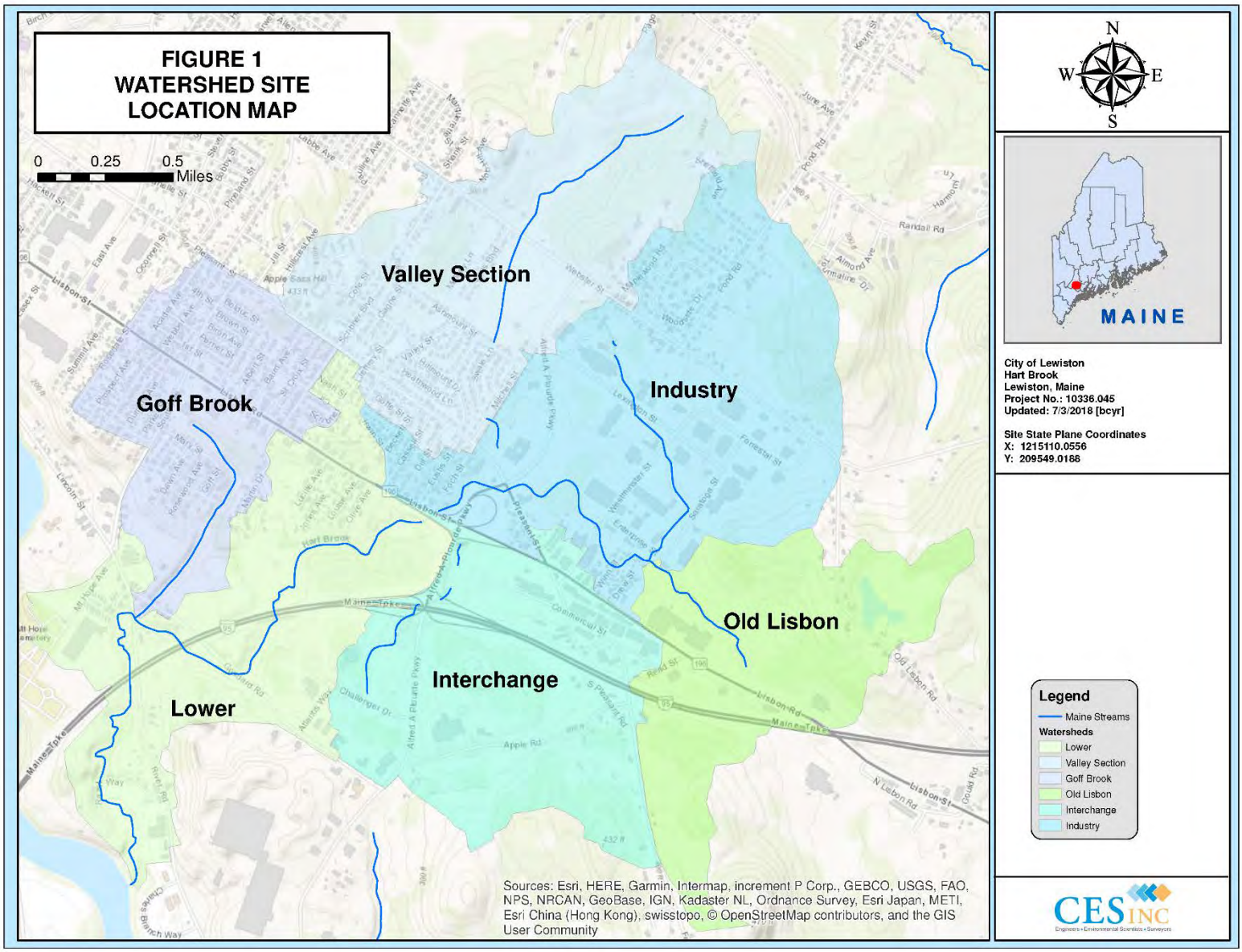
FIGURE 1
WATERSHED SITE
LOCATION MAP
0 0.25 0.5
Miles
Valley Section
Goff Brook
Industry
Old Lisbon
Interchange
Lower
N
W
E
S
MAINE
City of Lewiston
Hart Brook
Lewiston, Maine
Project No.: 10336.045
Updated: 7/3/2018 [bcyr]
Site State Plane Coordinates
X: 1215110.0556
Y: 209549.0188
Legend
Maine Streams
Watersheds
Lower
Valley Section
Goff Brook
Old Lisbon
Interchange
Industry
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

The City of Lewiston (City), in cooperation with MDEP, increased monitoring and observations of the Brook from 5 to 10 locations throughout the watershed. From 2011 to 2015 the City worked cooperatively with the MDEP and Volunteer River Monitoring Program (VRMP). Working with the VRMP, the City has developed a solid working relationship and received loans of monitoring equipment. Data collection and sampling was completed by City staff and interns. From 2016-2018, Lewiston hired CES Inc. to perform more extensive water quality sampling and analysis, water quality monitoring, measurement of stage and flow rate, and inspection of the brook's geomorphology CES Inc, (2017). CES also worked cooperatively with MDEP obtaining project guidance, through the loan of water quality instrumentation, MDEP performance and evaluation of macroinvertebrate monitoring and review of water quality results.

Goals of the increased investigation in 2016-2018 were to help form the basis for a WMP update by:

- Understanding the current water quality status of Hart Brook under base flow and stormflow conditions,
- Understand the status of the macroinvertebrates community in other areas of the watershed,
- Provide a broader set of data to help select and design stormwater treatment structures, and
- Develop a monitoring plan to measure watershed improvement effectiveness.

The data collected from these investigations has helped to better define the current condition of the watershed and actions necessary to reduce impairment and update the 2008 WMP.

Watershed Management Planning

The purpose of a WMP is to evaluate a watershed that has shown signs of water quality impairments, document sources of pollution, and provide a course of action to improve water quality. The original Hart Brook WMP was developed in 2008 with a limited database of water quality and aquatic information. In 2013, the US Environmental Protection Agency's (USEPA) published guidelines that require development of a nine-element watershed-based plan for nonpoint source pollution (NPS) of impaired waters prior to implementing projects using Clean Water Act section 319 funds (USEPA, 2013). This 2018 WMP has been updated to meet the criteria as shown in the **Guide**. This WMP Update is also designed to be a focused achievable plan with a timeline to be implemented over the next 10-year period and serve to restore water quality and habitat in the Hart Brook Watershed. The MDEP and USEPA can also use this plan to enhance their understanding of the watershed conditions and as a basis for future grant funding and planning purposes.

2.0 | PHYSICAL AND NATURAL FEATURES

2.1 Hydrology

Surface Water

The main branch of Hart Brook is 3.8 miles in length and has a watershed of approximately 2,100-acres. For the purposes of investigations related to this and previous plans, Hart Brook has been subdivided into six smaller sub watersheds: Lower (376 acres), Valley Section (396 acres), Goff (229 acres), Old Lisbon (279 acres), Interchange (342 acres), and Industry (487 acres) as shown on **Figure 1**.

The main branch of Hart Brook originates in the northern portion of the Industry sub watershed (north of Webster Street in Lewiston) and flows for approximately 0.5 miles before entering a concrete-lined channel. The brook flows through this channel for approximately 0.75 miles before returning to a "natural" brook and floodplain. The brook continues to flow in a southwesterly direction under Route 196, three crossings under the Maine Turnpike, and eventually empties into the Androscoggin River south of the River Road.

Hart Brook is a primarily low-gradient inland stream with several tributaries which flow through a mixture of residential, commercial and industrial land east of the urban center of the City. Many portions of the Brook have been channelized and redirected over the past 100-years due to past development and infrastructure improvement, resulting in sections of straightened and over-widened channels. Additionally, increased runoff from impervious surface has eroded and widened the stream to create shallow base flows.

Hart Brook's main branch is fed by several tributaries, including unnamed headwater streams from the Valley sub-watershed and Old Lisbon sub-watershed. In the Lower sub-watershed, Goff Brook flows into the main branch from the north/northwest, less than a mile before the discharge into the Androscoggin River.

Groundwater Resources

The Maine Geological Survey (MGS) has identified a significant sand and gravel aquifer within a portion the Lower Sub-watershed of the Hart Brook Watershed. There is no current or anticipated future significant drinking water withdrawal within the watershed. Lewiston residents receive drinking water from Lake Auburn, located in Auburn, Maine, which has a watershed area of 18.9 square miles. In general, groundwater recharge areas are in the topographic highs on the periphery of a watershed. In more urban watersheds, where the boundary is affected by anthropogenic activities, groundwater recharge areas may be situated outside of the watershed boundary. Permeable geologic strata that do not follow local topography will also impact a watershed's groundwater recharge. In the case of the Hart Brook Watershed, groundwater recharge areas are assumed to be in the most upstream sub watershed sections (Goff Brook, Valley Section, Industry, and Old Lisbon).

Groundwater-Surface Water Interaction

Groundwater and surface water are often connected whereby flow can occur in the subsurface between each water whereby a stream can "gain" or "lose" water to or from the groundwater. This is a function of the area geology and from the effects of precipitation seasonally or annually (i.e. droughts or flooding). Therefore, the quality of one water source can impact the quality of the other. To evaluate and protect surface water within the Hart Brook Watershed, groundwater and subsurface water conditions were assessed through hydrologic modeling in 2008. Groundwater and surface water interact in both recharge and discharge areas within the watershed. Stream flow observations and measurements made from July to September are typically indicators of flow derived from base flow which primarily comprised of groundwater discharge into the stream. Extremely low base flow levels were observed in 2016 during the drought experienced throughout Maine and the northeast. Even at drought levels, groundwater discharge to the stream, though greatly reduced, was observed in each of the headwater reaches of the watershed in Industry, Valley and Old Lisbon subwatersheds. Groundwater recharge area protection is critical to restoring and maintaining water quality within Hart Brook and its tributaries.

2.2 Topography and Soils

The maximum elevation of the Hart Brook watershed is 358 feet with a watershed slope of 1.35% as measured along the primary channel of Hart Brook to the Androscoggin River. The Industry, Old Lisbon and Valley sub watersheds are relatively low gradient areas or flatter areas. The Goff and Lower sub watersheds contain low and high gradient (steeper) sections. Higher gradient sections also include significant opportunities for stream aeration from water cascading over rock, boulder and cobbles as evidenced at sampling sites HB-1, 2 and 3 shown on **Figure 2**.

Soils influence runoff characteristics in a watershed and may affect the development and success of individual stormwater management systems. Hydrologic Soil Groups (HSG) are typically used as an initial screening tool to identify the general applicability of soils to support infiltration and stormwater runoff volume reductions. Classification of soils using the HSG falls under four groups, A, B, C, and D based on infiltration rate and runoff potential. Group A soils have a high infiltration rate and low runoff potential with Group D soils having a very slow infiltration rates with high runoff potential. It is probable that many of the surface soils have been altered through the course of development on this watershed (e.g. fill), which influences the potential for infiltration or shallow subsurface stormwater storage.

Overall, the Lower and Goff Brook sub watersheds contain the highest percentage of HSG A and B soils within the watershed, at 64% and 82% of sub watershed land area, respectively (USDA, 1970). The Industry, Interchange, and Old Lisbon sub watersheds are generally HSG C or D. The Valley sub watershed area is comprised of approximately 32% of HSG A and B soils.

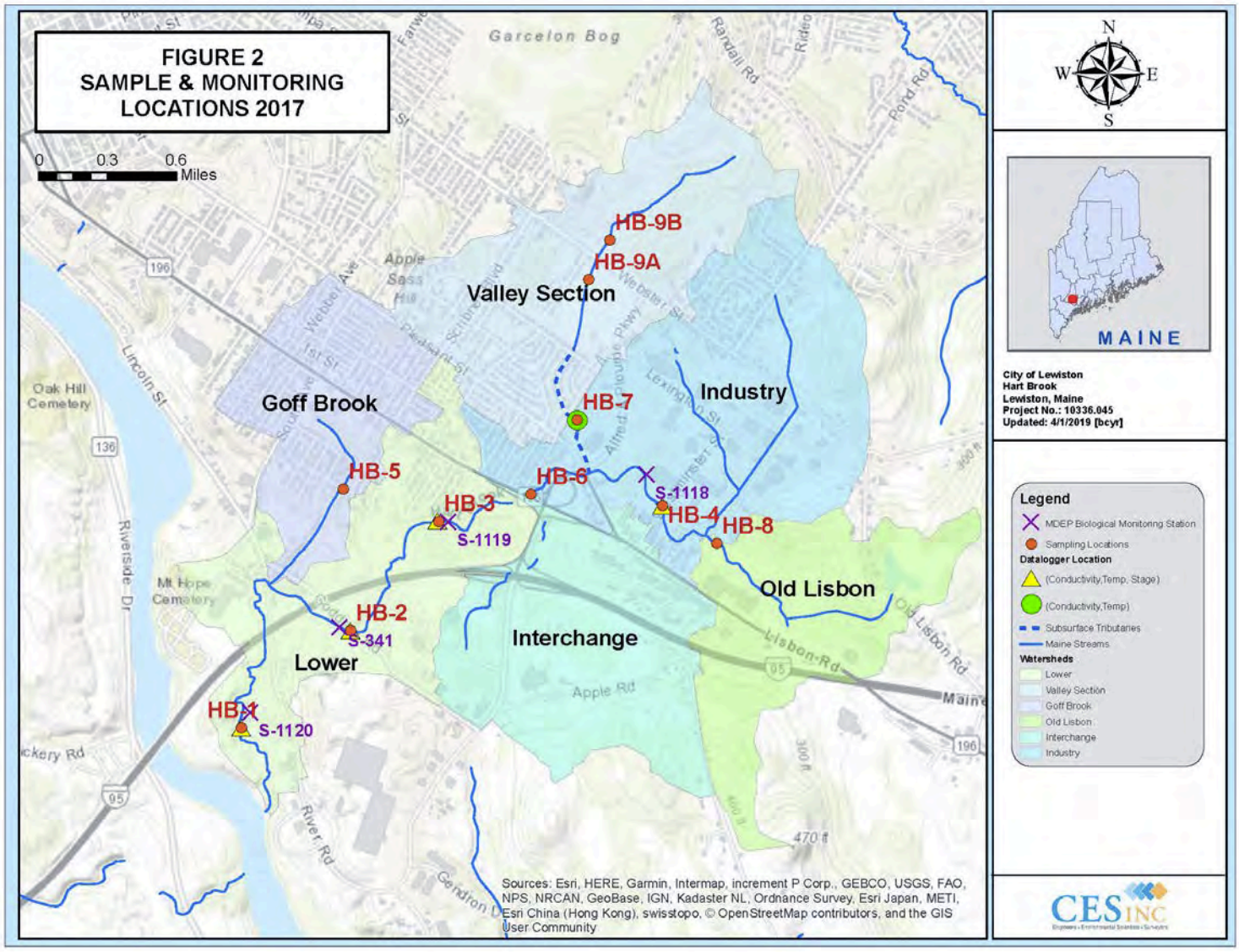
FIGURE 2
SAMPLE & MONITORING LOCATIONS 2017
0 0.3 0.6 Miles
N
W
E
S
MAINE
City of Lewiston
Hart Brook
Lewiston, Maine
Project No.: 10336.045
Updated: 4/1/2019 [bcyr]
Legend
MDEP Biological Monitoring Station
Sampling Locations
Datalogger Location
(Conductivity,Temp, Stage)
(Conductivity,Temp)
Subsurface Tributaries
Maine Streams
Watersheds
Lower
Valley Section
Goff Brook
Old Lisbon
Interchange
Industry
HB-9B
HB-9A
Valley Section
Industry
HB-7
Goff Brook
HB-5
HB-6
HB-3
S-1119
S-1118
HB-4
HB-8
Old Lisbon
HB-2
S-341
Lower
Interchange
HB-1
S-1120
Garcelon Bog
Oak Hill Cemetery
Mt Hope Cemetery
Apple Sass Hill
Lincoln St
Riverside Dr
Webber Ave
1st St
Pleasant St
Webster St
Lexington St
Alfred Loubie Pkwy
Lisbon Rd
Old Lisbon Rd
Apple Rd
River Rd
Randall Rd
Pond Rd
Maine
470 ft
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

2.3 Surficial Geology

According to the *Surficial Geology of the Lewiston* (MGS, 2002), the surficial soils in the watershed area are the result of the advance and retreat of glaciers at the end of the last glacial period. Major surficial geologic materials in the watershed are sand, gravel, and silt deposited in (or graded to) shallow marine waters (glaciomarine deposits) during late-glacial regression of the sea. This surficial material includes some significant sand plains that commonly overlie marine muds of the Presumpscot Formation, a significant statewide glaciomarine deposit. Additional surficial materials that comprise the watershed area include sands and gravels characteristic of esker deposits, which were laid down by meltwater streams under or running off the melting glaciers, and also from more recent stream alluvium deposits caused by erosion and deposition and flooding. These various sediments have been observed underlying the main channel and tributaries throughout Hart Brook and documented during geomorphological assessments performed in 2008 and 2017 (**Section 4.3)**. A significant sand & gravel aquifer is mapped by the MGS in the Lower Subwatershed as shown on **Figure 1**.

2.4 Climate

Lewiston averages 47° F with an average annual high temperature of 55.9^{o} F and average annual low temperature of 37.3^{o} F. Average annual precipitation in Lewiston is 45.8 inches and is inclusive of 68 inches of annual snowfall.

3.0 POPULATION CHARACTERISTICS AND LAND USE CLIMATE

3.1 Demographics and Geography

Lewiston is the second largest city in Maine, with a population of approximately 36,140 residents as of 2016 US Census data (United States Census, 2017). The total area of the City is 35.54 square miles. Lewiston is centrally located in Androscoggin County and is half of the Lewiston-Auburn Metropolitan Area. Lewiston shares borders with Auburn, Greene, Sabattus, Lisbon, and Durham and is considered one of the most culturally diverse areas in the State of Maine.

3.2 Historical Land Uses

Lewiston began as a growing agricultural town that with the coming of the industrial revolution transformed into an industrial hub. The presence of the Androscoggin River and Lewiston Falls as well as the coming of the Androscoggin & Kennebec Railroad and the construction of a canal led to a boom in textiles and hydroelectric power generation. The city is currently undergoing a post-industrial diversification and renaissance, assisted by new development, including institutions of higher education and new businesses moving to the area including the Industry and Interchange sub watersheds.

3.3 Current Land Uses

Today, there is a mix of land use types in the Hart Brook Watershed. The upper watershed still features relatively undisturbed areas with some residential development (Old Lisbon, Interchange and Lower sub watershed). There is considerable commercial and industrial development in the Industry, Interchange and Lower sub watershed sections, including businesses such as L.L. Bean, White Rock Distilleries, Wal-Mart, Pike Industries, Diamond-Phoenix, Phillips-Elmet, Geiger, Wahlco-Metroflex, and Spectrum.

3.4 Future Land Use

The revitalization of Lewiston, especially the downtown area, has continued to bring business development to Lewiston and watershed area. While increases in development and population within the Hart Brook Watershed are expected to continue for the foreseeable future from new growth and reuse of existing commercial and industrial areas. However, there has not been a measurable increase in Hart Brook in impervious surface from 1998 to the latest estimates completed using 2017 imagery (Personal communication Hannah Slattery, 2018). Therefore, this WMP update can use pollutant loading assessments form the 2008 report to evaluate the benefits of structural watershed improvements.

3.5 Land Use Effects on Hart Brook

Based on the 2008 MDEP evaluation, approximately 22% of the 2,100-acre watershed area is covered by impervious surfaces (rooftops, parking areas and roadways). Typically, watersheds that contain 10% or more impervious surface result in an, “impaired,” designation for their main stream. Impervious surfaces can allow for the direct discharge of nutrients (phosphorous and nitrogen), roadway salts, metals, petroleum hydrocarbons and other pollutants to surface water bodies without natural filtration. Direct discharge of high volumes of stormwater can also lead to stream channel erosion and increased sedimentation, affecting the stability and health of the stream.

3.5.1 Sanitary Stormwater

The City has also taken significant steps to reduce the impact of sewerage on the Brook. This includes performing annual camera inspections of sanitary sewers throughout the City to determine risks of failure or leakage. In 2014, a sewer leak was found discharging into the brook from a pipe suspended in the culvert where Hart Brook crosses under the Maine Turnpike at 142 Goddard Road. This leak was fixed in mid-October 2014. In addition, at this time, sanitary sewer from River Road in the Lower Subwatershed to Westminster Ave in the Industry Subwatershed was lined. Lewiston spends about $1.3 to 1.7 million dollars annually on sewer inspection and rehabilitation. After inspection, a risk analysis is used to prioritize pipes to be lined. A significant portion of sewer pipes directly abutting Hart Brook have already been lined. Although there is not a specific timetable to perform lining all pipes, Hart Brook is a priority area for sewer pipe rehabilitation. There are an estimated 139,239 linear feet of sewer piping in the Hart Brook Watershed. Since 2008, 82,597 linear feet of sewer have been inspected and 18,221 linear feet of sewer lined at a cost of about $1.5 million dollars. The location of sewer infrastructure, including inspected and lined sewers are shown on **Figure 3**.

When the WMP was written in 2008 there were two Combined Sewer Overflows (CSOs) in the Hart Brook Watershed located at Goff Brook and South Avenue. The South Avenue CSO was permanently plugged by the City in December 2008. A storage tank was installed at the Goff Brook (Morningside) CSO outfall in 2010. The tank was sized to hold a one-year storm event (2.05 inches in 6 hours). Additional separation in the drainage area since 2010 has increased the storage capacity to greater than a two-year storm. Overall, the volume of CSO discharges in the City have been decreased over 90% since 2000 and outfall pipes reduced from 32 to 8. The Goff Brook CSO did not discharge in 2017.

The City of Lewiston provides an Annual CSO Progress Report to the Maine DEP. This progress report outlines efforts being made to disconnect combined sewer systems, funds expended on CSO disconnection efforts, and total estimated discharges during a given year.

3.5.2 Stormwater Structural Controls

Since 2008, Lewiston has taken measures to reduce the impacts of impervious surfaces through improvements in stormwater control, treatment and detention. Several Focal Point® biofiltration basins were installed in the Valley and Industrial sub-watersheds to collect and treat stormwater runoff from streets and adjacent lawns. In 2017, assisted by U.S. EPA Clean Water Act Section 319 grant funds, the City installed a large bioretention structure on Webster Street to treat about 305,000 square feet of impervious surface from a mostly residential area of the Industry Subwatershed thereby reducing an estimated 0.74 tons of sediment and 3.92 pounds of phosphorus per year from entering Hart Brook.

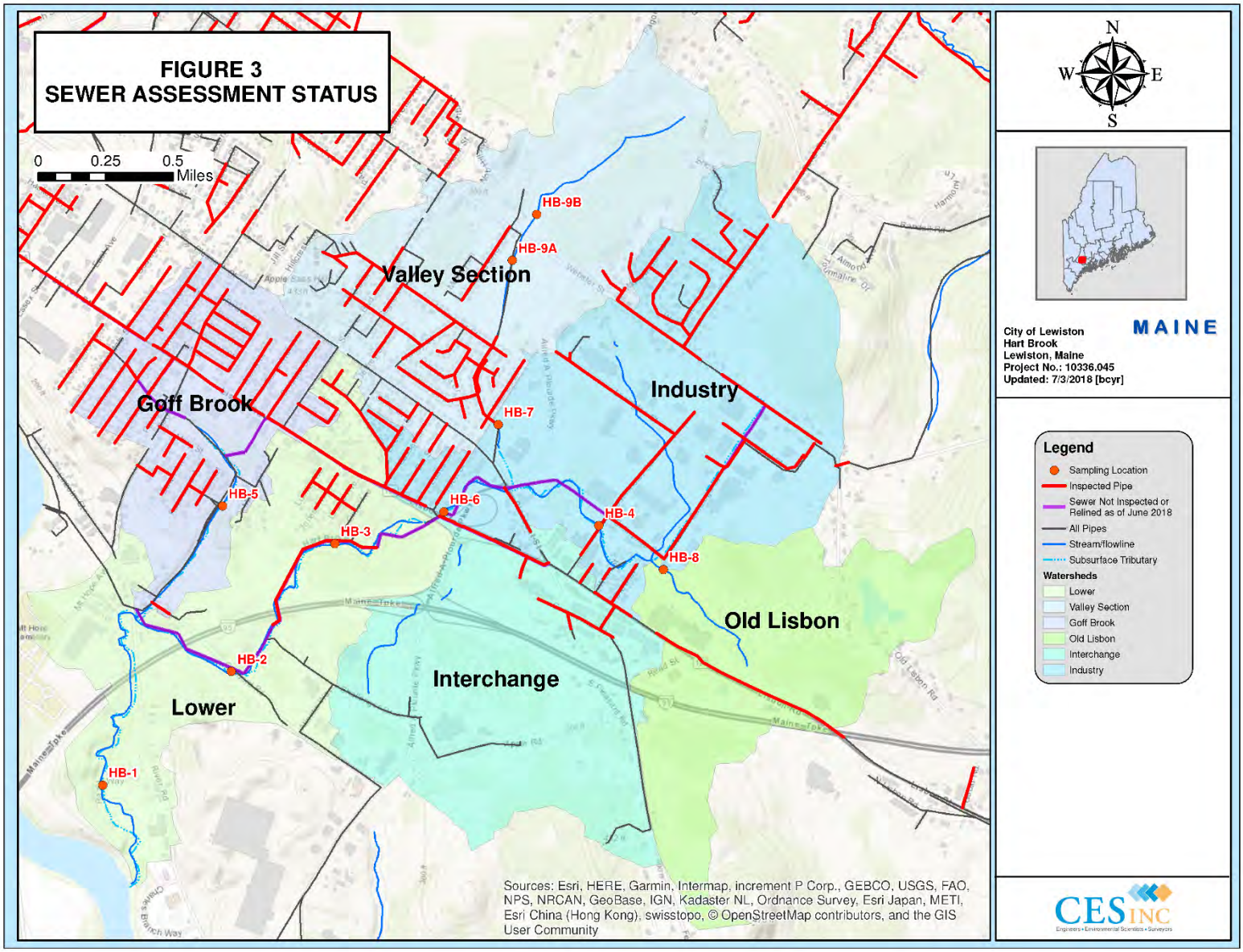
FIGURE 3
SEWER ASSESSMENT STATUS
0 0.25 0.5 Miles
HB-9B
HB-9A
Valley Section
Industry
Goff Brook
HB-7
HB-5
HB-6
HB-4
HB-3
HB-8
Old Lisbon
HB-2
Interchange
Lower
HB-1
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
N
W
E
S
MAINE
City of Lewiston
Hart Brook
Lewiston, Maine
Project No.: 10336.045
Updated: 7/3/2018 [bcyr]
Legend
Sampling Location
Inspected Pipe
Sewer Not Inspected or Relined as of June 2018
All Pipes
Stream/flowline
Subsurface Tributary
Watersheds
Lower
Valley Section
Goff Brook
Old Lisbon
Interchange
Industry

3.6 Transportation Infrastructure

Public roads and large commercial parking areas represent a significant amount of total impervious surface in the Hart Brook Watershed. These surfaces are an essential component of the developed infrastructure and closely linked to adjacent land use development patterns. Much of the polluted stormwater runoff generated in the watershed is conveyed along transportation corridors, either through underground stormwater systems or roadside channels. Public roads can also be a source of pollutants from vehicles (e.g., petroleum products, heavy metals, etc.) and winter maintenance activities (e.g., road salt and sand).

There is a rough correlation between traffic volumes and the amount of pollutants potentially generated from public roads. Increases in traffic volumes also increase the likelihood of pollutants from vehicles and winter maintenance activities.

In addition to winter maintenance activities on area roadways, the City is responsible for maintaining most of the roads. These activities include:

- Street sweeping and catch basin cleaning
- Minor road surface repair
- Shoulder maintenance and stabilization
- Underground drainage and sewerage infrastructure repair
- Surface drainage repair and maintenance (ditching)
- Road side grass and weed control,
- Maintenance of stormwater treatment/ detention systems

In addition, the Maine Department of Transportation (MDOT) performs similar maintenance of the Lisbon Street Route 196 section through the Hart Brook watershed and the Maine Turnpike Authority (MTA) maintains the Maine Turnpike that crosses the Hart Brook watershed in several locations.

Many of the activities performed by the City, MDOT, and MTA help control and reduce the amount of pollutants in stormwater. Routine street sweeping and catch basin cleaning are particularly important in removing the pollutants that accumulate on public roads and in stormwater piping systems before reaching nearby surface water bodies. These activities are of primary importance in the spring following winter road salt and sand applications. The City has updated its policies and procedures for sidewalk and street sweeping in 2018 to meet the intent of the Phase II USEPA Stormwater Program Management Plan. Since completion of the previous WMP, the City has improved sidewalk and street sweeping equipment including

- Two vacuum sweepers
- Two mechanical broom sweepers
- Three sidewalk sweepers

The sidewalk sweepers precede the street sweepers a day or two before street cleaning

so that material that is pushed off the sidewalks and into the street and is then removed by the street sweeper shortly thereafter. The goal is to remove potential salt-impacted sediment and other debris as soon as the possibility of winter weather has passed. Effectiveness of street sweeping efforts is believed to be reflected in limited increases in stream conductivity in Hart Brook during runoff events as monitored by continuous recording of conductivity performed outside winter meltwater periods.

3.7 Municipal Separate Storm Sewer Permit System

The City currently complies with requirements of the Clean Water Act through a Municipal Separate Storm Sewer System (MS4) general permit #MER041012. Numerous requirements under this permit focus on Hart Brook non-structural stormwater management efforts. The following is a summary of activities that have been completed and that have been initiated in the Hart Brook watershed for stormwater runoff improvement since 2008.

- *Adopted and Implemented a Post-Construction BMP Ordinance*- The City adopted a post-construction ordinance on December 31, 2009. The post-construction stormwater management standard is Article XIII Sec 15 of the Zoning and Land Use Code. New development and redevelopment within the City's urbanized area must have a Post-Construction Stormwater Maintenance Plan. A plan must be approved under the City's subdivision, site plan, or other zoning, planning, or land use ordinance and must meet the following requirements:
  - Annual Inspection
  - Corrective action(s) to address deficiencies.
  - Record of the maintenance or corrective action(s) taken, and
  - Annual signed certification
- *Storm Drain Stenciling* - The City stencils storm drains on an annual basis. The stenciling events have been coordinated with local Girl Scouts. Door hangers are left at homes in the stenciling area explaining the program. Since 2015, the following locations have been stenciled:
  - July 12, 2015 – Valley Neighborhood
  - April 30, 2016 – Fairmount Street Neighborhood
  - June 4, 2017 – Sunnyside Park Neighborhood
  - June 9, 2018 – Simard Neighborhood

- *Septic System Evaluations* – Evaluations were completed on eleven septic systems within the Hart Brook watershed on June 2, 2017 and June 8, 2017. The evaluations were completed by a certified plumbing inspector from the City's Code Enforcement Department. Residents were notified in advance and provided with an informational brochure on septic system maintenance. There were no malfunctioning septic systems identified during the evaluations.
- *Hydrant Flushing* – The City developed a Hydrant Flushing Impact Plan. As part of the development of the plan the City identified where hydrant discharges may impact receiving waters based on assumptions of in-stream flow rates and average hydrant flow rates. The plan is intended to reduce the risk of discharges containing high levels of total residual chlorine (TRC) into the City's waterways. City hydrant

crews should utilize diffusers and dichlorination products to ensure that discharges are below acute toxicity levels.

- *Illicit Discharge Detection and Elimination (IDDE) Standard Operating Procedures* – The City reviewed and updated IDDE SOP in December 2014 and trained affected staff.
- *Illicit Discharges – The* City conducts closed-circuit television (CCTV) inspections of their sanitary sewer system. CCTV inspections and has identified private sewer connections to the storm sewer system that are then corrected.
- *Operation and Maintenance (O&M) Plans for Municipal Facilities* – O&M Plans were developed for municipal facilities located in the Hart Brook watershed in 2015. Municipal facilities in the watershed include the Lisbon Street Fire Station, Goddard Cemetery, and the abandoned quarry now used as a permitted fill site. Recommended procedures were developed for each facility to reduce stormwater pollution. Management personnel for each facility were trained on the O&M manual in 2015 and are required to train their staff on the contents of the O&M Plans on an annual basis.
- *Priority Street Sweeping* – As noted in Section 3.6, the City completes sweeping of public roads and parking lots throughout the city with Priority given to Hart Brook as soon as possible after the winter season is concluded.

4.0 WATERSHED ANALYSIS AND STREAM MONITORING

4.1 Stream Class and Criteria

The Maine Legislature (Title 38 MRSA 464-468) establishes water quality classification standards for all surface waters in the State of Maine, which provide water quality goals and criteria for classified waters. Although all water bodies must meet fishable and swimmable goals in the Federal Clean Water Act, four classes of freshwater streams (AA, A, B and C) have been established to reflect differences in risk. This ranges from Class AA streams, which are in the most natural condition and highest water quality criteria, to Class C streams, which are still of good quality but have a higher risk of degradation.

Hart Brook is designated Class B by the MDEP (MRSA Title 38, Chapter 3). Class B streams must support aquatic life and allow for other designated uses such as drinking water supply after treatment, fishing, recreation in and on the water, industrial processes, hydroelectric power generation and navigation. In addition, Class B streams must meet specific criteria for dissolved oxygen (DO) and bacteria. According to the Integrated Water Quality Monitoring and Assessment Report (MDEP, 2016), Hart Brook does not meet Class B designated uses and criteria. Specifically, it is listed as impaired because it does not provide for aquatic life based on habitat, dissolved oxygen and E. coli.

Significant water quality monitoring has been done in Hart Brook since the original WMP in 2008. In addition, the MDEP has completed macroinvertebrate assessments in 2008, 2013 and 2017. Sampling locations are shown on **Figure 2**. The MDEP and the City have worked collaboratively on water quality analysis and water quality field parameter monitoring from 2008 to 2017. A discussion of the results follows in **Sections 4.3,** and **4.4**.

4.2 Initial Pollutant Load Estimates

During the development of the original WMP, there was limited water quality data to use in developing restoration priorities and methods. Non-point source pollutant load estimates were completed to provide a relative evaluation method of the contribution of individual source areas within the Hart Brook watershed. The 2008 watershed pollutant load estimates focused specifically on the evaluation of impervious surface source areas as the primary contributor to Hart Brook Watershed degradation. Pervious, undeveloped parcels were not evaluated for runoff quantity or quality but can contribute to overall watershed pollutant loads. The objective of this stormwater source area analysis was to estimate the pollutant loadings from impervious surfaces within the watersheds and to identify the sub watersheds most likely to contribute to stream impairment. In addition, the modeling effort delineated 194 sub catchments and provided a foundation on which to assess the nutrient reduction benefit of recommended improvements provided by structural or non-structural stormwater retrofits.

Using a modified Simple Method, pollutant load was determined by multiplying the median pollutant concentration for each sub catchment by total runoff volume leaving the sub catchment area. Model calibration was not a part of this planning process because of limited available data. Within each sub catchment, stormwater source areas were defined based on 2006 MDEP field data, two-foot contour intervals, city planimetric data (including

drainage infrastructure and aerial photographs), available site plans, and personal communication with Lewiston Public Services staff. In some cases, sub catchments were aggregated to describe a distinct catchment area flowing to a discrete discharge point (e.g. multiple impervious areas draining into one storm sewer and discharging as a single pipe). Each sub catchment containing significant impervious area, was modeled for water quantity generated in the one-inch 24-hour precipitation event and the one-year 24-hr precipitation event (2.5”). These storm events are the most likely to contribute to water quality and stream flows that create channel erosion. Larger storm events are likely to contribute to stream channel flooding; however, flooding was not considered to be a major issue for the Hart Brook watershed. Total runoff quantity from each sub catchment was determined using HydroCAD® 7.1 software and total pollutant load was assessed using the modified Simple Method.

Land-use and the impervious percentage of individual sub catchments were used to estimate likely pollutant concentration in stormwater runoff from that catchment based on national median concentrations for differing land-use classifications. A median concentration of Total Suspended Solids (TSS), Total Phosphorus (TP), Total Kjedahl Nitrogen (TKN), and Zinc from the National Stormwater Quality Database (NSQD) was identified for each sub catchment and used for pollutant loading estimates. In this hydrologic analysis all sub catchments were modeled independently and total runoff and pollutant load was summed, assuming no loss or transformation of pollutants within the pipe or stream channel network. Although the method used a simplified approach to water quality modeling, it provided a relative comparison of pollutant loads within a watershed area. Model input and calculations can be found in **Appendix A** of the original WMP (Woodard & Curran, 2008). This method was used in 2018 to estimate the reduction of pollutant load for the Action Plan items, as shown in Section 6.0 Pollutant Load Reduction Solutions and Section 10.0 Measures of Success/ Measurable Interim Milestones Table.

4.3 Aquatic Macroinvertebrate Assessments

MDEP collected samples of benthic macroinvertebrate communities from one location (HB-2 as shown on **Figure 2**) in Hart Brook (part of the Androscoggin River Basin) in 1998, 2003, 2008, and 2013. In 2017, after requests made by the City, MDEP expanded macroinvertebrate testing to four locations in the watershed. Samples were collected, sorted, and stored for identification. MDEP then entered the data into its statistical model. The model compared a sample to the baseline data for each of Hart Brook’s water quality class (Class B) criteria including non-attainment, indicating attainment or non-attainment of aquatic life standards.

The historical biological monitoring sample (No. 341) is collected downstream of the Goddard Road crossing of Hart Brook at Station DEP No. 341 near water quality monitoring station HB-2 as shown in **Figure 2**. The 1998-2013 results showed that Hart Brook did not attain its statutory class (Class B) at No. 341. The 2013 sampling results summary indicated that the brook has very low macroinvertebrate diversity and a high percentage (almost 60%) of the organisms collected were midges Paratanytarsus, Dicrotendipes and worms, both which are more tolerant of low dissolved oxygen and heavy sediment loads. MDEP noted that Total Phosphorus and Total Dissolved Solids

(TDS) were elevated during the 2013 sampling, indicative of an urban system.
In 2017, MDEP sampled macroinvertebrates at four additional locations throughout Hart Brook. The purpose of the sampling increase was to determine if aquatic impairment historically only measured at one location (No. 341) was representative of the watershed. As with water quality data, a better understanding of geographic distribution of impairment would allow more focused and targeted responses to restoration. Sets of three rock bags were deployed at four locations along the main stem from the Lower sub watershed up to the Industry sub watershed as illustrated on **Figure 2**. The 2017 macroinvertebrate rock bags were deployed July 27, 2017 and retrieved August 24, 2017. Analysis was completed by MDEP on March 30, 2018, as shown on the Aquatic Life Classification Attainment Report included in **Appendix A**.

Three stations did not meet Statutory Class B or the minimum Class C aquatic life criteria. Station No. 1119 (Goff Brook/ Olive Street) did not meet the minimum provision for Total Mean Abundance which is a calculated mean of 50 organisms per bag. This station only had 36 organisms per bag and could not be used to determine if it met classification. Overall, MDEP found the stations were similar in their macroinvertebrate community make up as summarized in **Table1.**

MDEP did not provide a written report on the Hart Brook analysis. The following is an e-mail summary from Leon Tsomides, manager of the MDEP Biomonitoring Unit. "*Generic Richness or the number of different kinds of organisms was very similar between stations. Most of the organisms were tolerant or eurytopic. EPT Generic Richness or the number of different kinds of organisms in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies) were very low for all stations. These groups tend to have the most sensitive groups of organisms. Isopods (Caecidotea) were generally the most dominant organism in the community. Isopods are primarily inhabitants of shallows rarely being found in water more than a meter deep. They are generally found under rocks, vegetation and debris. This behavior probably makes them less prone to high flow events. Some species are indicators of organic pollution.*

In summary, I do not see a difference in the communities found at these stations. They all lack sensitive organisms, and abundances and richness of the communities are low. MDEPs observation was that conductivity is high at all stations but the temperature and DO are good, at least during the sampling period."

Table 1 | Summary of MDEP 2018 Aquatic Life Attainment Analysis

Station #	Subwatershed	Total Mean Abundance	Generic Richness	EPT Richness	Dominant Organism
S-1118	**Industry** Below Westminster Street Near HB-4	133	24	2	Caecidotea (71%)
S-1119	**Goff Brook** Below Olive Street Near HB-5	36*	24	0	Tanytarsus (17%)
S-341	**Lower** Along Goddard Road Near HB-2	66	21	1	Caecidotea (24%)
S-1120	**Lower** Along River Road 100 feet Upstream of HB-1	60	23	1	Caecidotea (30%)

* Did not meet criteria for Total Mean Abundance

4.4 Stream Corridor Assessment

A rapid geomorphic assessment of Hart Brook was completed in 2008 to determine if stream channel adjustments are likely contributing to watershed impairment and if stream restoration at targeted locations along the channel could lead to improved stability and habitat for aquatic macroinvertebrates. The evaluation consisted of geomorphic assessment of channel features, and targeted topographic surveys. These tasks are described in detail below. The results of the assessment were used to identify potential restoration projects that would improve channel stability and habitat value. In 2017 CES performed a similar rapid geomorphic assessment to assess current conditions of Hart Brook relative to 2008.

4.4.1 Rapid Geomorphic Assessment 2008

The 2008 rapid geomorphic assessment of Hart Brook was completed by Field Services for Woodard and Curran as part of the original WMP. The assessment was done on 11 reaches of uneven length using an adaptation of the USEPA's *Streamwalk* protocol developed by the Maine Department of Inland Fisheries and Wildlife (MDIFW). The assessment consisted of the identification of stream channel characteristics that may contribute to watershed impairment.

While the rapid geomorphic assessment is a way to identify channel adjustments at the reach scale, mapping of the stream channel can provide more detailed information on bank stability, bank composition, and physical habitat features. Several channel features were recorded along the length of Hart Brook and included bank composition, bank stability, and grade controls (i.e. culverts). Mapping was completed using mylar overlays

placed over aerial photographs of the watershed. The mapped information was later digitized on digital aerial photography to create ArcGIS shapefiles for integration into existing GIS databases.

Detailed topographic surveys of longitudinal profiles and cross sections were conducted at five select sites in 2008. Longitudinal profiles were measured at the lowest part of the channel bottom (i.e., thalweg) from the upstream to downstream end of the selected channel segment. Survey points were recorded at the beginning and ends of riffles, deepest parts of pools, and at other selected points needed to accurately represent variations in channel bed elevation and planform geometry of the channel thalweg. Channel cross sections extended, at a minimum, from the bank full elevation on both banks; however, attempts were made to survey across the entire floodplain and up the slopes of valley margins. Surveys were completed to compare channel morphology between sites where different natural and human land use conditions may manipulate stream channel stability.

4.4.2 Rapid Geomorphic Assessment 2017

In the summer of 2017, CES performed a follow-up inspection of the stream channel geomorphology to qualitatively assess the status of Hart Brook in comparison to the 2008 findings. The assessment also served to identify areas of concern to observe with MDEP staff and the City of Lewiston. An electronic tablet was used to collect site data and a GPS location of areas of concern including pipes, erosion, and sedimentation were noted. The sections of the stream were divided into reaches and defined areas of concern or interest are numbered as show on **Figure 4**. A more detailed summary of the CES stream inspection with a detailed table and photos is included in **Appendix B**.

The main stem of Hart Brook was inspected by CES personnel from the confluence of Hart Brook and the Androscoggin River to HB-4 in the Industry sub watershed. During a site visit in the Fall 2017 with the City, CES and MDEP a portion of the concrete channel in the Industrial Park (Industry sub watershed) was also inspected from HB-4 to Midway Street.

In general, the stream inspection completed by CES observed similar conditions in 2017 to those observed in 2008 including:

- Areas of bank erosion,
- Areas of in stream sedimentation from channel erosion,
- Areas of sedimentation from road runoff,
- Stream channels straightened for utility or transportation infrastructure,
- Stream channels cut off from floodplains by deep incision of the stream,
- Stream channels cut off from floodplains by berms possibly created by channel straightening, and
- Inadequate stream crossings.

In the Spring and Fall 2017, the MDEP, City, and CES staff walked sections of Hart Brook to observe areas of concern identified by CES. These included areas of erosion, sediment deposition, blockages with natural debris (tree branches and roots), and areas where

stream alterations had been performed. Areas of erosion were a result of increased runoff, likely a result of the high percentage of impervious surface in the watershed. Additional areas of concern were related to channel straightening performed for improvements to sewer pipelines and transportation infrastructure.

Although there are areas where stream channel restoration could be completed, unless high flows from stormwater runoff are first reduced, these may be short lived solutions. A more comprehensive geomorphic analysis should be performed before performing any channel improvements. Discussion of structural solutions is included in **Section 6 and Section 7.**

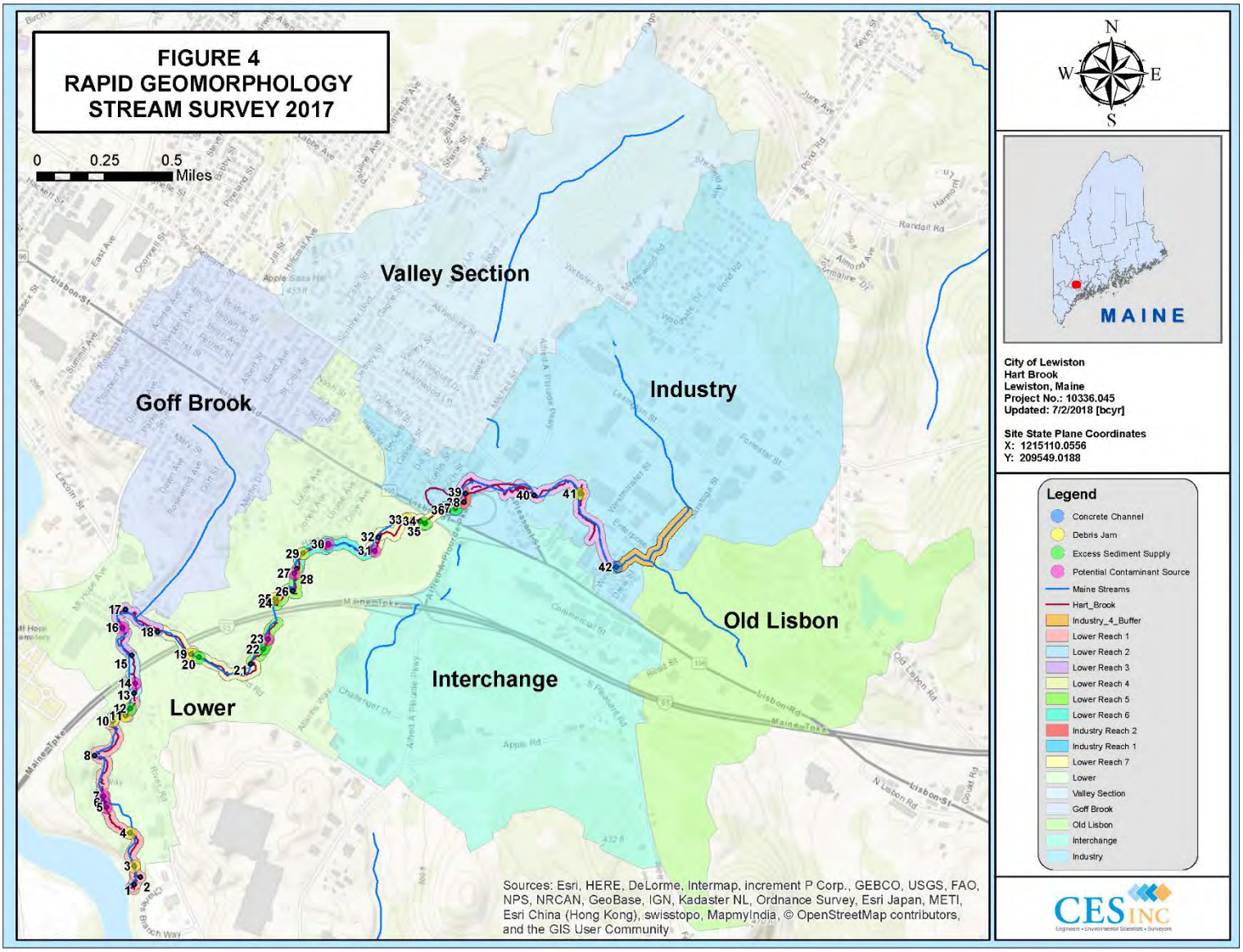
FIGURE 4
RAPID GEOMORPHOLOGY
STREAM SURVEY 2017
0 0.25 0.5 Miles
Valley Section
Goff Brook
Industry
Old Lisbon
Interchange
Lower
N
W
E
S
MAINE
City of Lewiston
Hart Brook
Lewiston, Maine
Project No.: 10336.045
Updated: 7/2/2018 [bcyr]
Site State Plane Coordinates
X: 1215110.0556
Y: 209549.0188
Legend
Concrete Channel
Debris Jam
Excess Sediment Supply
Potential Contaminant Source
Maine Streams
Hart_Brook
Industry_4_Buffer
Lower Reach 1
Lower Reach 2
Lower Reach 3
Lower Reach 4
Lower Reach 5
Lower Reach 6
Industry Reach 2
Industry Reach 1
Lower Reach 7
Lower
Valley Section
Goff Brook
Old Lisbon
Interchange
Industry
Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

4.5 Water Quality Assessment

The water quality of Hart Brook was assessed through the VRMP from 2011 to 2015 in collaboration between the MDEP and City. Data tables for 2011-2017 are included in **Appendix C** and historical time-series charts 2011-2017 are provided in **Appendix D.** Annual time-series charts of data collected by CES in 2016 and 2017 are included in **Appendix E.** Charts of concentration with distance along Hart Brook are included in **Appendix F.**

In 2016, CES collected water quality samples at base flow and during stormwater runoff. In 2017, CES only collected water quality samples at base flow. In addition, CES maintained dataloggers in Hart Brook in 2016 and 2017 to better understand temporal changes in water quality including diurnal effects on DO and stormwater runoff effects on specific conductivity from road salt. The 2016 data set was the most robust for number of samples and because it was done at baseflow and during stormwater runoff. In addition, 2016 data was collected during a regional drought with lower than average base flow. The laboratory analysis in 2016 also included an expanded list of parameters including petroleum and metals. The following summary is of data collected from June to September 2016 and from July to September 2017.

4.5.1 E. coli

Maine uses *E. coli* as indicator organisms of potential harmful pathogens in fresh water and *enterococci* for estuarine or marine recreational waters (38 MRSA Ch. 3 §465). E coli is in Hart Brook throughout the watershed and appears to be related to wastewater, however, other sources such as animal feces in runoff may also contribute.

In 2016, *E. coli* was sampled during seven events at nine locations and was detected over the geometric mean at all nine locations. In addition, all locations failed the instantaneous standard between three to seven times. This data appeared to be higher than 2015; however, may be due to the low flow (less dilution) during drought conditions in 2016. In 2017, *E. coli* was sampled three times at 10 locations and detected over the geometric mean at 9 locations. The same station locations failed the instantaneous standard one to three times over the same sampling interval as 2016. In 2016, *E. Coli* was detected at HB-9A just below Webster Street in a small headwater tributary. To evaluate the source of the *E. Coli* at HB-9A, HB-9B was added upstream of Webster Street. HB-9B passed the criterion indicating that the E. coli source is likely located at or between station HB-9A and HB-9B. This area of the Valley sub watershed has an unlined sewer that may indicate a possible source of *E. Coli* to the Brook.

4.5.2 Temperature

Water temperature can affect the types of organisms that can reside in a stream as different aquatic species have a preferred temperature range. Maine's Regulations relating to Temperature (06-096 CMR Chapter 582) require that discharge of pollutants not raise the temperature of any river and stream above the EPA criteria for indigenous species (23°C maximum and 19°C weekly average). However, there is no specific standard for temperature in assessing the Class B water standards. However, water temperature has a significant effect on a waters capacity to hold dissolved oxygen with warmer water holding less oxygen than cold water. Aquatic organisms similarly have a

preferred range of DO preferences. DO is discussed further in **Section 4.5.3**

Water temperature in 2016 was manually measured 11-14 times at up to nine locations at base flow conditions, twice under storm flow conditions, and continuously at four locations. Elevated surface water temperatures and slow moving or stagnant water due to low rainfall in 2016 (drought conditions) resulted in historically high measured temperature values in late July through August. Temperatures observed in dataloggers on a daily moving average, ranged from approximately 15 to 22 degrees Celsius from May to September. During the warmest period of July and August they were manually measured from 20-22° C. The main areas of concern observed for temperature are the open concrete channels located in the Industry sub watershed with limited tree cover, resulting in temperatures at HB-4 observed manually or with dataloggers from 17 to 24 at peak periods in 2016 and 2017. These high peaks above 23°C can directly affect organisms as noted above. High temperatures significantly reduce the ability of the water to retain DO. The higher temperatures are indicative of the amount of sun on the brook in this area which can encourage algae growth and organic loading of the algae that is then decomposing as discussed below.

4.5.3 Dissolved Oxygen and Nutrients

DO is one of the more critical and complex components to affect which organisms can thrive or survive in a stream. Aquatic organisms have a preferred range of DO which can be affected by temperature but can also be affected by oxygen use by organisms. Excessive algae growth can be responsible for large diurnal DO swings. DO is lowered during the night when algal consumption of DO during respiration is not compensated for by algal release of DO during photosynthesis. The decomposition of organic materials such as plant matter or wastewater can contribute to the depression. While some diurnal change is normal, large swings (greater than 2 mg/L) is typical of streams with excessive nutrients. In addition, groundwater is generally lower in DO. When streams are at low baseflow, they are primarily fed by groundwater and thus headwater streams sections can have low D.O throughout the season. Upper parts of the Hart Brook watershed, specifically the Valley (HB-9A & 9B) and Old Lisbon (HB-8) sub watersheds, contain small headwater tributaries that are shallow, low velocity, and fed by groundwater base flow.
DO is measured in percent saturation and concentration. A stream must meet both the 7 mg/L concentration and 75% DO criteria to meet the standard. In 2016, DO was manually measured during five events at up to nine locations under morning base flow conditions, three times during afternoon base flow conditions, two events under stormwater runoff conditions, and continuously at four station locations (HB-1, HB-2, HB-3 and HB-8). In 2016, Hart Brook did not meet the 7 mg/L standard for Class B Waterbodies two to four times at three sampling locations HB-4, HB-6, and HB-2 (in order upstream to downstream) in 2016. In addition, Hart Brook did not meet the 75% DO saturation standard for Class B Waterbodies at five locations including HB-9, HB-8, HB-4, HB-6, and HB-2 (in order upstream to downstream) in 2016. Failure in at least one DO criteria saturation or concentration thus resulted in a total of five of nine locations not meeting the DO standard at least once in 2016.

In 2017, DO was manually measured during seven events at up to ten locations under morning base flow conditions, three times during afternoon base flow conditions and

continuously at two station locations (HB-2 & HB-4). All 10 locations failed one of the DO criteria (saturation or concentration) at least one out of seven measurements.

As noted in **Section 4.5.2** a large portion of the Industry sub watershed includes the industrial park and its concrete channels. These channels contain shallow flow at base flow levels and limited shading. As a result, water temperatures can be 4 to 6 degrees Celsius warmer than in other locations throughout the watershed. In June, July, and August, these conditions limit the DO holding capacity (DO% saturation) of the water, creating low concentrations. In addition, two head water streams converge in the Industry Subwatershed. As noted previously, these streams are generally groundwater derived with potential for low DO. They then flow through the concrete channel which has many open sections without shade. The high temperatures and corresponding low DO that leaves the Industrial park propagates this water quality 3,000 to 5,000 feet downstream in the main stem of Hart Brook before temperatures decrease and DO rebounds to acceptable levels around HB-3 (75% saturation, 7.0 mg/L). Increase in DO in these downstream areas above HB-3 is likely aided by shading creating lower temperatures and steeper slopes and aeration as water cascades over the rocky substrate.

Excessive nutrients in the stream, such as nitrogen and phosphorus, can contribute to excessive algae and plant growth. The concentration of nitrogen measured in Hart Brook was less than 1 mg/L. There are no regulatory standards for Nitrogen in surface water. Phosphorus has a draft MDEP guideline of 0.03 mg/L Total Phosphorus along with several other criteria to assess impairment including algal cover, water column chlorophyll a, Secchi disk depth, patches of bacteria and fungi, pH, dissolved oxygen, and aquatic life criteria. Average Phosphorus in Hart Brook for 2016-2017 exceeded this guideline. Phosphorus ranges from 0.001 – 1.66 mg/L and has been exceeded at all locations over the two years data has been collected, especially at summer baseflow levels.

Heavy algae growth possibly due to nutrients and temperature as observed at HB-4 may contribute to oxygen input during the day but can also contribute a significant load of organic matter that when decomposed in the stream can cause a reduction in DO at night. Morning and afternoon measurements of DO were completed three times each in 2011, 2016 and 2017. In general, DO was higher in the afternoon due to photosynthesis of algae adding oxygen during daylight hours. The decrease overnight seems to indicate that night time respiration or decomposition of organic solids (manmade or natural) is occurring and using more DO than plants can place in the water during daylight photosynthesis. In 2016 and 2017 the diurnal variations were observed primarily along the main stem of Hart Brook in the Lower and Industry sub watersheds ranging from 1-4 mg/l between morning and afternoon. Low DO is especially evident in the Industry sub watershed at sampling location HB-4 where daytime DO is already significantly below regulatory standard and the effect of the low DO propagates over one mile downstream past HB-3 and HB-2.

4.5.4 Specific Conductance/ Chloride

4.5.4.1 Specific Conductance

Specific conductivity is an indicator of total dissolved solids in water and is specifically relevant to indicating potential chloride from road salt. For streams, EPA's recommended acute (instantaneous level) criteria for chloride is 860 mg/L and chronic (long-term) criteria is 230 mg/L. Although there is no standard for specific conductivity, a specific conductance versus chloride relationship was created for Hart Brook (see Appendix H). MDEP agrees that for Hart Brook that specific conductance readings over 1000 µs/cm are approaching chronically toxic levels.

In 2016, specific conductivity was manually measured up to 14 times at up to 9 locations in a season at base flow, twice under storm flow conditions, and continuously at four locations (HB-1, HB-2, HB-3 and HB-8). Stormwater runoff was only able to be measured in June 2016 due to difficulties in capturing a runoff event.

In 2017, specific conductivity was manually measured up to 10 times at up to 10 locations in the season at base flow only, and continuously at four locations (HB-1, HB-2, HB-4 and HB-7).

The highest values measured manually occur in the main stem areas downstream of the industrial park and commercial areas, but most evident below the more traveled roads (e.g. Lisbon Street Route 196 and the Maine Turnpike Interchange area) that likely use more salt. No values exceeded the Hart Brook site specific conductance levels of 3,000 µS/cm that correlate to EPA's acute (instantaneous) chloride standard of 860 mg/L as shown on the Chloride vs Specific Conductance shown in Appendix H. However, some exceed or bordered on chronic levels at the site-specific conductivity of 1,000 µS/cm, which could have a long-term impact to aquatic life. The highest specific conductivities at non-runoff conditions were observed during the summer months July-September at base flow conditions but were still well below acute levels. This may indicate a large percentage of the previous winters salt flushes out of the system early in the spring, but that residual still resides in groundwater. At this time, the specific conductivity values are below acute levels that have immediate effects on aquatic organisms, but there could be long term impacts if the levels become consistently elevated (chronic).

4.5.4.2 Chloride

The level of chloride observed in Hart Brook from 2015 to 2017 ranged from 9.5 to 330 mg/L. For streams, the acute (instantaneous level) criteria for chloride is 860 mg/L and chronic (long-term) criteria is 230 mg/L. Chloride versus specific conductance have been plotted for data from 2015-2017 and seem to correlate with an R^2 of 0.85 (**Appendix H)**. Additional data may allow for development of a regression equation so that chloride concentrations can be estimated using specific conductivity field measurements. Road salt is likely contributing to the elevated specific conductance and TDS levels evident at base flow when stream flow is comprised primarily of groundwater discharge. Flow rate measurement and stage data monitoring over a period of several years is needed to

assess mass loading of chloride and TDS to Hart Brook, which should allow the determination of trends in chloride and TDS.

4.5.5 Metals

Heavy metals were not detected in significant concentrations in Hart Brook under base flow or stormwater runoff in 2016 and do not appear to be a significant contaminant of concern (COC) at this time. They were not sampled for in 2017.

4.5.6 Petroleum Hydrocarbons

Petroleum Hydrocarbons were not detected in significant concentrations in Hart Brook in base flow or stormwater runoff in 2016 and do not appear to be a COC at this time. They were not sampled for in 2017.

5.0 | IDENTIFICATION AND CAUSES OF IMPAIRMENT

Hart Brook is an impaired urban stream that has been affected by manmade alterations and increased impervious surface for over sixty years. The MDEP estimated impervious surface area is 22% of the watershed. The stream stability and habitat have been impacted from increased stormwater runoff from impervious surfaces throughout the watershed. The major source of the increased flows are the heavily developed portions of the upper watershed that contribute large volumes of stormwater runoff including Old Lisbon, Industry, and Interchange Subwatersheds. MDEP states in the 2013 Hart Brook Total Maximum Daily Load (TMDL) Assessment that to support Class B aquatic life, Hart Brook may need to have the characteristics of a watershed with 8% impervious surface.

Impacts to water quality are documented for temperature, DO, bacteria and nutrients with the major sources being the heavily developed Old Lisbon, Valley, Industry and Interchange Subwatersheds. The impacted water quality starts in the headwaters of Hart Brook and propagates downstream through approximately 50% of the watershed. The following summarizes the causes of impairment. A summary of the impairments by subwatershed are shown in Table 2.

5.1 Dissolved Oxygen, Temperature and Nutrients

As noted in **Section 4.5**, the low DO in headwater streams in Valley and Old Lisbon Subwatersheds are likely due to the high percentage of groundwater which naturally makes up their flow. However, these low DOs are significantly exacerbated in the Industry area by increases in temperature during summer months due to lack of shade and concrete channels designed for stormwater runoff that result in shallow flow at base flow. This increased temperature causes decreased DO holding capacity of the water (saturation) and concentration. In addition, DO levels are further impaired from excessive growth and associated nighttime respiration of algae from nutrients such as phosphorus or nitrogen from stormwater, wastewater, fertilizers or natural organic waste (leaves grass clippings). The effects of these conditions are impacting almost one half of upper portion of Hart Brooks temperature and DO.

5.2 Bacteria

E. coli has been observed in Hart Brook throughout the watershed. This may be an indicator of nutrient loading to Hart Brook that is affecting DO levels from biodegradation. The source may be a combination of underground leakage of sanitary sewer pipes and potential runoff from pet waste especially in the Valley subwatershed residential areas.

5.3 Road Salt/ Conductivity/ Chloride

Historical and continued use of road salt have caused chloride to enter the system from both surface and groundwater flow. Runoff from winter salt application on state highways, municipal roads, and private driveways cause elevated chloride in the early winter and late winter/early spring runoff period. These flows have not been studied but likely have higher concentrations of salt (chloride) . Late Spring (May) to Fall (November) monitoring periods did not measure specific conductivity values at the acute level (instantaneous impact to aquatic life). However, the specific conductivity readings at baseflow suggest that road salt (chloride) may be also entering the system during the summer months from

groundwater discharge. These elevated specific conductivity levels observed in the stream during base flow conditions border on a chronic impact to aquatic life (long term effect). Continued monitoring of water quality parameters especially by datalogger (**Section 8.0**) is recommended to better understand the potential impact and trends of road salt in Hart Brook.

5.4 Stream Channel Impacts

Hart Brook has been significantly altered by straightening of channels, conversion from natural substrates to concrete channels, road and railroad crossings, and complete relocation of the stream for sewer installations. This has led to a stream channel that behaves unnaturally to stormwater runoff and is not stable resulting in significant erosion and deposition that affects habitat and water quality. During stormwater runoff the brook cannot access the flood plains to slow down and modulate flows thus creating additional erosion. In some cases, the brook has become isolated from the floodplain by manmade berms from channel modifications (Interchange area upstream of railroad culvert) as shown on **Figure 5**. In addition, even the natural substrate brook has in many areas become wide with steep high banks that at baseflow results in shallow flow with low velocity that is susceptible to increased temperature and decreased DO.

Table 2 | Summary of Impairment by Subwatershed

Subwatershed	Industry	Interchange	Valley	Lower	Old Lisbon	Goff Brook
Sampling Locations	HB-4 HB-6		HB-7 HB-9A HB-9B	HB-1 HB-2 HB-3	HB-8	HB-5
Watershed Area	487ac	342ac	396ac	376ac	279ac	229ac
Dissolved Oxygen	X^{46}	Unknown	X^{9}	X^{23}	X^{8}	
Temperature	X^{4}	Unknown			X^{8}	X
Nutrients	X^{46}	Unknown	X^{79}	X^{123}	X^{8}	X^{5}
Bacteria	X^{46}	Unknown	X^{79}	X^{123}	X^{8}	X^{5}
Chloride/ Conductivity	X^{46}	X		X^{23}	X^{8}	
Stream Channel Geomorphology	X^{46}	Unknown		X^{9}	Unknown	X^{9}

X^{46} Impairment at sampling location HB-4 and HB-6

6.0 | POLLUTANT LOAD REDUCTION SOLUTIONS

To develop the most effective and targeted restoration plan possible, this plan explores both structural and non-structural solutions to address the issues affecting watershed's health.

6.1 Structural Solutions

Efforts should focus on reducing and controlling peak runoff through storage/ infiltration and detention projects that reduce runoff of contaminants, and lower stream flow and velocities. In addition, improvements to roadside erosion control, stream channel morphology and shading in the Industry area could provide significant benefit to improvement of aquatic habitat and water quality not just in the subwatershed but also in the downstream Lower Subwatershed. The structural solutions and channel improvements are listed in **Table 3** and shown on **Figure 5.** The solutions identified in the upper watersheds (Industry, Valley and Interchange) that provide detention or infiltration of stormwater should provide the greatest benefit in reducing peak runoff and providing better stream habitat. Alternatives to infiltration of salty water will be considered in areas which show signs of higher or increasing chloride in baseflow conditions.

While no structural solutions for the Interchange sub watershed are listed in the Table 3 Structural Solution Summary, this developed area will be further evaluated through the monitoring program and site walks to determine if structural treatment opportunities are warranted and available.

Table 3 | Structural Solution Summary

Structural Code[1)]	Description	Location
1	Stormwater Bioretention Filters	Industry Sub-watershed, two locations South End of Saratoga Street and along Forrestal Street
2	Concrete Channel Conversion	Industry Sub-watershed from Westminster Southeast to Saratoga and northeast along Saratoga
3	Tree Plantings to Reduce Solar Heating.	Industry Sub-watershed from tree line northwest of Westminster, Southeast to Saratoga and northeast along Saratoga Street
4	Shoulder Erosion Reduction	Valley Sub-watershed, Industry, Lower Roadway Shoulder Erosion Reduction,
5	Floodplain Berm Removal	Interchange Sub-watershed, between Lisbon Street southeast on ramp and railroad tracks
6	Culvert Upgrades	Interchange Sub-watershed, between Lisbon Street southeast on-ramp, passing under railroad tracks.
7	Combined Sewer Overflow	Goff Sub-watershed, possible separation, detention or infiltration solution.

1) Structural Code is used on Figure 5 to show the proposed structural solution location

Development of the structural solutions related to the natural channels and the concrete

channels could require some targeted geomorphologic analysis near the Industry and Interchange sub watersheds. The goal of this analysis should be to develop plans to restore the concrete channel to a more natural state and restore access to some natural floodplains for stormwater detention.

HydroCAD software and treatment effectiveness of proposed biofilters was used to calculate estimated pollutant load reductions to the brook from recommended bioretention and shoulder erosion reduction BMPs (Table 4). See Section 4.2 Initial Pollutant Load Estimates for a description of the HydroCAD analysis which was completed as part of the 2014 WMP. Estimated load reductions are for total suspended sediments (TSS) and total phosphorus (TP). Estimates of lineal feet addressed were made for the conversion of concrete channel and tree plantings. Floodplain berm removal, culvert replacement and combined sewer overflow BMPs are not included in this analysis as further fluvial geomorphic and engineering design are needed to estimate pollutant load reductions.

Table 4 | Pollutant Load Reductions

Location	Structural BMP	Load Reduction (lbs/year)		Linear feet addressed (ft)
		TSS	TP	
Forrestal Street	Biofilter	308	0.46	N/A
Saratoga Street	Biofilter	510	0.96	N/A
Goddard Rd	Shoulder Erosion Reduction	4000	1.68	800
Valley Sub-watershed	Shoulder Erosion Reduction	125	0.05	600
Lower Sub-watershed	Shoulder Erosion Reduction	125	0.05	600
Industrial Park	Concrete channel replacement/retrofit	N/A	N/A	3400
Industrial Park	Shade tree planting	N/A	N/A	3400
Total		**5,068**	**3.2**	**8,800**

6.2 Ordinances and Site Design Guidelines

The following is a summary of the City Site Design Guidelines and Ordinances which were initially identified in 2008 and continue to be promoted or enhanced to improve stormwater management opportunities within the Hart Brook watershed and the City. The City performed a review of the ordinances and guidelines in 2018 and continues to make improvements with input from the watershed working group.

Urban Design Objectives

- Streetscape and front setback landscape enhancements can be integrated with stormwater management systems. Development that can integrate streetscape landscapes with stormwater management systems should be encouraged.
- Encourage less direct access to area roadways as good traffic control and stormwater practice. Access roadway impervious areas can generate untreated overland stormwater flow to the roadway storm sewer system. Minimizing or discouraging multiple access curb cut areas reduces traffic congestion and minimizes untreated impervious surface runoff drainage to the MS4.

Consideration should be given to addressing stormwater run-on from private access roadways to the public right of way in curb-cut access permitting. Private drainage areas allowed to drain to the MS4 without treatment should be minimized.

Design Criteria and Planning

- Integrate stormwater Low Impact Development (LID) language into the "visual" breakup of parking areas. Promote the use of islands as landscaped bioretention filter or depression storage features (see example below). Consider requiring parking islands to run across parking area slopes instead of along slopes. Treatment in island bioretention systems are more functional if designed across slopes.

On-Site Circulation

- Permeable pavements should be encouraged for parking or driveway areas that are not likely to be heavily salted. Improve roadway and parking design requirements in ordinances to allow for the development of pervious pavements, particularly as overflow parking.

On-Site Walkways

- Planting strip esplanades between the roadway and walkway provide a potential location for stormwater water quality filters. Proprietary filters of this type are being manufactured by Filterra® (www.filterra.com) and others. Consider this type of stormwater management system in esplanades for treatment of roadway runoff or for treatment on small, highly developed impervious parcels, particularly in the Highway Business zone. Consideration should be given in the design as to whether infiltration should be promoted for this method dependent on whether salt infiltration is a concern.
- The use of heated walkways can be promoted in some areas especially those with adjacent buildings to minimize salt use.

Stormwater Management

- Adjust language to encourage the direction of small areas of stormwater runoff to buffers and green space in order to promote infiltration as opposed to encouraging the routing of stormwater to piped drainage systems, unless area will be heavily salted.
- Adjust language related to detention of 25-year storm to "only if necessary" to protect infrastructure from downstream flooding. Currently, flooding is not a significant problem on Hart Brook. The stormwater management priority in Hart Brook should be on providing water quality treatment (1-inch rainfall retention and filtration) in areas that are largely resilient to large flooding effects. This requirement should be easier for developers to comply with and could save valuable land for other uses.
- Evaluate whether setback requirements are needed for snow plowing storage areas from streams and drainage structures.

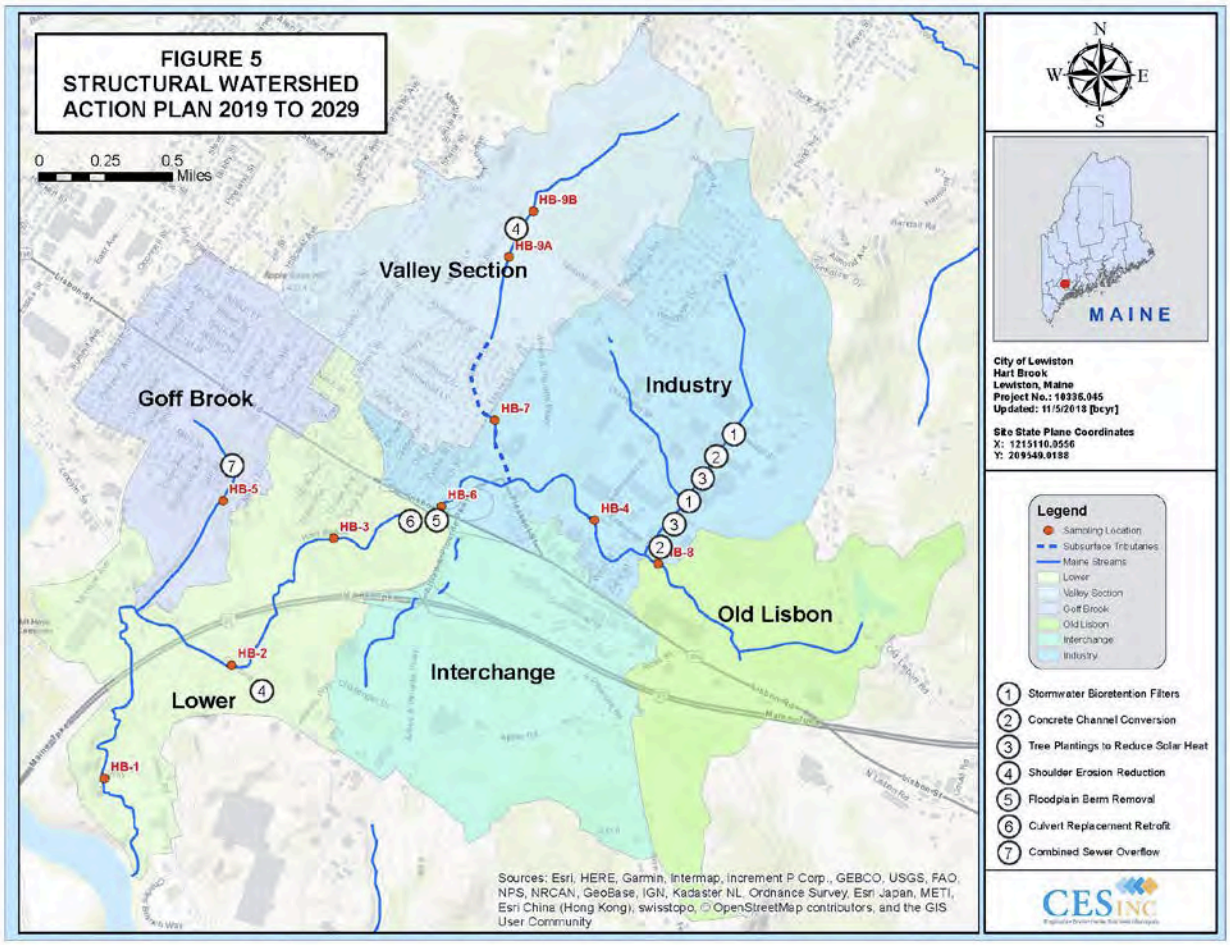
FIGURE 5
STRUCTURAL WATERSHED
ACTION PLAN 2019 TO 2029
0 0.25 0.5 Miles
Valley Section
Goff Brook
Industry
Old Lisbon
Interchange
Lower
HB-9B
HB-9A
HB-7
HB-5
HB-6
HB-3
HB-4
HB-8
HB-2
HB-1
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
N
W
E
S
MAINE
City of Lewiston
Hart Brook
Lewiston, Maine
Project No.: 10336.045
Updated: 11/5/2018 [bcyr]
Site State Plane Coordinates
X: 1215110.0556
Y: 209549.0188
Legend
Sampling Location
Subsurface Tributaries
Maine Streams
Lower
Valley Section
Goff Brook
Old Lisbon
Interchange
Industry
1 Stormwater Bioretention Filters
2 Concrete Channel Conversion
3 Tree Plantings to Reduce Solar Heat
4 Shoulder Erosion Reduction
5 Floodplain Berm Removal
6 Culvert Replacement Retrofit
7 Combined Sewer Overflow
CES INC

- In areas that will likely receive water from heavily salted areas (parking lots, major roads, turnpike exits), ensure stormwater management structures and BMPs are lined to prevent infiltration of salty stormwater.
- In areas where the groundwater is, or is likely to become, contaminated with chloride, infiltrate as much relatively clean roof runoff as possible to provide dilution.

General Parking

- Satisfactory language about "breaking up" parking areas. Add language that would consider using the areas created in the disaggregation of parking areas for water quality treatment systems.
- For large parking lots with seasonal demand (i,e. Christmas), consider having methods for blocking off the parking areas during low demand months (January to Mid-April) so sand and salt and plowing are not needed.
- Allow curb breaks for drainage and provide design guidelines to allow stormwater access to landscaped islands and vegetated setback areas.
- Encourage the use of compact car parking spaces to minimize impervious areas. Consider adjusting parking requirements by zone based on most recent parking research in the Parking Generation report by the Institute of Transportation Engineers (ITE, 2010).
- Consider reducing 'minimum' parking space standards to allow developments to create less impervious parking area if not necessary.

Over the next 10 years, the City should continue to upgrade planning review related to water resource protection of Hart Brook including:

- Site Plan Review and Guidelines,
- Development Review and Standards,
- Comprehensive Plan,
- Code of Ordinances, and
- Specific Zone Requirements.

Specific zone requirements might include an overlay district for Hart Brook with special stormwater management requirements for small commercial sites (<1 acre disturbed) and/ or for all commercial redevelopment projects.

6.3 NPDES MS4 Program Solutions

The City currently complies with requirements of the Clean Water Act through an MS4 permit system. The following is a summary of activities that are recommended for the Hart Brook watershed for stormwater runoff improvement. Some of these activities are ongoing as noted in **Section 3.7**

- *Storm Drain Stenciling* – Prioritize this effort on the residential neighborhoods closest to Hart Brook and where stencils can be seen by residents. Issue door hangers to residential homes within the watershed describing the stenciling efforts and purpose.

- *Dry Weather Outfall Inspections* – Complete dry-weather outfall inspections of the Hart Brook watershed over five years with field sampling for chlorine, surfactants, and ammonia at outfalls where dry weather flows are observed.
- *Pet Waste Collection Stations* - Consider the development of pet waste collection stations with instructional signage in watersheds with residential neighborhoods and recreational facilities and trails.
- *CCTV Inspections* – Implement a CCTV inspection program for the storm drainage network within Hart Brook. CCTV inspection findings may include cross connections, illicit discharges, infrastructure failures, etc.
- *Annual Catch Basin Cleaning & Street Sweeping* - Continue municipal catch basin and street sweeping programs in the watershed. Utilize high-efficiency vacuum sweepers during summer sweeping when street pollutant loads are primarily comprised of fine particulates.
- *Focus MPDES Education Requirements on Hart Brook* – Develop awareness and/or behavior change campaigns for the commercial and/or residential audiences within the Hart Brook watershed.
- *Increase Erosion and Sediment Control Inspections in Hart Brook*- Increase frequency of inspections in Hart Brook. Consider the development of a Lewiston-certified contractor program similar to the Town of Cumberland and require or incentivize use of an erosion control certified contractor. Work with MDEP and others to develop training for certification of local landscapers, contractors and engineers on BMP inspection and maintenance.

7.0 | WATERSHED ACTION PLAN

7.1 Maintain a Watershed Working Group

In order to implement the Hart Brook Watershed Action Plan, there is a need for a Watershed Working Group. The working group should provide program oversight assistance on the development of grant applications, identify financial incentives for improved stormwater management and support other critical efforts in the successful implementation of the plan.

The watershed working group should be led by a City Project Manager and comprised of City staff representing: engineering, public works, city arborist, planning, code and economic development. Key watershed stakeholders could include MDEP, members of civic organizations. Landowners relevant to the tasks outlined in the Hart Brook Watershed Action Plan should also be asked to participate. The Watershed Working Group should meet at least annually to review and implement action plan priorities.

Subwatershed Focus: All
Proposed Funding Source: City NPDES MS4 Program Budget
Cost Estimate: $20,000 over 10-years
Funding Rationale: Staffing and printing.
Schedule: First meeting Winter -Spring 2019 to review approved updated plan.

7.2 Structural Stormwater Improvements

The concentrated runoff from large impervious surfaces should be reduced to prevent heavy runoff that can cause erosion and carry off salt and other contaminants. As part of a focused effort to improve the impacts from the Industry area to a significant portion of Hart Brook downstream, two bioretention filters are planned for the Industrial Park off Forrestal and Saratoga to detain and treat impervious surface. These installations need to be coordinated with roadway paving projects on these roads in 2021 and 2022. Additional structures may be added as opportunities are identified through evaluation and interaction with commercial and industrial landowners.

Subwatershed Focus: Industry
Proposed Funding Source: Section 319 Clean Water Act Funds, MaineDOT Surface Water Quality Protection Program and other grants.
Cost Estimate: $500,000
Funding Rationale: Previous construction costs Webster Street 2017
Schedule: Summer 2021 and 2022

7.3 Stream Channel Improvements

The concentrated runoff from large impervious surfaces creates heavy runoff that causes erosion and deposition that have created channels that are wide with steep banks downstream of the Industry Subwatershed and continue in other downstream sections. A geomorphic analysis of the Industry and Interchange area are needed to evaluate options for removing or retrofitting the concrete channel and evaluating floodplain restoration options adjacent the on-ramp to the Maine Turnpike Interchange at Lisbon Street. Other

downstream sections of the watershed may be evaluated and prioritized for future improvements and stabilization.

Subwatershed Focus: Industry
Proposed Funding Source: Section 319 Clean Water Act Funds, MaineDOT Surface Water Quality Protection Program and other grants.
Cost Estimate: $1,000,000 (estimate for concrete channel improvements only)
Funding Rationale: Engineers estimate.
Schedule: Geomorphologic analysis 2019-2020, improvements 2021-2029

7.4 Shade Tree Planting

Upper Hart Brook, within the Industry sub watershed, flows through a concrete-lined channel for over 3/4 of a mile before returning to a "natural" floodplain. The concrete channel contributes to temperature increases, as documented in the Hart Brook watershed assessment, and as noted by reductions in Dissolved Oxygen that contribute to overall stream impairment. Because of these impairments at the headwaters of Hart Brook, the downstream impact greatly affects the water quality throughout half the watershed due in large part to high stream temperatures in summer months

To maintain temperatures of stream water through the concrete-lined portion of the stream, planting of shade trees along the channel is being investigated along with stream channel improvements A shade tree planting program would need to be done without compromising the integrity of the concrete channel. Fast-growing trees such as poplar or birch will be considered for the planting plan. The planting plan should be provided for review to landowners and adjacent property owners. Lewiston is a Tree City with established tree planting policies and it is assumed that the City arborist would oversee this action item. A landscape plan and shade tree planting also has the added benefit of improving aesthetics in the Industrial Park.

Subwatershed Focus: Industry
Proposed Funding Source: Compensation Fee Utilization Plan or Project Canopy Grant program.
Cost Estimate: $25,000
Funding Rationale: Development of landscape planting plan, public meetings, purchase of trees, planting along concrete channel and first year maintenance.
Schedule: 2020-2029 coordinated with concrete channel replacement/ retrofit

7.5 Sanitary Sewer Assessment and Lining

The Hart Brook watershed contains over 56,000 linear feet of sanitary sewer that is over 25 years old. As sanitary infrastructure ages, the likelihood of pipe failures, open joints and leaks increase and the potential exists for migration of sanitary sewage to the stream. Over 19,000 linear feet of sanitary sewer is within 75 feet of the mainstem of Hart Brook. Additionally, numerous stream crossings by sanitary sewer may increase the likelihood of sewer leaks due to stream erosion and undermining of concrete abutments and sewer supports. Existence of cracks in the sanitary sewer lines adjacent Hart Brooks have been documented as part of the Hart Brook study since 2006. Detection of E. Coli throughout the Hart Brooks watershed indicate the potential for sanitary sewer impacts from pipe or

manhole leakage to groundwater. In addition, large daily fluctuations of dissolved oxygen within Hart Brook indicate the potential for a source of nutrients which may be indicative of sanitary sewage contamination in the watershed.

The ongoing action under this item is an evaluation of sanitary sewer pipe within the Hart Brook watershed as part of the Citywide evaluations. The evaluation would include a pre-flushing and Close Circuit Television (CCTV) inspection of the sanitary sewer pipe to determine location, size and severity of existing cracks and leaks. Based on a risk evaluation matrix, lining projects are then prioritized and implemented annually. Lining of potentially leaking sections within 200 feet of Hart Brook is a priority for the WMP especially in the following areas:

- Valley Sub Watershed, Webster St. and Swale Lane areas,
- Industry Sub Watershed, Westminster St., Enterprise St. and Saratoga St. areas,
- Lower Sub Watershed, Olive Lane area, and
- Goff Brook Sub Watershed, Morningside St. and Goff Ave. area.

Subwatershed Focus: All
Proposed Funding Source: City Capital Improvements Plan (CIP) Budget.
Cost Estimate: $200,000 for Evaluation Annually.
Funding Rationale: Estimates based on current sewer line inspection program
Schedule: Ongoing

7.6 Town Roadway Erosion Reduction

Numerous roadways within the Hart Brook watershed have excessive shoulder erosion. To reduce stormwater runoff and sediment transport to the stream and to improve area aesthetics, the City should continue to address shoulder erosion through maintenance and long-term solutions. Specific areas of concern are along Goddard Road, Webster Blvd. at the Hart Brook crossing (Valley Section) and along the roadways within the Industrial Park. Goddard Road is the highest priority due to chronic maintenance problems that injects significant flow and sediment into Hart Brook in the area upstream and downstream of HB-2 as shown on **Figure 2**. Shoulder stabilization could be accomplished through some curbing with periodic curb breaks or cutouts to route gutter stormwater flow to road right-of-way for dispersion and natural infiltration, and/or other stormwater detention or filters prior to reaching a catch basin inlet

Road shoulder and ditch stabilization should follow guidance from the MaineDOT Best Management Practices manual and would include grading, turnouts, crushed stone stabilization and/or shoulder paving if necessary. Potential integration with identified road-edge stormwater retrofits may be possible in many locations and would be preferred if new pavement and curbing are implemented as a part of shoulder improvements.

Subwatershed Focus: All
Proposed Funding Source: City Highway Department maintenance budget and MaineDOT Surface Water Quality Protection Program.
Cost Estimate: $150,000 over 10-years
Schedule: 2019-2029

7.7 Roadway Pavement Management

The Hart Brook watershed contains over 36 miles of roadway. This includes 21 miles of city-owned roadway and 15 miles of state or state-aid roadways of which five miles is operated and maintained by the Maine Turnpike Authority. Roadway impervious surfaces cover 7% of the watershed area. Roadways have been shown to generate some of the highest stormwater generated pollutant loads in national research but opportunities for installing structural stormwater management practices are often limited due to narrow right of way, adjacent sidewalks and other utility constraints.

To reduce the potential for pollutant loading from roadways, enhanced management is necessary and should include targeted pavement sweeping and catch basin cleaning. Pavement sweeping is estimated to be 10 times less expensive than catch basin cleaning and is therefore a value-added activity. Pavement sweeping for stormwater pollutant reductions must be accomplished by using the best available vacuum or regenerative air technologies. The conventional method utilizing mechanical broom sweepers can provide removal of heavy particles, operate in wet conditions and reduce catch basin cleaning but do very little for stormwater pollutant loads which are primarily attached to fine particles. Research in the Chesapeake Bay area has documented that with the appropriate street sweeping equipment, total suspended sediment (TSS) can be reduced by approximately 16-32% in a watershed through a targeted pavement sweeping program ranging from weekly to monthly (Center for Watershed Protection, 2006).

Currently, the Hart Brook watershed is not a specific focus area for street sweeping programs, but the City has upgraded their street sweeping equipment and protocols over the last 10-years (see **Section 3.6**) which is utilized in the Hart Brook watershed for stormwater pollutant reductions. The targeted sweeping program should include the following:

- Sweeping of roads to remove debris and winter sand will be performed in the late Fall after most leaf drop and as soon as possible in the spring following snowmelt. The Hart Brook watershed roads would be a primary focus area and swept at least monthly from Spring to Late Fall as well as when heavy accumulation is observed.
- Sweeping for winter sand should include a single pass with a mechanical broom for heavy particles and a second pass with a vacuum sweeper.
- Early summer sweeping of all area roadways after spring tree seed and flower drops.
- Late summer sweeping after extended dry periods on targeted roadways that are directly connected impervious areas and carry large volumes of traffic, including but not limited to Route 196, Industrial Park roadways and Pleasant Street.
- Fall sweeping after leaf drop.

Pavement best management practices should continue to include catch basin cleaning which is already an annual activity by the City.

Subwatershed Focus: All
Proposed Funding Source: City Highway Department maintenance budget.
Cost Estimate: $100,000 Annually

Funding Rationale: Additional spring, summer and fall sweeping would require additional staffing and equipment use by Highway Department. Estimate is based on miles of highway within watershed and sweeper use miles of roadway per day (one to three miles per day). Cost estimate is based on city staff, equipment charges and annual maintenance on sweepers, dump trucks and water wagon
Schedule: Annually

7.8 Summer Intern Program

The City currently employs interns each summer to assist in the implementation of various public works activities. The Hart Brook Watershed Action Plan, NPDES MS4 permit compliance and other stormwater-related activities could require an increasing level of effort from City staff for implementation.

Summer interns provide valuable support for the implementation of the Hart Brook Watershed Action Plan. Specifically, interns perform water quality monitoring, storm-drain stenciling, Yardscaping and other community outreach, shade tree planting, and stormwater BMP inspections among others. The Watershed Working Group should continue to explore opportunities for partnerships with Bates College, the University of Southern Maine-Lewiston/Auburn and Central Maine Community College as a source of summer interns and possible cost-sharing initiatives.

Subwatershed Focus: All
Proposed Funding Source: City NPDES MS4 Program Budget and/or grants including the Davis Conservation Foundation and John Sage Foundation, among others.
Cost Estimate: $30,000 over 10 years
Funding Rationale: Staff administration and oversight with support from project consultant, intern salary, initial grant writing effort, trainings and grant reporting.
Schedule: Program development Winter -Spring 2019. Intern starts Summer 2019

7.9 Private Commercial Facility Owner Outreach Program

The Hart Brook watershed assessment identified large impervious commercial and industrial facilities as likely sources of stormwater pollutants. Parking areas and rooftops occupy approximately 12% of the watershed land area and a large percentage of this is in commercial or industrial ownership. There are approximately 825 properties within the industrial and commercially-zoned portions of the watershed.

To continue to develop and redevelop within this watershed it will be critical for the Watershed Working Group to provide information to private facilities on methods for management of stormwater runoff at their facilities and to identify grant opportunities and incentives for the structural retrofitting of infrastructure for water quality improvements.

The outreach to commercial and industrial landowners in the watershed should be led by the Watershed Working Group and include the following activities.

- Compile mailing lists for commercial and industrial landowners within the watershed. Obtain contact information for facility managers.
- Work with Lewiston-Auburn Economic Growth Council to develop an initial mailing providing specific information on the Hart Brook watershed and the economic importance of actions to reduce pollutant loads and thermal pollution of the brook. The initial mailing could provide specific information on non-structural facility management such as; vacuum pavement sweeping, alternative deicers, low or no fertilizer and toxics landscape management, appropriate pavement sealants, and snow removal and storage strategies and a list of local contractors providing these services.
- Develop a list of properties with structural retrofit potential. The list should include sites that are likely contributing the most to the stressors in the stream and plans on how to encourage addressing the highest impact sites.
- Initiate site walks on properties identified with structural retrofit potential to discuss opportunities for including stormwater management retrofits through capital improvements. Opportunities for financial incentives and grant writing support could be outlined for landowners.
- Work with interested landowners to develop financing and technical strategies for implementation of non-structural and structural stormwater best management practices.
- Maintain contact with facility owners through regular email updates concerning trainings/workshops, grant opportunities and "stormwater friendly" landscape and pavement management contractors.

Subwatershed Focus: All
Proposed Funding Source: City NPDES MS4 Program Budget and grant funding. The possibility of incentives through the Stormwater Utility Fee Credit System should also be explored.
Cost Estimate: $20,000 over 10-years
Funding Rationale: Staff administration for development and production of mailings, postage, mailing costs, site walks (assume 10 properties), consultant fee for technical support, development of specific financing strategies for interested landowners and periodic email updates.
Schedule: Initial mailing Spring-Summer 2019. Site visits starting 2020.

7.10 Yardscaping Outreach and Education

Residential, commercial and industrial landowners manage over 428 acres of lawn within the Hart Brook watershed (22% of the watershed area). The potential for fertilizer, pesticide and herbicide migration from these managed surfaces into Hart Brook is high, particularly in the Valley Section, Industry and Goff Brook sub watersheds, where lawn makes up a significant portion of the sub watershed areas. A focus could initially be on abutters to Hart Brook and then the larger watershed community.

In an effort to reduce the potential for nutrient and toxics of Hart Brook it could be important to reduce or eliminate the use of fertilizers, pesticides, and herbicides on watershed lawns, reduce the potential for erosion from these surfaces, improve soil condition within lawn areas to maximize rainfall infiltration and evapotranspiration and create opportunities for shallow storage and evaporation of small rainfall events in constructed raingardens within lawn areas. Yardscaping programs are being successfully implemented at the State-level through the Maine Board of Pesticide Control and locally through the University of Maine Extension and the Androscoggin Valley Soil and Water Conservation District (AVSWCD).

Subwatershed Focus: All
Proposed Funding Source: City NPDES MS4 Program Budget and MDEP 319 grants.
Cost Estimate: $20,000 over 10-years
Schedule: Initial mailing Spring-Summer 2019

7.11 Watershed Monitoring Program

The monitoring of water quality and quantity data for Hart Brook should be continued annually to document the status of Hart Brook in relation to meeting Class B Standards and to measure progress from structural and non-structural stormwater improvements over the next 10 years. Working with the MDEP, the City plans to continue a watershed monitoring program in cooperation with the VRMP and MDEP Biomonitoring Unit.

The initial watershed monitoring program should consist of periodic water quality sampling and analysis under base flow conditions during four sampling events (June, July, August and September) Samples should be collected at six to nine of the locations shown on **Figure 6**. At least 6 sets of samples should be collected for bacteria to facilitate the calculation of geometric means. A Sampling and Analysis Plan (SAP) should be developed annually following field data compilation and analysis and in consultation with MDEP for the next field season. Sampling locations may be reduced if water quality meets standards or new locations added if water quality standards are not met or other water quality issues identified. The sampling program should be developed in cooperation with the MDEP and follow the VRMP Quality Assurance Project Plan (QAPP). Water quality sampling would include Total Suspended Solids, Chloride, Nitrate, Phosphorus, and Bacteria (Total Coliform and E.coli). Morning and afternoon field parameter measurement should be done to determine diurnal variations in D.O. Continuous reading data loggers should be used at 1-4 locations (HB-1, HB-2, HB-3 and HB-4) to monitor stormwater runoff and temporal and diurnal impacts to water quality. Monitoring of D.O, Temperature, Conductivity and Stage should be done at each location. Additionally, a watershed monitoring program would include the development of a stage and discharge readings at a minimum of HB-1, HB-3 and HB-4. The establishment of stage-discharge curves at several locations throughout the watershed would allow measurement of stream flow rate, estimation of mass loading of contaminants for trend analysis and evaluation of rainfall runoff. An improved understanding of the stream's response to rainfall would allow for refined future modeling efforts. To reduce costs, the City could also continue to work with the Lewiston Auburn Water Pollution Control Authority to use their laboratory facilities for water quality testing.

Subwatershed Focus: All
Proposed Funding Source: City NPDES MS4 Permit Program Budget and grants.
Cost Estimate: $300,000 over 10- years.
Funding Rationale: Sampling personnel, equipment, and laboratory testing. Development of staff gage, stage discharge curve.
Schedule: June-September Annually

8.0 PUBLIC OUTREACH

The goal of public outreach is to develop partnerships around improving and restoring water quality within the Hart Brook Watershed. Under the original WMP, public outreach efforts included personal outreach through phone calls and emails to watershed stakeholders and representative community organizations, a regularly updated project website (www.ci.lewiston.me.us/stormwater/hartbrook/index.htm), a direct mailing to commercial property owners, two public meetings, public access TV announcements, and two press releases. In the past, outreach efforts have not garnered much public and private support. The revised public outreach efforts are focused on groups that have shown an interest or have the most potential for direct impacts or improvements to Hart Brook.

Website

There is a Hart Brook website that was hosted by the City to provide the public with reports and meeting minutes and Microsoft PowerPoint presentations from any meetings. Links should be maintained to provide readers with more information regarding stormwater management opportunities and ongoing projects.

Personal Contact

E-mails should be sent to key watershed property owners, conservation advocacy groups, transportation agencies and civic organizations. The following could contacted by email and/or phone dependent on the focus area in the watershed: Elmet Technologies, University of Southern Maine – Lewiston/Auburn, Androscoggin Land Trust, Androscoggin River Watershed Council, Androscoggin River Alliance, Pike Industries, L.L. Bean, Wahlco Metroflex, MaineDOT Region 1, Maine Turnpike Authority, White Rock Distilleries, Androscoggin Valley Soil and Water Conservation District, Ramada Inn, Allen-Edmonds, Holy Cross Church, Gendron and Gendron, and Saperson & Day. Phone calls should be done to determine the relevant contact for commercial/industrial facilities within the watershed.

Direct Mailings

A direct mailing could be sent to the over 300 watershed property owners within the “commercial” zones of the watershed. A mailed letter invitation should also be delivered to city council members representing areas within Hart Brook and the appropriate state representatives and senator. The mailing would be conducted to provide a brief overview of the project and its status and to invite the property owners to any public meetings.

Public Meetings

Any public meeting should be announced through a press release in the Lewiston Sun Journal and would be developed to provide an introduction to the Hart Brook watershed and an overview of the watershed management plan development process and status. The meeting would provide a forum for discussion of the history of the watershed and would hopefully facilitate discussion about the ways the business or citizen community could be involved in the plan and identified other organizations or individuals that should be invited into the process. Any meetings may also provide a mechanism to solicit involvement in the Watershed Advisory Committee.

9.0 MONITORING PLAN

Historical monitoring has been conducted in coordination with the MDEP VRMP with data collected by the MDEP, City and CES. The number of sampling locations increased from an initial five in 2011 to eight in 2015 and nine and 10 respectively in 2016 and 2017. Sample location descriptions are as shown in **Table 3** with the Site Code shown on **Figure 2**. In 2016 CES, Inc. (CES) added an additional sampling location downstream of Webster Street to provide background data upstream of the section of a tributary of Hart Brook that is buried in a culvert under the Swale Road neighborhood. Data from this location was planned to be used to evaluate whether significant nutrient loading of phosphorus or nitrates from lawn fertilizers or wastewater was occurring either from stormwater runoff or via leaching to groundwater and discharge to the brook. However, detection of E Coli just below Webster Street in 2016 led to the addition of another upgradient sampling location in 2017 to determine the source of the E coli.

TABLE 5 | HISTORIC SAMPLING LOCATIONS FOR FIELD PARAMETERS AND LABORATORY ANALYSIS

MDEP VRMP SITE ID	SITE CODE	SAMPLE LOCATION
Hart Brook-ADL04-VRMP	HB-1	Pike Industries
Hart Brook-ADL14-VRMP	HB-2	Goddard Road
Hart Brook-ADL19-VRMP	HB-3	Olive Street
Hart Brook-ADL28-VRMP	HB-4	Westminster Street
Hart Brook-ADLUA04-VRMP	HB-5	Morningside Street
Hart Brook-ADL23-VRMP	HB-6	Foch Street & Route 196
Hart Brook-ADLUB-02-VRMP	HB-7	Mitchel Street and Swale Lane
Hart Brook-ADL30VRMP	HB-8	Saratoga Street & Enterprise Street
Not Applicable	HB-9A	Downstream of Webster Street
Not Applicable	HB-9B	Upstream of Webster Street

Historical monitoring has consisted of field measurements of parameters including dissolved oxygen in both percent and concentration, specific conductance, and temperature. Analytical water quality data for Hart Brook includes coliform, E. coli, nitrates, phosphorus, Total Dissolved Solids (TDS), chloride, metals and petroleum hydrocarbons. Based on the results of stormwater and base flow sampling in 2016, an increased suite including metals and petroleum hydrocarbons did not appear to be an issue for Hart Brook and has been removed from the sampling plan.

A summary of the proposed monitoring plan and data quality objectives are included in **Table 5** in **Section 9.3.**

FIGURE 6

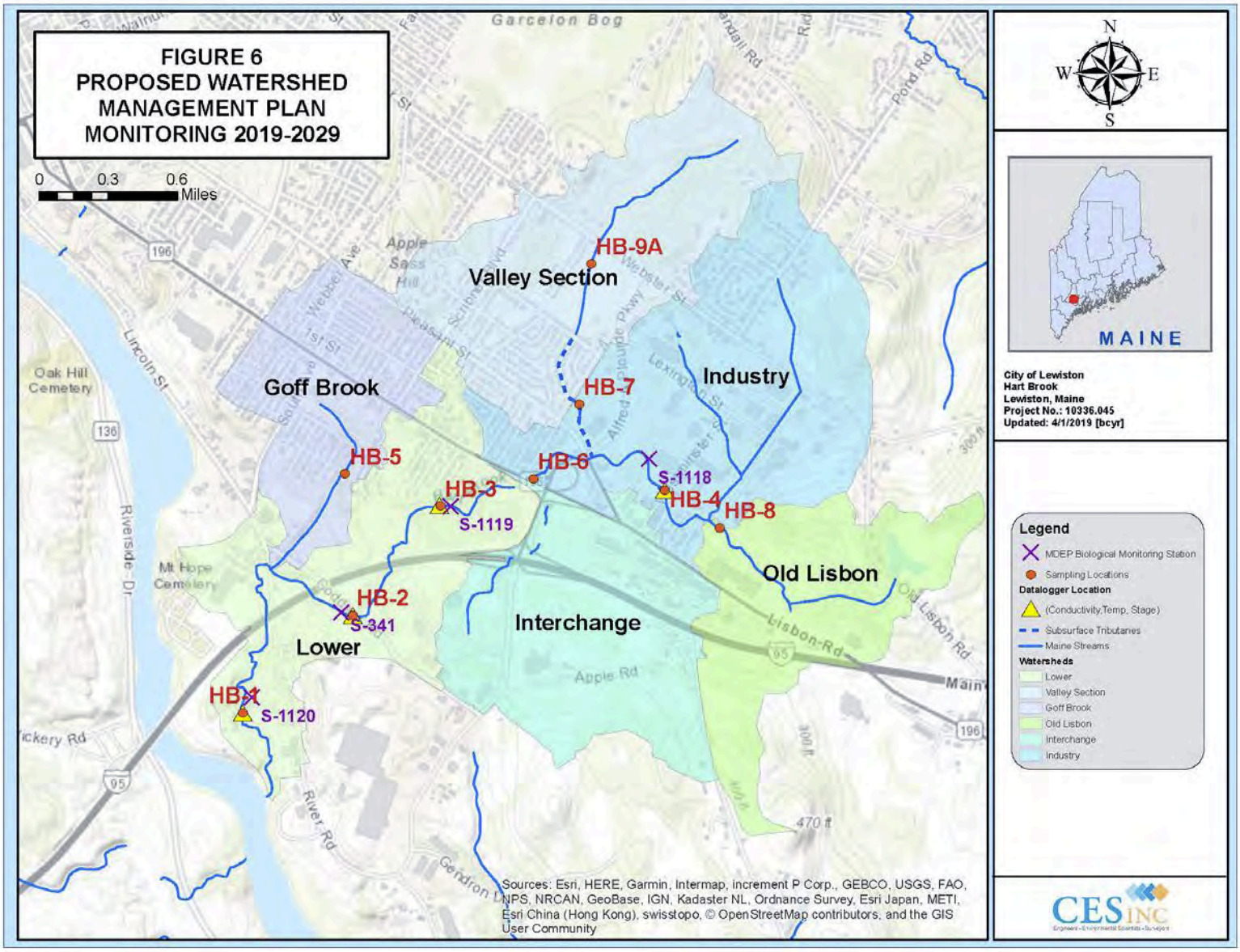
FIGURE 6
PROPOSED WATERSHED
MANAGEMENT PLAN
MONITORING 2019-2029
0 0.3 0.6 Miles
HB-9A
Valley Section
Industry
HB-7
Goff Brook
HB-5
HB-6
HB-3
S-1119
S-1118
HB-4
HB-8
Old Lisbon
HB-2
S-341
Lower
Interchange
HB-1
S-1120
Garcelon Bog
Oak Hill Cemetery
Mt Hope Cemetery
Apple Sass Hill
Lincoln St
Riverside Dr
Lisbon Rd
Apple Rd
River Rd
Old Lisbon Rd
Pond Rd
Webster St
Pleasant St
1st St
Lexington St
Alfred Plourde Pkwy
Gendron Ln
470 ft
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
N
W
E
S
MAINE
City of Lewiston
Hart Brook
Lewiston, Maine
Project No.: 10336.045
Updated: 4/1/2019 [bcyr]
Legend
MDEP Biological Monitoring Station
Sampling Locations
Datalogger Location
(Conductivity,Temp, Stage)
Subsurface Tributaries
Maine Streams
Watersheds
Lower
Valley Section
Goff Brook
Old Lisbon
Interchange
Industry

The objective of this Hart Brook Monitoring Plan are to monitor conditions in the brook to identify areas where surface water is not meeting water quality criteria and to measure progress in meeting Class B Classification and observe geomorphologic changes in the brook as stormwater controls and geomorphic improvements are made.

9.1 Macroinvertebrate Community

Currently MDEP's macroinvertebrate monitoring (or biomonitoring) program is the primary means used to assess whether Maine rivers and streams meet their designated uses. Benthic macroinvertebrates are useful indicators of the effects of a wide range of stresses on streams and are also used to determine whether Maine streams meet their aquatic life criteria. MDEP's past macroinvertebrate monitoring indicates that the stations in Hart Brook do not meet the Class B standards for aquatic life. Since benthic macroinvertebrate sampling is MDEP's primary indicator for 303(d) listing, future monitoring in the watershed should include additional MDEP macroinvertebrate monitoring including the new sites added in 2017. The City should request MDEP continue to monitor the three additional monitoring sites for a total of four in Hart Brook. Hopefully this will help to show improvements in Hart Brook sequentially over time in the watershed rather than relying on one location low in the watershed.

TABLE 6 BIOMONITORING PROGRAM SUMMARY

SAMPLE FREQUENCY	SAMPLER	NUMBER OF SITES	PROTOCOL	MDEP SITE NO.
Once every 5-years	MDEP	4	Rock bags	S-341 S-1118 S-1119 S-1120

9.2 Water Chemistry

An annual Sampling and Analysis Plan will be developed each year of monitoring, designed to answer specific questions about specific reaches and stressors. The proposed monitoring plan for 2019-2029 includes six field sampling events per year in the months of June, July, August and September at up to 9 locations as shown on **Table 5** and in **Figure 6**. At least 6 sets of samples will be collected for bacteria so that geometric means can be calculated. The measurements will be initially be completed during dry periods, but wet event sampling can be added in later years depending on the question the monitoring is aimed to answer. Samples at baseflow conditions will be collected before 8:30 AM for laboratory analysis of Total Suspended Solids, Chloride, Nitrate, Phosphorus, and Bacteria (Total Coliform and E.coli). Water quality parameters should also be measured in the afternoon of the sampling event day to observe for diurnal effects on DO levels from biodegradation. Water quality measurements for conductivity, temperature, dissolved oxygen, pH and stage will be recorded during each sample event or data download.

In addition, data loggers could be used to perform continuous monitoring of conductivity, temperature, dissolved oxygen and stage (HB-1, HB-2, HB-3 and HB-4). The stage monitoring should be combined with the flow monitoring in **Section 9.3** to develop stage discharge curves. Using flow and concentration data, mass loading in the stream can be calculated to determine trends in water quality parameters for use in additional tasks including stage discharge monitoring to track changes in stormwater runoff and track mass loading of contaminants to determine trends in water quality. Water chemistry parameters, including dissolved oxygen saturation (%) and concentration (mg/L), specific conductivity (µS/cm) and temperature (C Degrees) should continue to be monitored during datalogger downloads and two times per day (morning and night) on days of monthly sampling.

TABLE 7 | SUMMARY OF FIELD PARAMETERS, LABORATORY ANALYTICAL SAMPLES AND DATA QUALITY OBJECTIVES

MATRIX	PARAMETER	METHODS	STATE OR FEDERAL STANDARD
Field Parameters			
Surface Water	pH	YSI 556 multi-meter	RCRA Maine Surface Water Standards Class B Waterway
	Dissolved Oxygen	YSI 556 multi-meter	
	Specific Conductance	YSI 556 multi-meter	Maine Surface Water Standards Class B Waterway
	Temperature	YSI 556 multi-meter	Maine Surface Water Standards Class B Waterway
Laboratory Analysis			
Surface Water	E Coli Bacteria		**236 Instantaneous/ 63 Geomean**
	Chloride	Standard Method 2540D	N/A
	Total Nitrogen	USEPA Method 365.2	N/A
	Total Phosphorous	Standard Method 4500P-E	Draft Maine Freshwater Nutrient Criteria
	Total Suspended Solids	Standard Method 4500	N/A

9.3 Stream Flow and Channel Monitoring

1. Field staff should monitor stream hydrology conditions including stage and flow at three to four locations to be located based on geomorphologic assessments and observed changes to the stream profile over time. However, a minimum of 3 stage-discharge stations should be developed and maintained for the 10-year period in order to track changes in the watershed as improvements are made. Stage monitoring could be done by a surveyed staff gage and datalogger with a pressure transducer to record water height over the transducer, but other methods may be appropriate. Stream discharge could be calculated at each stage monitoring station using the cross-sectional flow method or hydraulic structures. Additionally, stream channel geomorphology conditions can be monitored to assess changes over the monitoring period. Examples of geomorphological stream channel conditions to monitor include width, depth profile, and presence or absence of habitat for invertebrates or fish. The location and detail of geomorphological monitoring should be determined during the proposed geomorphological assessment. Bank chains and pins, used for the initial geomorphological assessment, may be used in subsequent years to perform additional comprehensive analyses of sediment transport through the system. Photo points should be established at each monitoring site to track hydrologic and geomorphologic changes.

10.0 | MEASURES OF SUCCESS/ MEASURABLE INTERIM MILESTONES

Table 8: Measures Of Success/ Measurable Interim Milestones

	Interim Targets		
	2019-2021	2022-2024	2025-2029
Water Quality Benchmarks			
Reduction of Peak Temperature at HB-4 GOAL: Reduce Peak Temperatures at HB-4 from 28° C) to below 23° C	25% of goal (26° C)	50% of goal (24° C)	100% of goal (22° C)
Enhance macroinvertebrate type, abundance, and distribution. GOAL: Sample Sites on Average Meeting Class B Standards	0%	25%	50%
Structural Benchmarks			
Amount of Funding Secured for Structural Elements of plan implementation (include contributions from town, fees, donations, and grants) GOAL: $ 3,675,000.00	$1,102,500.00	$1,302,500.00	$1,270,000.00
Number of Areas Installed with Structural Retrofits (Biofilters) or Shoulder Erosion Reduction GOAL: 4-8 sites	Biofilter Forrestal Street. Removal of 308 lbs. TSS /year 0.46 lbs. P /year Goddard Shoulder Erosion Reduction 267 lf /year 4000 lbs. TSS/year 1.68 lbs. P/year	Biofilter Saratoga Street Removal of 510 lbs. TSS /year 0.96 lbs. P /year Annual Shoulder Erosion Reduction 200 lf. /year 125 lbs. TSS /year 0.05 lbs. P /year	Annual Shoulder Erosion Reduction 200 lf /year 125 lbs. TSS /year 0.05 lbs. P /year
Geomorphic Assessment of Industry and Interchange Subwatershed to create plans for Concrete Channel Replacement/ Retrofit, Floodplain Restoration and Railroad Culvert Replacement or Retrofit. GOAL: Complete Assessment and Plans 2019-2021	1	0	0
Implement Floodplain Restoration and Railroad Culvert Replacement or Retrofit. GOAL: Complete over 10-year period if deemed appropriate during Geomorphologic Assessment	0	0	100%
Implement Concrete Channel Replacement/ Retrofit, GOAL: Complete concrete channel over 10-year period	0 LF	1,600 LF North of Forrestal St southeast to USM Campus	1,800 LF USM Campus southwest past Enterprise St, West to Westminster St.
Implement Shade Tree Planting Along Concrete Channel and Drainages in Industrial Park, GOAL: Complete plantings concurrent with Concrete Channel restoration of over 10-year period		1,600 LF North of Forrestal St southeast to USM Campus	1,800 LF USM Campus past Enterprise St. & West to Westminster St.

Table 7: Measures Of Success/ Measurable Interim Milestones (cont.)

	Interim Targets		
	2019-2021	2022-2024	2025-2029
Non-Structural Benchmarks			
Amount of Funding Secured for Non-Structural Elements of plan implementation (include contributions from town, fees, donations, and grants). GOAL: $ 1,090,000.00	$327,000	$327,000	$436,000.
Roadway Pavement Management. GOAL: Annually	100% Annually	100% Annually	100% Annually
Review of Design Standards, Ordinances, and Financial Solutions. GOAL: Review every 5-years	0	100%	100%
Contact Commercial/ Industrial Companies regarding stormwater retrofits or upgrades outreach. GOAL: Prioritize and contact 15 Companies in the watershed	5	5	5
Contact a Number of Watershed Residences through YardScaping outreach. GOAL: All watershed residences reached over 10-year period	33%	66%	100%
Contact a Number of Hart Brook Abutters through YardScaping outreach. GOAL: All abutters residences reached every 3-years	100%	100%	100%

11.0 | REFERENCES

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38 Maine Revised Statutes Title 38 Section 464 (1985) Classification of Maine Waters

DRAFT

APPENDIX A

MDEP MACROINVERTEBRATE ASSESSMENT, 2017

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Classification Attainment Report

Station Information

Station Number:	**S-1119**	River Basin:	Androscoggin
Waterbody:	Hart Brook - Station 1119	HUC8 Name:	Lower Androscoggin
Town:	Lewiston	Latitude:	44 4 28.81 N
Directions:	LISBON ST TO OLIVE ST. PARK AT END OF DEAD END. WALK DOWN 100' ON PATH TO STREAM.	Longitude:	70 11 19.56 W
		Stream Order:	1

Sample Information

Log Number:	**2592**	Type of Sample:	ROCK BAG	Date Deployed:	7/27/2017
Subsample Factor:	X1	Replicates:	3	Date Retrieved:	8/24/2017

Classification Attainment

Statutory Class:	**B**	**Final Determination:**	**I**	Date:	3/30/2018
Model Result with P≥0.6:	I	**Reason for Determination:**	**Best Professional Judgement**		
Date Last Calculated:	3/30/2018	Comments:	Minimum Provision for Total Mean Abundance not met.		

Model Probabilities

First Stage Model				C or Better Model	
Class A	0.00	Class C	0.00	Class A, B, or C	0.00
Class B	0.00	NA	1.00	Non-Attainment	1.00

B or Better Model		A Model	
Class A or B	0.00	Class A	0.00
Class C or Non-Attainment	1.00	Class B or C or Non-Attainment	1.00

Model Variables

01	Total Mean Abundance	36.33
02	Generic Richness	24.00
03	Plecoptera Mean Abundance	0.00
04	Ephemeroptera Mean Abundance	0.00
05	Shannon-Wiener Generic Diversity	3.92
06	Hilsenhoff Biotic Index	5.77
07	Relative Abundance - Chironomidae	0.63
08	Relative Generic Richness Diptera	0.71
09	*Hydropsyche* Abundance	0.00
11	*Cheumatopsyche* Abundance	0.00
12	EPT Generic Richness/ Diptera Generic Richness	0.00
13	Relative Abundance - Oligochaeta	0.00
15	Perlidae Mean Abundance (Family Functional Group)	0.00
16	Tanypodinae Mean Abundance (Family Functional Group)	4.67
17	Chironomini Abundance (Family Functional Group)	3.33
18	Relative Abundance Ephemeroptera	0.00
19	EPT Generic Richness	0.00
21	Sum of Abundances: *Dicrotendipes, Micropsectra, Parachironomus, Helobdella*	0.00
23	Relative Generic Richness- Plecoptera	0.00
25	Sum of Abundances: *Cheumatopsyche, Cricotopus, Tanytarsus, Ablabesmyia*	7.67
26	Sum of Abundances: *Acroneuria, Maccaffertium, Stenonema*	0.00
28	EP Generic Richness/14	0.00
30	Presence of Class A Indicator Taxa/7	0.00

Five Most Dominant Taxa

Rank	Taxon Name	Percent
1	*Tanytarsus*	17.43
2	*Physa*	14.68
3	*Paratanytarsus*	11.93
4	*Parametriocnemus*	10.09
5	*Zavrelimyia*	5.50
6	*Microtendipes*	5.50

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Classification Attainment Report

Station Number: S-1119 Town: Lewiston Date Deployed: 7/27/2017
Log Number: 2592 Waterbody: Hart Brook - Station 1119 Date Retrieved: 8/24/2017

Sample Collection and Processing Information

Sampling Organization: BIOMONITORING UNIT Taxonomist: LOTIC INC.

Waterbody Information - Deployment			Waterbody Information - Retrieval		
Temperature:	18.2	deg C	Temperature:	17.4	deg C
Dissolved Oxygen:	8.88	mg/l	Dissolved Oxygen:	8.04	mg/l
Dissolved Oxygen Saturation:	94.6	%	Dissolved Oxygen Saturation:	83.1	%
Specific Conductance:	256.9	uS/cm	Specific Conductance:	687	uS/cm
Velocity:	18	cm/s	Velocity:	5	cm/s
pH:			pH:		
Wetted Width:	4.3	m	Wetted Width:	3.5	m
Bankfull Width:	6.6	m	Bankfull Width:	6.6	m
Depth:	24	cm	Depth:	18	cm

Water Chemistry

Summary of Habitat Characteristics

Landuse Name	Canopy Cover	Terrain	
Upland Conifer	Dense	Rolling	
Upland Hardwood			
Urban			
Potential Stressor	**Location**	**Substrate**	
Urban Runoff	Below Urban NPS	Rubble/Cobble	60 %
		Sand	40 %

Landcover Summary - 2004 Data

Sample Comments

WATER MUCH LOWER AT RETRIEVAL.

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Taxonomic Inventory Report

Station Number: S-1119 Waterbody: Hart Brook - Station 1119 Town: Lewiston

Log Number: 2592 Subsample Factor: X1 Replicates: 3 Calculated: 3/30/2018

Taxon	Maine Taxonomic Code	Count (Mean of Samplers) Actual	Count (Mean of Samplers) Adjusted	Hilsenhoff Biotic Index	Functional Feeding Group	Relative Abundance % Actual	Relative Abundance % Adjusted
Prostoma	04010101001	0.67	0.67		--	1.8	1.8
Caecidotea	09010101001	1.00	1.00	8	SH	2.8	2.8
Gammarus	09010201003	1.33	1.33	4	--	3.7	3.7
Orconectes	09010301008	0.33	0.33		CG	0.9	0.9
Boyeria	09020301004		1.00	2	PR		2.8
Boyeria vinosa	09020301004012	1.00			--	2.8	
Tipula	09021001002	1.00	1.00	4	SH	2.8	2.8
Antocha	09021001004	0.33	0.33	3	CG	0.9	0.9
Dicranota	09021001005	0.33	0.33	3	PR	0.9	0.9
Bezzia/palpomyia	09021010043	1.33	1.33	6	PR	3.7	3.7
Chironomidae	09021011				--		
Ablabesmyia	09021011001	1.33	1.33	8	PR	3.7	3.7
Natarsia	09021011011	0.67	0.67	8	PR	1.8	1.8
Thienemannimyia	09021011020		0.67	3	PR		1.8
Thienemannimyia group	09021011020041	0.67			--	1.8	
Zavrelimyia	09021011022	2.00	2.00	8	PR	5.5	5.5
Limnophyes	09021011047	0.33	0.33	8	CG	0.9	0.9
Nanocladius	09021011049	0.33	0.33	3	CG	0.9	0.9
Parametriocnemus	09021011053	3.67	3.67	5	CG	10.1	10.1
Paratanytarsus	09021011071	4.33	4.33	6	--	11.9	11.9
Tanytarsus	09021011076	6.33	6.33	6	CF	17.4	17.4
Microtendipes	09021011094		2.00	6	CF		5.5
Microtendipes pedellus group	09021011094166	2.00			--	5.5	
Paralauterborniella	09021011099		0.33	8	CG		0.9
Paralauterborniella nigrohalteralis	09021011099175	0.33			--	0.9	
Polypedilum	09021011102		0.33	6	SH		0.9
Polypedilum aviceps	09021011102181	0.33			--	0.9	
Tribelos	09021011107	0.67	0.67	5	CG	1.8	1.8
Physa	10010202027	5.33	5.33		SC	14.7	14.7
Helisoma	10010203030	0.67	0.67		SC	1.8	1.8

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Classification Attainment Report

Station Information

Station Number:	**S-1118**	River Basin:	Androscoggin
Waterbody:	Hart Brook - Station 1118	HUC8 Name:	Lower Androscoggin
Town:	Lewiston	Latitude:	44 4 36.54 N
Directions:	BEHIND DINGLEY PRESS- SW CORNER. PARK AT END OF DIRT PARKING AREA. WALK IN 50'.	Longitude:	70 10 34.5 W
		Stream Order:	1

Sample Information

Log Number:	**2593**	Type of Sample:	ROCK BAG	Date Deployed:	7/27/2017
Subsample Factor:	X1	Replicates:	3	Date Retrieved:	8/24/2017

Classification Attainment

Statutory Class:	**B**	**Final Determination:**	**NA**	Date:	3/30/2018
Model Result with P≥0.6:	NA	**Reason for Determination:**	**Model**		
Date Last Calculated:	3/30/2018	Comments:			

Model Probabilities

First Stage Model				C or Better Model	
Class A	0.00	Class C	0.00	Class A, B, or C	0.00
Class B	0.00	NA	1.00	Non-Attainment	1.00

B or Better Model		A Model	
Class A or B	0.00	Class A	0.01
Class C or Non-Attainment	1.00	Class B or C or Non-Attainment	0.99

Model Variables

01	Total Mean Abundance	133.67
02	Generic Richness	24.00
03	Plecoptera Mean Abundance	0.00
04	Ephemeroptera Mean Abundance	0.33
05	Shannon-Wiener Generic Diversity	1.81
06	Hilsenhoff Biotic Index	7.50
07	Relative Abundance - Chironomidae	0.20
08	Relative Generic Richness Diptera	0.42
09	*Hydropsyche* Abundance	0.00
11	*Cheumatopsyche* Abundance	0.00
12	EPT Generic Richness/ Diptera Generic Richness	0.20
13	Relative Abundance - Oligochaeta	0.00
15	Perlidae Mean Abundance (Family Functional Group)	0.00
16	Tanypodinae Mean Abundance (Family Functional Group)	6.67
17	Chironomini Abundance (Family Functional Group)	5.33
18	Relative Abundance Ephemeroptera	0.00
19	EPT Generic Richness	2.00
21	Sum of Abundances: *Dicrotendipes, Micropsectra, Parachironomus, Helobdella*	1.33
23	Relative Generic Richness- Plecoptera	0.00
25	Sum of Abundances: *Cheumatopsyche, Cricotopus, Tanytarsus, Ablabesmyia*	0.67
26	Sum of Abundances: *Acroneuria, Maccaffertium, Stenonema*	0.00
28	EP Generic Richness/14	0.07
30	Presence of Class A Indicator Taxa/7	0.00

Five Most Dominant Taxa

Rank	Taxon Name	Percent
1	*Caecidotea*	71.57
2	*Paratanytarsus*	10.72
3	*Thienemannimyia*	3.74
4	*Enallagma*	2.49
5	*Microtendipes*	2.00

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Classification Attainment Report

Station Number: S-1118 Town: Lewiston Date Deployed: 7/27/2017
Log Number: 2593 Waterbody: Hart Brook - Station 1118 Date Retrieved: 8/24/2017

Sample Collection and Processing Information

Sampling Organization: BIOMONITORING UNIT Taxonomist: LOTIC INC.

Waterbody Information - Deployment			Waterbody Information - Retrieval		
Temperature:	18.1	deg C	Temperature:	18.9	deg C
Dissolved Oxygen:	4.96	mg/l	Dissolved Oxygen:	6.98	mg/l
Dissolved Oxygen Saturation:	51	%	Dissolved Oxygen Saturation:	76.1	%
Specific Conductance:	872	uS/cm	Specific Conductance:	580	uS/cm
Velocity:	4	cm/s	Velocity:	5	cm/s
pH:			pH:		
Wetted Width:	2.1	m	Wetted Width:	2	m
Bankfull Width:	2.8	m	Bankfull Width:	2.8	m
Depth:	31	cm	Depth:	36	cm

Water Chemistry

Summary of Habitat Characteristics

Landuse Name	Canopy Cover	Terrain	
Upland Hardwood	Partly Open	Rolling	
Urban			
Potential Stressor	**Location**	**Substrate**	
Urban Runoff	Below Urban NPS	Sand	95 %
		Silt	5 %

Landcover Summary - 2004 Data

Sample Comments

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Taxonomic Inventory Report

Station Number: S-1118 Waterbody: Hart Brook - Station 1118 Town: Lewiston

Log Number: 2593 Subsample Factor: X1 Replicates: 3 Calculated: 3/30/2018

Taxon	Maine Taxonomic Code	Count (Mean of Samplers) Actual	Count (Mean of Samplers) Adjusted	Hilsenhoff Biotic Index	Functional Feeding Group	Relative Abundance % Actual	Relative Abundance % Adjusted
Limnodrilus	08020202022	0.33	0.33		CG	0.2	0.2
Helobdella	08030101005		1.00		--		0.7
Helobdella modesta	08030101005004	1.00			--	0.7	
Erpobdella	08030203002	1.00	1.00		--	0.7	0.7
Caecidotea	09010101001	95.67	95.67	8	SH	71.6	71.6
Orconectes	09010301008	1.00	1.00		CG	0.7	0.7
Aeshna	09020301001	1.67	1.67	5	PR	1.2	1.2
Enallagma	09020309051	3.33	3.33	9	PR	2.5	2.5
Procloeon	09020401010	0.33	0.33		CG	0.2	0.2
Ptilostomis	09020608041	0.33	0.33	5	SH	0.2	0.2
Chauliodes	09020701001	0.33	0.33	4	PR	0.2	0.2
Chironomidae	09021011				--		
Thienemannimyia	09021011020		5.00	3	PR		3.7
Thienemannimyia group	09021011020041	5.00			--	3.7	
Zavrelimyia	09021011022	1.67	1.67	8	PR	1.2	1.2
Paratanytarsus	09021011071	14.33	14.33	6	--	10.7	10.7
Tanytarsus	09021011076	0.67	0.67	6	CF	0.5	0.5
Chironomus	09021011080	1.00	1.00	10	CG	0.7	0.7
Cryptochironomus	09021011082	0.33	0.33	8	PR	0.2	0.2
Dicrotendipes	09021011085	0.33	0.33	8	CG	0.2	0.2
Microtendipes	09021011094		2.67	6	CF		2.0
Microtendipes pedellus group	09021011094166	2.67			--	2.0	
Paralauterborniella	09021011099		0.33	8	CG		0.2
Paralauterborniella nigrohalteralis	09021011099175	0.33			--	0.2	
Tribelos	09021011107	0.67	0.67	5	CG	0.5	0.5
Stagnicola	10010201025	0.33	0.33		--	0.2	0.2
Gyraulus	10010203029	0.33	0.33		SC	0.2	0.2
Helisoma	10010203030	0.33	0.33		SC	0.2	0.2
Sphaerium	10020201003	0.67	0.67		CF	0.5	0.5

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Classification Attainment Report

Station Information

Station Number:	**S-341**	River Basin:	Androscoggin
Waterbody:	Hart Brook - Station 341	HUC8 Name:	Lower Androscoggin
Town:	Lewiston	Latitude:	44 4 11.52 N
Directions:	BELOW GODDARD RD. CROSSING	Longitude:	70 11 44.37 W
		Stream Order:	1

Sample Information

Log Number:	**2594**	Type of Sample:	ROCK BAG	Date Deployed:	7/27/2017
Subsample Factor:	X1	Replicates:	3	Date Retrieved:	8/24/2017

Classification Attainment

Statutory Class:	**B**	**Final Determination:**	**NA**	Date:	3/30/2018
Model Result with P≥0.6:	NA	**Reason for Determination:**	**Model**		
Date Last Calculated:	3/30/2018	Comments:			

Model Probabilities

First Stage Model				C or Better Model	
Class A	0.00	Class C	0.00	Class A, B, or C	0.00
Class B	0.00	NA	1.00	Non-Attainment	1.00

B or Better Model		A Model	
Class A or B	0.00	Class A	0.00
Class C or Non-Attainment	1.00	Class B or C or Non-Attainment	1.00

Model Variables

01	Total Mean Abundance	66.00
02	Generic Richness	21.00
03	Plecoptera Mean Abundance	0.00
04	Ephemeroptera Mean Abundance	0.00
05	Shannon-Wiener Generic Diversity	3.44
06	Hilsenhoff Biotic Index	5.85
07	Relative Abundance - Chironomidae	0.45
08	Relative Generic Richness Diptera	0.57
09	*Hydropsyche* Abundance	0.00
11	*Cheumatopsyche* Abundance	0.00
12	EPT Generic Richness/ Diptera Generic Richness	0.08
13	Relative Abundance - Oligochaeta	0.00
15	Perlidae Mean Abundance (Family Functional Group)	0.00
16	Tanypodinae Mean Abundance (Family Functional Group)	4.67
17	Chironomini Abundance (Family Functional Group)	3.33
18	Relative Abundance Ephemeroptera	0.00
19	EPT Generic Richness	1.00
21	Sum of Abundances: *Dicrotendipes, Micropsectra, Parachironomus, Helobdella*	0.00
23	Relative Generic Richness- Plecoptera	0.00
25	Sum of Abundances: *Cheumatopsyche, Cricotopus, Tanytarsus, Ablabesmyia*	3.67
26	Sum of Abundances: *Acroneuria, Maccaffertium, Stenonema*	0.00
28	EP Generic Richness/14	0.00
30	Presence of Class A Indicator Taxa/7	0.00

Five Most Dominant Taxa

Rank	Taxon Name	Percent
1	*Caecidotea*	24.24
2	*Paratanytarsus*	18.69
3	*Ferrissia*	14.65
4	*Boyeria*	7.07
5	*Thienemannimyia*	6.06

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Classification Attainment Report

Station Number: S-341 Town: Lewiston Date Deployed: 7/27/2017
Log Number: 2594 Waterbody: Hart Brook - Station 341 Date Retrieved: 8/24/2017

Sample Collection and Processing Information

Sampling Organization: BIOMONITORING UNIT Taxonomist: LOTIC INC.

Waterbody Information - Deployment			Waterbody Information - Retrieval		
Temperature:	18	deg C	Temperature:	18.2	deg C
Dissolved Oxygen:	8.68	mg/l	Dissolved Oxygen:	6.72	mg/l
Dissolved Oxygen Saturation:	91.5	%	Dissolved Oxygen Saturation:	71.8	%
Specific Conductance:	236.5	uS/cm	Specific Conductance:	546	uS/cm
Velocity:	20	cm/s	Velocity:	7	cm/s
pH:			pH:		
Wetted Width:	3.8	m	Wetted Width:	2.9	m
Bankfull Width:	4.8	m	Bankfull Width:	4.8	m
Depth:	27	cm	Depth:	32	cm

Water Chemistry

Summary of Habitat Characteristics

Landuse Name	Canopy Cover	Terrain
Upland Hardwood	Partly Open	Rolling
Urban		

Potential Stressor	Location	Substrate	
Urban Runoff	Below Urban NPS	Rubble/Cobble	70 %
		Sand	30 %

Landcover Summary - 2004 Data

Total Area (ac)	1781	High Int. Dev. %	16.6	Water %	0.0	Non-vegetated %	0.0
		Med Int. Dev. %	10.5	Wetland %	1.6	Tilled Agriculture %	1.7
		Low Int. Dev. %	12.8	Upland Woody %	38.0	Grassland %	5.4
		Development %	39.9	Natural %	39.6	Human Altered %	60.4
						Impervious %	26.3
Total Land (ac)	1780	High Int. Dev. %	16.6	Water %	N/A	Non-vegetated %	N/A
		Med Int. Dev. %	10.5	Wetland %	1.6	Tilled Agriculture %	1.7
		Low Int. Dev. %	12.8	Upland Woody %	38.0	Grassland %	5.4
		Development %	39.9	Natural %	39.6	Human Altered %	60.4
						Impervious %	26.3

Sample Comments

WATER LEVEL LOWER AT RETRIEVAL.

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Taxonomic Inventory Report

Station Number: S-341 Waterbody: Hart Brook - Station 341 Town: Lewiston

Log Number: 2594 Subsample Factor: X1 Replicates: 3 Calculated: 3/30/2018

Taxon	Maine Taxonomic Code	Count (Mean of Samplers) Actual	Count (Mean of Samplers) Adjusted	Hilsenhoff Biotic Index	Functional Feeding Group	Relative Abundance % Actual	Relative Abundance % Adjusted
Caecidotea	09010101001	16.00	16.00	8	SH	24.2	24.2
Gammarus	09010201003	0.33	0.33	4	--	0.5	0.5
Orconectes	09010301008	1.33	1.33		CG	2.0	2.0
Collembola	090201	0.33	0.33		--	0.5	0.5
Boyeria	09020301004		4.67	2	PR		7.1
Boyeria vinosa	09020301004012	4.67			--	7.1	
Hydroptila	09020607026	0.67	0.67	6	P	1.0	1.0
Tipula	09021001002	0.33	0.33	4	SH	0.5	0.5
Chironomidae	09021011				--		
Thienemannimyia	09021011020		4.00	3	PR		6.1
Thienemannimyia group	09021011020041	4.00			--	6.1	
Zavrelimyia	09021011022	0.67	0.67	8	PR	1.0	1.0
Cricotopus	09021011037		1.00	7	SH		1.5
Cricotopus trifascia	09021011037070	1.00			--	1.5	
Nanocladius	09021011049	2.67	2.67	3	CG	4.0	4.0
Orthocladius	09021011050	0.67	0.67	6	CG	1.0	1.0
Parakiefferiella	09021011052	0.33	0.33		CG	0.5	0.5
Parametriocnemus	09021011053	2.00	2.00	5	CG	3.0	3.0
Paratanytarsus	09021011071	12.33	12.33	6	--	18.7	18.7
Tanytarsus	09021011076	2.67	2.67	6	CF	4.0	4.0
Microtendipes	09021011094		2.33	6	CF		3.5
Microtendipes pedellus group	09021011094166	2.33			--	3.5	
Polypedilum	09021011102		1.00	6	SH		1.5
Polypedilum aviceps	09021011102181	1.00			--	1.5	
Stenelmis	09021113070	0.33	0.33	5	SC	0.5	0.5
Physa	10010202027	2.67	2.67		SC	4.0	4.0
Ferrissia	10010204035	9.67	9.67		SC	14.6	14.6

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Classification Attainment Report

Station Information

Station Number:	**S-1120**	River Basin:	Androscoggin
Waterbody:	Hart Brook - Station 1120	HUC8 Name:	Lower Androscoggin
Town:	Lewiston	Latitude:	44 3 57.84 N
Directions:	RIVER RD TO DRAGON PIKE. TELEPHONE POLE #1055. WALK IN NW CORNER, DOWN BANK.	Longitude:	70 12 5.4 W
		Stream Order:	1

Sample Information

Log Number:	**2595**	Type of Sample:	ROCK BAG	Date Deployed:	7/27/2017
Subsample Factor:	X1	Replicates:	3	Date Retrieved:	8/24/2017

Classification Attainment

Statutory Class:	**B**	**Final Determination:**	**NA**	Date:	3/30/2018
Model Result with P≥0.6:	NA	**Reason for Determination:**	**Model**		
Date Last Calculated:	3/30/2018	Comments:			

Model Probabilities

First Stage Model				C or Better Model	
Class A	0.00	Class C	0.00	Class A, B, or C	0.00
Class B	0.00	NA	1.00	Non-Attainment	1.00

B or Better Model		A Model	
Class A or B	0.00	Class A	0.00
Class C or Non-Attainment	1.00	Class B or C or Non-Attainment	1.00

Model Variables

01	Total Mean Abundance	60.00
02	Generic Richness	23.00
03	Plecoptera Mean Abundance	0.00
04	Ephemeroptera Mean Abundance	0.00
05	Shannon-Wiener Generic Diversity	3.54
06	Hilsenhoff Biotic Index	6.10
07	Relative Abundance - Chironomidae	0.44
08	Relative Generic Richness Diptera	0.52
09	*Hydropsyche* Abundance	0.00
11	*Cheumatopsyche* Abundance	0.00
12	EPT Generic Richness/ Diptera Generic Richness	0.08
13	Relative Abundance - Oligochaeta	0.00
15	Perlidae Mean Abundance (Family Functional Group)	0.00
16	Tanypodinae Mean Abundance (Family Functional Group)	4.67
17	Chironomini Abundance (Family Functional Group)	6.33
18	Relative Abundance Ephemeroptera	0.00
19	EPT Generic Richness	1.00
21	Sum of Abundances: *Dicrotendipes, Micropsectra, Parachironomus, Helobdella*	0.00
23	Relative Generic Richness- Plecoptera	0.00
25	Sum of Abundances: *Cheumatopsyche, Cricotopus, Tanytarsus, Ablabesmyia*	3.33
26	Sum of Abundances: *Acroneuria, Maccaffertium, Stenonema*	0.00
28	EP Generic Richness/14	0.00
30	Presence of Class A Indicator Taxa/7	0.00

Five Most Dominant Taxa

Rank	Taxon Name	Percent
1	*Caecidotea*	30.56
2	*Paratanytarsus*	12.78
3	*Stenelmis*	10.56
4	*Parametriocnemus*	7.22
5	*Microtendipes*	6.11

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Classification Attainment Report

Station Number: S-1120 Town: Lewiston Date Deployed: 7/27/2017
Log Number: 2595 Waterbody: Hart Brook - Station 1120 Date Retrieved: 8/24/2017

Sample Collection and Processing Information

Sampling Organization: BIOMONITORING UNIT Taxonomist: LOTIC INC.

Waterbody Information - Deployment			Waterbody Information - Retrieval		
Temperature:	17.6	deg C	Temperature:	18.3	deg C
Dissolved Oxygen:	8.95	mg/l	Dissolved Oxygen:	6.82	mg/l
Dissolved Oxygen Saturation:	95.2	%	Dissolved Oxygen Saturation:	73	%
Specific Conductance:	309.8	uS/cm	Specific Conductance:	506	uS/cm
Velocity:	20	cm/s	Velocity:	10	cm/s
pH:			pH:		
Wetted Width:	7.4	m	Wetted Width:	7.3	m
Bankfull Width:	10.8	m	Bankfull Width:	10.8	m
Depth:	37	cm	Depth:	22	cm

Water Chemistry

Summary of Habitat Characteristics

Landuse Name	Canopy Cover	Terrain
Upland Conifer	Partly Open	Rolling
Upland Hardwood		

Potential Stressor	Location	Substrate	
Urban Runoff	Below Urban NPS	Bedrock	5 %
		Boulder	5 %
		Gravel	35 %
		Rubble/Cobble	25 %
		Sand	30 %

Landcover Summary - 2004 Data

Sample Comments

WATER LEVEL MUCH LOWER AT RETRIEVAL.

Maine Department of Environmental Protection
Biological Monitoring Program
Aquatic Life Taxonomic Inventory Report

Station Number: S-1120 Waterbody: Hart Brook - Station 1120 Town: Lewiston

Log Number: 2595 Subsample Factor: X1 Replicates: 3 Calculated: 3/30/2018

Taxon	Maine Taxonomic Code	Count (Mean of Samplers) Actual	Count (Mean of Samplers) Adjusted	Hilsenhoff Biotic Index	Functional Feeding Group	Relative Abundance % Actual	Relative Abundance % Adjusted
Glossiphonia	08030101004		0.33		--		0.6
Glossiphonia elegans	08030101004001	0.33			--	0.6	
Caecidotea	09010101001	18.33	18.33	8	SH	30.6	30.6
Gammarus	09010201003	1.00	1.00	4	--	1.7	1.7
Orconectes	09010301008	1.33	1.33		CG	2.2	2.2
Boyeria	09020301004		1.67	2	PR		2.8
Boyeria vinosa	09020301004012	1.67			--	2.8	
Enallagma	09020309051	0.33	0.33	9	PR	0.6	0.6
Limnephilus	09020610055	1.33	1.33	3	SH	2.2	2.2
Tipula	09021001002	0.33	0.33	4	SH	0.6	0.6
Dicranota	09021001005	0.33	0.33	3	PR	0.6	0.6
Chironomidae	09021011				--		
Thienemannimyia	09021011020		3.33	3	PR		5.6
Thienemannimyia group	09021011020041	3.33			--	5.6	
Zavrelimyia	09021011022	1.33	1.33	8	PR	2.2	2.2
Cricotopus	09021011037		0.67	7	SH		1.1
Cricotopus trifascia	09021011037070	0.67			--	1.1	
Parametriocnemus	09021011053	4.33	4.33	5	CG	7.2	7.2
Paratanytarsus	09021011071	7.67	7.67	6	--	12.8	12.8
Tanytarsus	09021011076	2.67	2.67	6	CF	4.4	4.4
Microtendipes	09021011094		3.67	6	CF		6.1
Microtendipes pedellus group	09021011094166	3.67			--	6.1	
Paralauterborniella	09021011099		0.33	8	CG		0.6
Paralauterborniella nigrohalteralis	09021011099175	0.33			--	0.6	
Polypedilum	09021011102		1.00	6	SH		1.7
Polypedilum aviceps	09021011102181	1.00			--	1.7	
Tribelos	09021011107	1.33	1.33	5	CG	2.2	2.2
Stenelmis	09021113070	6.33	6.33	5	SC	10.6	10.6
Amnicola	10010104013	0.33	0.33		SC	0.6	0.6
Physa	10010202027	1.00	1.00		SC	1.7	1.7
Ferrissia	10010204035	1.00	1.00		SC	1.7	1.7

APPENDIX B

RAPID GEOMORPHIC ASSESSMENT, 2017

MEMO

To: David Brooks

From: Dorota Schweier

Re: Hart Brooks Rapid Geomorphological Screening 2017

Date: October 23, 2017

HART BROOK GEOMORPHOLOGY ASSESSMENT

This report describes the results and recommendations of a fluvial geomorphology assessment of Hart Brook Watershed located entirely within the City of Lewiston, Maine, completed by CES, Inc. (CES) for the City of Lewiston committed to improving and enhancing the ecological and community values of Hart Brook and its watershed. The Hart Brook Watershed is 2,100-acres and encompasses areas of commercial, industrial, agricultural, and residential development. Currently over 22% of the watershed consists of impervious surfaces which have resulted in significant stormwater impacts to Hart Brook. Hart Brook Watershed is located northeast of the Androscoggin River, where Hart Brook ends its run. The brook is classified by the Maine Department of Environmental Protection (MDEP) as a Class B impaired stream due to aquatic life (macroinvertebrates and algae), habitat, low dissolved oxygen and E. Coli. Impaired waterbodies are under increased scrutiny by state and federal regulators and current state regulations can require new development within an impaired watershed to implement additional stormwater management requirements.

HART BROOK WATERSHED ASSESSMENT BACKGROUND

Hart Brook has been monitored by the MDEP Biological Monitoring Program since 2003. In 2007, the City of Lewiston began a watershed assessment to identify likely sources of pollutants and implement corrective actions to reduce stormwater impacts in Hart Brook. The watershed was divided into six sub-watersheds of similar land use to assist in identifying potential sources of stormwater pollution as shown on **Figure 2**. The City has worked cooperatively in data collection with the MDEP Voluntary River Monitoring Program (VRMP) in 2011, 2013, 2014, and 2015. In 2016, City of Lewiston hired CES to perform additional assessments of water quality and flow rate to better understand the status of Hart Brook and provide a baseline to select stormwater treatment and monitor treatment effectiveness. Data from this effort has been collected following MDEP Quality Assurance and Quality Control (QA/QC) guidelines and was provided to the MDEP VRMP for their 2016 report.

In 2017, City of Lewiston hired CES to perform geomorphology assessment on Hart Brook Watershed. The assessment covered approximately 2.6 miles of mainstem of Hart Brook.

Seven Locations in Maine | www.ces-maine.com
640 Main Street
Lewiston, Maine 04240
T 207.795.6009
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SUBDIVIDING REACHES

Since different portions of a stream might respond differently to the same natural and human factors, the first assessment task is to subdivide the stream into distinct reaches. A reach is the length of channel uniform with respect to discharge, depth, area and slope. Within a given reach, the stream is assumed to respond similarly to changing watershed conditions while adjacent reaches may respond differently. Reaches that share similar characteristics may have the same channel restoration response. Points between the reaches are made on the presence of one or more conditions, including natural changes in valley slope, constrictions or expansions of valley width and the confluence of a major tributary. The locations of the reach breaks are likely points of channel instability with excess sediment formation, bank erosion or channel migration, which is typically in reference to meandering streams. Depicting the reach breaks and understanding the morphological conditions present in each reach are critical for identifying the natural and human conditions leading to channel instability.

Stream classification is based primarily on the measured bankfull stage, stage at which a stream first overflows its natural banks, morphology of the river because it is the bankfull stage that is responsible for shaping and maintaining the channel dimensions over time. The stream classification system consists of a hierarchical assessment of channel morphology that includes four levels of assessment (Rosgen, 1994, 1996).

Level I of the hierarchical assessment is the geomorphic characterization where streams are classified at a broad level on the basis of valley landforms and observable channel dimensions.

Level II is the morphological description that classifies stream types within certain valley types using field measurements of the same criteria necessary for the broad-level classification from specific channel reaches and fluvial features.

Level III assesses stream condition to predict river stability (e.g., aggradation, degradation, sediment supply, streambank erosion and channel enlargement).

Level IV is conducted to validate process-based assessments of stream condition, potential and stability as predicted from Levels I–III.

GEOMORPHOLOGICAL ASSESSMENT OF HART BROOK

Hart Brook was subdivided into 10 reaches based on the geomorphological assessment performed by CES in August and September of 2017. The reaches were numbered consecutively from the downstream end (Androscoggin River) and designated as Lower Reach or Industry Reach to indicate their location. CES performed mapping channel conditions continuously along the stream's length and mapping cross sections of reaches and existing sites of concerns.

Most reaches were only walked in their entirety while within the stream channel, some features found outside of the stream channel may have been overlooked. As a result, wetlands, stormwater inputs and other features commonly located adjacent to the valley or floodplain could have been missed during the performance of the continuous mapping channel conditions.

Twenty-one cross sections were completed throughout the mainstem of Hart Brook using cross section surveys consisting of a series of paired horizontal and vertical measurements to describe the shape, or changes in shape, of the bottom of the stream, its banks and floodplains. The cross sections surveys were performed by measuring horizontal distances along a tape stretched between two reference points (end stakes) on opposite banks and by measuring vertical distances with a hand-held optical level and a level rod. This technique, although time consuming and requires two people, can be fairly accurate. When the x and y coordinates of the tape reading are known, the y coordinate of the surface being surveyed is obtained by subtracting the measured vertical distance between the tape and the surface being surveyed, in this case the bottom of the channel, from the y coordinate of the tape. The calculations were then programmed to the Excel spreadsheet for computer analysis and complete picture of each cross section. Additional field data collected at the time of the cross-section survey can also be incorporated into the cross section analysis. Collection of the water depth data collected while surveying channel cross sections made it possible to plot the water level for each cross section.

Lower Reach 1 – begins at the confluence of Hart Brook tributary to Androscoggin River. Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply. High sediment supplies due to the confluence of the stream, steep channel slopes and deep channel cross-sections. The reach ends when the stream transforms to the modified, channelized stream along the River Road.

Lower Reach 2 – begins downstream of Interstate along the River Road as the stream in this location is modified and has been straightened. The channel was walled along east bank with stone wall and wire. The gradient of the channel is low. The reach ends upstream of the Interstate below the Geiger Bros parcel where the stream transitions from a channelized stream to more natural setting.

Lower Reach 3 – begins below the Geiger Bros parcel and ends before going under the River Road below the trailer park located of the Mt. Hope Avenue. A stream that occupies a wide, flat flood plain with a low gradient typically carries only sand-sized and finer sediments and develops a sinuous flow pattern. When a stream flows around a corner, the water on the outside has farther to go and tends to flow faster. This leads to erosion of the banks on the outside of the curve, deposition on the inside, and formation of a point bar. Over time, the sinuosity of the stream becomes increasingly exaggerated, and the channel migrates around within its flood plain, forming a meandering pattern. Woody debris jam was observed in this reach causing significant amounts of sediment to be backed up.

Lower Reach 4 – begins upstream of the River Road, between the River Road and Goddard Road, and ends upstream of the Interstate. Moderately entrenched, have a cross-section width/depth ratio, display a low channel sinuosity, and exhibit a "rapids" dominated bed morphology. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply. Big boulders deposited in the stream by the glacier create a trash and excess sediment accumulation obstructing the flow. Erosion in the watershed resulted in excessive input of sediment (cobble) creating a cobble island and braided stream conditions.

Lower Reach 5 – begins upstream of the Interstate along and under Goddard Road and under the Interstate below Jones Avenue. A stream that occupies a wide, flat flood plain with a low gradient typically carries only sand-sized and finer sediments and develops a sinuous flow pattern. When a stream flows around a corner, the water on the outside has farther to go and tends to flow faster. This leads to erosion of the banks on the outside of the curve, deposition on the inside, and formation of a point bar. Over time, the sinuosity of the stream becomes increasingly exaggerated, and the channel migrates around within its flood plain, forming a meandering pattern.

Beaver dam was observed in the Lower Reach 5, upstream from the Interstate. Beaver dams modify the natural flow of the stream by slowing it down and create ponding of the water. Significant amounts of sediment are backed up behind the dam and water table upstream of the dam is significantly higher than the downstream water level. The reading of the stream temperature upgradient and downgradient of the beaver dam shows that the beaver dam could lower water temperature in the stream – keeping temperature-sensitive aquatic life safe from dangerous highs. Temperature upstream of the beaver dam was recorded as 19.1°C (66.4°F) and downstream of the beaver dam as 19.49°C (67.1°F).

Lower Reach 6 – begins below Jones Avenue and ends below Olive Avenue upgradient from HB-3 sampling location. Stream exhibiting bar-braided pattern with a very little to no flow across the cross-section and sediment deposition. Very shallow stream depths. Braided streams can develop anywhere there is more sediment than a stream is able to transport. Bank erosion rates are high due to moderate to steep slopes. Woody debris jams were observed in this reach, causing the significant amounts of sediment to be stored/backed up, which are periodically flushed out by high velocity flows. Bank erosions can contribute to the amount of sediment trapped by the debris jam. Also observed in this reach was what appears to be a stream bifurcation. Stream bifurcation appears to be man-made and related to the City's sewer running along Hart Brook causing alteration of the natural substrate of the stream.

Lower Reach 7 – begins below Olive Avenue upgradient from HB-3 sampling location and ends downgradient of Route 196. Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply. Alteration of the stream was also noted in this reach due to the railroad tracks. On the north side of the railroad tracks pooling and high-water depths were observed. On the south side of the railroad tracks shallow water depths were observed. Alteration of the natural substrate of the stream was observed caused by railroad construction. Woody debris jam causing the significant amounts of sediment to be stored/backed up, which are periodically flushed out by high velocity flows. Bank erosions can contribute to the amount of sediment trapped by the debris jam. Downstream of HB-6 sampling point – under the Interstate ramp – the stream is exhibiting excess input of sediment dividing the flow across the cross-section and sediment deposition. Very shallow stream depth. Bank erosion rates are high due to moderate to steep slopes.

Industry Reach 1 – begins upgradient of Route 196 and the HB-6 sampling location and ends along Alfred A Plourde Parkway West ramp. Upstream of HB-6 sampling point – classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply. Excess sediment supply was noted because of the woody debris jam caused by the large tree trunk which have fallen into the stream and sprouted. The debris jam has significantly narrowed the stream channel and obstructed the flow as well as created significant amounts of sediment to be stored/backed up and pooling of water behind it. Bank erosions can contribute to the amount of sediment trapped by the debris jam.

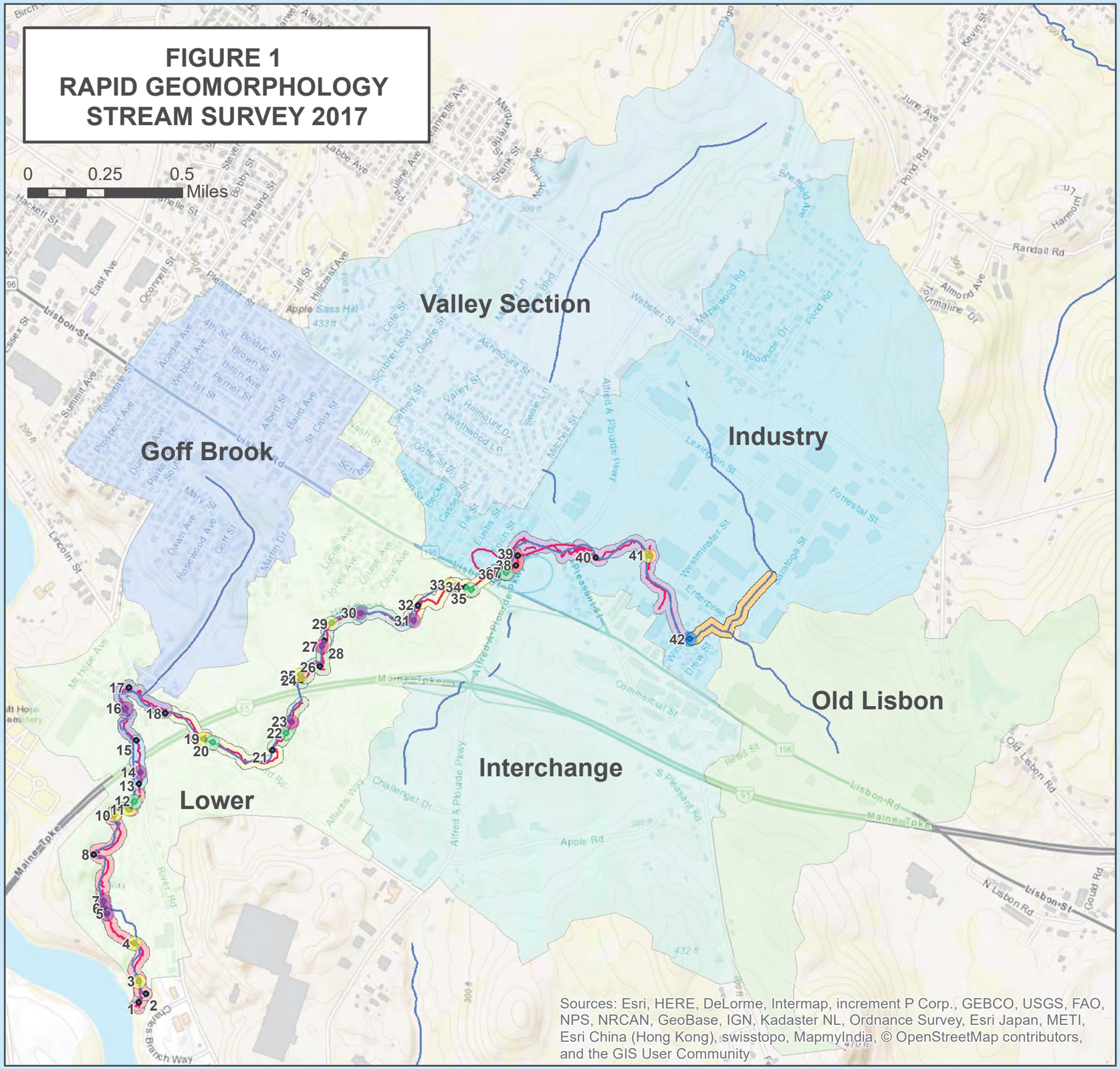
Industry Reach 2 – begins and ends along Alfred A. Plourde Parkway West ramp. The bedforms are a step-pool morphology, meaning that the stream consists of a series of pools connected by rapids and waterfalls. Steep gradients and steep and narrow V-shaped valley, well entrenched and totally confined (laterally contained). High energy and high velocity flows due to inherently steep channel slopes and narrow V-shaped channel cross-sections.

Industry Reach 3 – begins upgradient of Pleasant Street and ends under Westminster Street. Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply. Downstream from HB-4 sampling point water backed up in its course as compared with its normal condition of flow, caused by a natural dam created by bank erosion and a tumbled tree. A rise in stage and water stagnation are also results of the backwater. Significant amounts of sediment are also backed up. Water Quality of the stagnant water was collected.

CONCLUSIONS

A fluvial geomorphologic assessment of the Hart Brook has revealed natural and human factors controlling sediment inputs to the stream. The most obvious sediment sources in Hart Brook are from eroding banks, debris jams alternating the channel conditions and human activities like dumping. While some high eroding banks could potentially be stabilized, it could be too impractical, costly and time consuming. A more feasible approach to reducing sediment inputs and improving the flow of Hart Brook would be reestablishing more even flow by cleaning some of the debris jams and making the floodplains more accessible in areas of the watershed where it's feasible. The objective of stream restoration is to return the stream channel to equilibrium and, by so doing, mitigate fluvial erosion hazards, reduce sediment and nutrient loading, and improve aquatic habitat. Potential restoration sites should be prioritized in terms of habitat benefits, ability to improve channel stability, long term sustainability and enhancing the ecological and community values of Hart Brook and its watershed.

FIGURE 1
RAPID GEOMORPHOLOGY STREAM SURVEY 2017



City of Lewiston
Hart Brook
Lewiston, Maine
Project No.: 10336.045
Updated: 7/2/2018 [bcyr]

Site State Plane Coordinates
X: 1215110.0556
Y: 209549.0188

Legend

- Concrete Channel
- Debris Jam
- Excess Sediment Supply
- Potential Contaminant Source
- Maine Streams
- Hart_Brook
- Industry_4_Buffer
- Lower Reach 1
- Lower Reach 2
- Lower Reach 3
- Lower Reach 4
- Lower Reach 5
- Lower Reach 6
- Industry Reach 2
- Industry Reach 1
- Lower Reach 7
- Lower
- Valley Section
- Goff Brook
- Old Lisbon
- Interchange
- Industry

CES INC
Engineers • Environmental Scientists • Surveyors

#	Time (EST)	Type of Site	Substrate	Visual Velocity	Channel Grade	Flood Plain	Flood Plain Available	Bankfull Width (feet)	Bankfull Depth (feet)	Bankfull Width / Depth Ratio	Stream Width (feet)	Stream Depth (feet)	Stream Width / Depth Ratio	Bank Slope	Channel Slope	Notes	Field Book Location	Reach Determination Based on Substrate	Reach Designation	Cross Section	Photo
1	9/5/2017 9:19	New Reach	Sand	Slow	Slight	Yes	Yes	28	4	7.0	22	1.7	12.9	75	2.2	Confluence of Hart Brook, tributary to Androscoggin River. Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply. High sediment supplies due to the confluence of the stream, steep channel slopes and deep channel cross-sections.	16	NEW	Lower Reach 1	X	
2	9/5/2017 10:04	New Reach	Cobble	Medium	Slight	Yes	Yes	39	5.5	7.1	21	0.65	32.3	90	0.8	Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and and high sediment supply.	17	NEW		X	
3	9/5/2017 10:09	Debris Jam														Fallen tree across the stream likely due to the bank erosion, which can contribute to the amount of sediment trapped by the debris jam.					
4	9/5/2017 10:19	Debris Jam														Fallen tree across the stream likely due to the bank erosion, which can contribute to the amount of sediment trapped by the debris jam.					
5	9/5/2017 10:31	Stream Channel Alteration														Pipe (stormwater pipe?), water discharge was observed, coming out from the bank slope.					X
6	9/5/2017 10:35	Stream Channel Alteration														Pipe (stormwater pipe?), no discharge observed, coming out from the bank slope.					X
7	9/5/2017 10:40	Stream Channel Alteration														What appears to be an aboveground storage tank was observed partially burried in the bank slope.					X
8	9/5/2017 11:45	New Reach	Sand	Slow	Slight	Yes	Yes	34	5	6.8	18	2.4	7.5	75	0.8	Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and and high sediment supply.	18	NEW		X	
9	9/5/2017 11:54	Stream Crossing														Pipeline crossing - petroleum pipeline crossing the stream.					X
10	9/5/2017 11:55	Debris Jam														Woody debris jam causing the significant amounts of sediment to be stored/backed up. Low gradient, meandering, point bar, riffle/pool, alluvian channels with broad, well-defined and accessible floodplains.					X
11	9/5/2017 12:00	Debris Jam														Woody debris jam causing the significant amounts of sediment to be stored/backed up. Low gradient, meandering, point bar, riffle/pool, alluvian channels with broad, well-defined and accessible floodplains.					X
12	9/5/2017 12:03	Excess Sediment Supply														Soil erosion in the watershed or bank erosion resulting in excessive input of fine sediment (sand) creating large sand island.					X

#	Time (EST)	Type of Site	Substrate	Visual Velocity	Channel Grade	Flood Plain	Flood Plain Available	Bankfull Width (feet)	Bankfull Depth (feet)	Bankfull Width / Depth Ratio	Stream Width (feet)	Stream Depth (feet)	Stream Width / Depth Ratio	Bank Slope	Channel Slope	Notes	Field Book Location	Reach Determination Based on Substrate	Reach Designation	Cross Section	Photo
13	9/5/2017 12:06	New Reach	Sand	Slow	Slight	No	No	11	10	1.1	11	1.6	6.9	90		The stream in this location is modified, and has been straightened. The channel was walled along east bank, with stone wall and wire. The gradient of the channel is low.		NEW	Lower Reach 2		X
14	9/5/2017 12:17	Stream Channel Alteration														Stormwater pipe carrying stormawater discharge under the road, no discharge observed at the time.					X
15	9/5/2017 12:23	New Reach	Sand													A stream that occupies a wide, flat flood plain with a low gradient typically carries only sand-sized and finer sediments and develops a sinuous flow pattern. When a stream flows around a corner, the water on the outside has farther to go and tends to flow faster. This leads to erosion of the banks on the outside of the curve, deposition on the inside, and formation of a point bar. Over time, the sinuosity of the stream becomes increasingly exaggerated, and the channel migrates around within its flood plain, forming a meandering pattern.		NEW	Lower Reach 3		
16	9/5/2017 12:32	Stream Channel Alteration														SPLIT - soil erosion in the watershed or bank erosion resulting in excessive input of fine sediment (sand) creating vegetated sand island and braided stream conditions. DEBRIS JAM - Woody debris jam causing the significant amounts of sediment to be stored/backed up. Low gradient, meandering, point bar, riffle/pool, alluvian channels with broad, well-defined and accessible floodplains.					X
17	9/5/2017 13:12	New Reach	Sand	Medium	Slight	Yes	Yes	26	5	5.2	13	1.6	8.1	85	1.3	A stream that occupies a wide, flat flood plain with a low gradient typically carries only sand-sized and finer sediments and develops a sinuous flow pattern. When a stream flows around a corner, the water on the outside has farther to go and tends to flow faster. This leads to erosion of the banks on the outside of the curve, deposition on the inside, and formation of a point bar. Over time, the sinuosity of the stream becomes increasingly exaggerated, and the channel migrates around within its flood plain, forming a meandering pattern.	19	NEW		X	
18	9/5/2017 14:09	New Reach	Cobble	Medium	Slight	Yes	No	43	6	7.2	17.5	0.8	21.9	90	1	Moderately entrenched, have a cross-section width/depth ratio, display a low channel sinuosity, and exhibit a "rapids" dominated bed morphology. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply.	20	NEW	Lower Reach 4		
19	9/5/2017 14:20	Debris Jam														Big boulders deposited in the stream by the glacier create a trash and excess sediment accumulation obstructing the flow.					X
20	9/5/2017 14:23	Excess Sediment Supply														Erosion in the watershed resulting in excessive input of sediment (cobble) creating a cobble island and braided stream conditions.					X

#	Time (EST)	Type of Site	Substrate	Visual Velocity	Channel Grade	Flood Plain	Flood Plain Available	Bankfull Width (feet)	Bankfull Depth (feet)	Bankfull Width / Depth Ratio	Stream Width (feet)	Stream Depth (feet)	Stream Width / Depth Ratio	Bank Slope	Channel Slope	Notes	Field Book Location	Reach Determination Based on Substrate	Reach Designation	Cross Section	Photo
21	9/5/2017 15:02	New Reach	Clay	Medium	Slight	Yes	Yes	24	3	8.0	12	1.1	10.9	60	1.5	Substrate - clay. A stream that occupies a wide, flat flood plain with a low gradient typically carries only sand-sized and finer sediments and develops a sinuous flow pattern. When a stream flows around a corner, the water on the outside has farther to go and tends to flow faster. This leads to erosion of the banks on the outside of the curve, deposition on the inside, and formation of a point bar. Over time, the sinuosity of the stream becomes increasingly exaggerated, and the channel migrates around within its flood plain, forming a meandering pattern.	21	NEW		X	
22	9/5/2017 15:11	Excess Sediment Supply														SPLIT - soil erosion in the watershed or bank erosion resulting in excessive input of fine sediment (sand) creating vegetated sand island and and braided stream conditions.					X
23	9/5/2017 15:15	Stream Crossing														Pipeline crossing - sewer pipe crossing the stream. Low gradient, meandering, point bar, riffle/pool, alluvian channels with broad, well-defined and accessible floodplains.					X
24	8/16/2017 8:55	New Reach	Sand	Stagnant	Flat	Yes	Yes	19	4	4.8	19	1.34	14.2	90	9	Interstate. A stream that occupies a wide, flat flood plain with a low gradient typically carries only sand-sized and finer sediments and develops a sinuous flow pattern. When a stream flows around a corner, the water on the outside has farther to go and tends to flow faster. This leads to erosion of the banks on the outside of the curve, deposition on the inside, and formation of a point bar. Over time, the sinuosity of the stream becomes increasingly exaggerated, and the channel migrates around within its flood plain, forming a meandering pattern.	1	NEW	Lower Reach 5	X	X
25	8/16/2017 10:07	Debris Jam	Sand	Stagnant	Slight	Yes	Yes	15	2	7.5	13	2	6.5	90		Beaver dam upgradient of the Interstate. A stream that occupies a wide, flat flood plain with a low gradient typically carries only sand-sized and finer sediments and develops a sinuous flow pattern. When a stream flows around a corner, the water on the outside has farther to go and tends to flow faster. This leads to erosion of the banks on the outside of the curve, deposition on the inside, and formation of a point bar. Over time, the sinuosity of the stream becomes increasingly exaggerated, and the channel migrates around within its flood plain, forming a meandering pattern.	2			X	X
26	8/16/2017 10:43															Tributary. Low gradient, meandering, point bar, riffle/pool, alluvian channels with broad, well-defined floodplains.					X
27	8/16/2017 10:54	Stream Channel Alteration	Sand	Slow	Slight	Yes	Yes	16	3.5	4.6	12	0.5	24.0	80	0.5	Pipe floating in the water was observed. Low gradient, meandering, point bar, riffle/pool, alluvian channels with broad, well-defined floodplains. Taken Water Quality measurements.	3			X	X
28	8/16/2017 11:21	New Reach	Gravel	Slow	Slight	Yes	Yes	24	4	6.0	6	0.2	30.0	90	0.5	Stream exhibiting bar-braided pattern with a very little to no flow across the cross-section and sediment deposition. Very shallow stream depths. Braided streams can develop anywhere there is more sediment than a stream is able to transport. Bank erosion rates are high due to moderate to steep slopes.	4	NEW		X	
29	8/16/2017 11:55	Debris Jam	Cobble	Slow	Slight	Yes	Yes	20	2	10.0	17	0.24	70.8	60	1	Woody debris jam causing the significant amounts of sediment to be stored/backed up, which are periodically flushed out by high velocity flows. Bank erosions can contribute to the amount of sediment trapped by the debris jam.	5		Lower Reach 6	X	
30	8/16/2017 12:30	Stream Channel Alteration	Cobble	Slow	Slight	No	No	30	5	6.0	11	0.3	36.7	75	0.4	FORK SPLIT. Stream bifurcation appears to be man-made and related to the City's sewer running along Hart Brook causing alteration of the natural substrate of the stream.	6			X	X

#	Time (EST)	Type of Site	Substrate	Visual Velocity	Channel Grade	Flood Plain	Flood Plain Available	Bankfull Width (feet)	Bankfull Depth (feet)	Bankfull Width / Depth Ratio	Stream Width (feet)	Stream Depth (feet)	Stream Width / Depth Ratio	Bank Slope	Channel Slope	Notes	Field Book Location	Reach Determination Based on Substrate	Reach Designation	Cross Section	Photo
31	8/16/2017 13:29	Stream Crossing	Cobble	Slow												SEWER PIPE - on the north side of the railroad tracks / the deep side, pooling, alteration of the natural substrate of the brook caused by railroad construction.					X
32	8/16/2017 13:41	New Reach	Sand	Slow	Slight	Yes	Yes	12	4	3.0	5	0.5	10.0	75	0.7	SEWER PIPE - on the south side of the railroad tracks / the shallow side, alteration of the natural substrate of the brook caused by railroad construction.	7	NEW		X	X
33	8/16/2017 14:12	Debris Jam	Sand	Slow	Slight	Yes	Yes	19	3.5	5.4	2	0.1	20.0	75	0.8	Woody debris jam causing the significant amounts of sediment to be stored/backed up, which are periodically flushed out by high velocity flows. Bank erosions can contribute to the amount of sediment trapped by the debris jam. Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply.	8		Lower Reach 7	X	
34	8/16/2017 14:38															Orange water is often a type of bacteria. This bacteria takes iron dissolved in groundwater and oxidizes it (a chemical reaction similar to forming rust), drawing energy from the process of turning it into fuzzy orange gunk. Oxidation prevents iron from dissolving in the water and produces either an orange colored slime. This can indicate that the stream is fed by groundwater.					X
35	8/16/2017 14:45	Excess Sediment Supply	Sand	Slow	Slight	Yes	Yes	29	5	5.8	8	0.6	13.3	75	0.5	Downstream of HB-6 sampling point – under the Interstate ramp – the stream is exhibiting excess input of sediment dividing the flow across the cross-section and sediment deposition. Very shallow stream depth. Bank erosion rates are high due to moderate to steep slopes.	9			X	
36	8/25/2017 8:57	New Reach	Sand	Slow	Slight	Yes	Yes	17	4	4.3	11	0.8	13.8	75	1.3	Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply.	10	NEW	Industry Reach 1	X	
37	8/25/2017 9:47	Excess Sediment Supply	Sand	Slow	Medium	Yes	Yes	25	4.5	5.6	2	0.25	8.0	60	2.5	Excess sediment supply was noted because of the woody debris jam caused by the large tree trunk which have fallen into the stream and sprouted. The debris jam has significantly narrowed the stream channel and obstructed the flow as well as created significant amounts of sediment to be stored/backed up and pooling of water behind it. Bank erosions can contribute to the amount of sediment trapped by the debris jam.	11			X	X
38	8/25/2017 10:55	New Reach	Bedrock	Medium	Medium	No	No	27	4	6.8	10	1	10.0	75	3.8	BEDROCK. The bedforms are a step-pool morphology, meaning that the stream consists of a series of pools connected by rapids and waterfalls. Steep gradients and steep and narrow V-shaped valley, well entrenched and totally confined (laterally contained). High energy and high velocity flows due to inherently steep channel slopes and narrow V-shaped channel cross-sections.	12	NEW	Industry Reach 2	X	X
39	8/25/2017 12:54	New Reach	Clay	Slow	Slight	Yes	Yes	19	5	3.8	11	0.5	22.0	90	0.2	BANK EROSION. Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply.	13	NEW		X	X
40	8/25/2017 13:51	New Reach	Sand	Slow	Slight	Yes	Yes	11	3	3.7	5	0.25	20.0	80	1	Water lillies. Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and and high sediment supply.	14	NEW	Industry Reach 3	X	
41	8/25/2017 14:11	Debris Jam	Sand	Stagnant	Slight	Yes	Yes	17	3.5	4.9	12	1.2	10.0	60	2	Downstream from HB-4 sampling point water backed up in its course as compared with its normal condition of flow, caused by a natural dam created by bank erosion and a tumbled tree. A rise in stage and water stagnation are also results of the backwater. Significant amounts of sediment are also backed up. Water Quality of the stagnant water was collected.	15			X	X

CITY OF LEWISTON
HART BROOK GEOMORPHOLOGICAL ASSESSMENT

Photo No. 1

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #3

Description:
Fallen tree across the stream and excess sand accumulation.

Photo By:
DES

Photo No. 2

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #4

Description:
Bank erosion. Fallen tree across the stream likely due to extreme bank erosion.

Photo By:
DES

Photo No. 3

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #5

Description:
Water discharge from the pipe located in the bank, was observed entering the stream. The pipe is located downstream from Razel Way.

Photo By:
DES

Photo No. 4

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #6

Description:
The pipe located in the bank was observed; however, no discharge was observed. The pipe is located downstream from Razel Way.

Photo By:
DES

Photo No. 5

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #6

Description:
Buried tank located in the bank was observed. The tank is located downstream from Razel Way.

Photo By:
DES

Photo No. 6

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #6

Description:
Buried tank located in the bank was observed. The tank is located downstream from Razel Way.

Photo By:
DES

Photo No. 7

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #7

Description:
The pipe located in the bank was observed; however, no discharge was observed. The pipe is located downstream from Razel Way.

Photo By:
DES

Photo No. 8

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #9

Description:
Exposed petroleum pipeline crossing the stream.

Photo By:
DES

Photo No. 9

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #10

Description:
Woody debris jam just upstream from the petroleum pipeline stream crossing.

Photo By:
DES

Photo No. 10

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #11

Description:
Woody debris jam combined with trash.

Photo By:
DES

Photo No. 11

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #12

Description:
Excessive input of fine sediment creating large sand island.

Photo By:
DES

Photo No. 12

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 1
Location #12

Description:
Metal debris located next to the excessive input of fine sediment creating large sand island.

Photo By:
DES

Photo No. 13

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 2
Location #13

Description:
The stream is modified and has been straightened, channelized. The east bank is walled with stone and wire.

Photo By:
DES

Photo No. 14

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 2
Location #14

Description:
The pipe, most likely stormwater discharge, no discharge was observed.

Photo By:
DES

Photo No. 15

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 3
Location #16

Description:
Soil erosion in the watershed or bank erosion resulting in excessive input of fine sediment creating a vegetated island and braided stream conditions.

Photo By:
DES

Photo No. 16

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 3
Location #16

Description:
Woody debris jam causing significant amounts of sediment to be stored/backed up.

Photo By:
DES

Photo No. 17

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 4
Location #19

Description:
Debris jam caused by big boulders deposited in the stream by glacier trapping trash debris causing excess sediment accumulation obstructing the flow.

Photo By:
DES

Photo No. 18

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 4
Location #20

Description:
Erosion in the watershed resulting in the excessive input of sediment (cobble) creating an island and braided stream conditions.

Photo By:
DES

Photo No. 19

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 5
Location #22

Description:
Excessive input of sediment (sand) creating a vegetated island and braided stream conditions.

Photo By:
DES

Photo No. 20

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 5
Location #23

Description:
Exposed pipeline crossing the stream.

Photo By:
DES

Photo No. 21

Photo Date:
September 5, 2017

Site Location:
Hart Brook
Lower Reach 5
Location #23

Description:
Observed tributary just upstream from the exposed pipeline crossing the stream.

Photo By:
DES

Photo No. 22

Photo Date:
August 16, 2017

Site Location:
Hart Brook
Lower Reach 5
Location #24

Description:
Stagnant conditions and very deep water levels were observed upstream from the Interstate.

Photo By:
DES

Photo No. 23

Photo Date:
August 16, 2017

Site Location:
Hart Brook
Lower Reach 5
Location #25

Description:
Beaver dam observed upstream of the Interstate. Visible difference in the water table level between upstream and downstream of the beaver dam.

Photo By:
DES

Photo No. 24

Photo Date:
August 16, 2017

Site Location:
Hart Brook
Lower Reach 5
Location #26

Description:
Tributary.

Photo By:
DES

Photo No. 25

Photo Date:
August 16, 2017

Site Location:
Hart Brook
Lower Reach 5
Location #27

Description:
Pipe floating in the water was observed.

Photo By:
DES

Photo No. 26

Photo Date:
August 16, 2017

Site Location:
Hart Brook
Lower Reach 6
Location #30

Description:
Stream bifurcation, appears to be man-made and related to the City's sewer running along the stream causing alteration to natural substrate of the stream.

Photo By:
DES

Photo No. 27

Photo Date:
August 16, 2017

Site Location:
Hart Brook
Lower Reach 7
Location #31

Description:
Sewer pipe downstream of the railroad tracks before going underneath the tracks. Very deep water, pooling.

Photo By:
DES

Photo No. 28

Photo Date:
August 16, 2017

Site Location:
Hart Brook
Lower Reach 7
Location #32

Description:
Upstream of the railroad tracks. Very shallow.

Photo By:
DES

Photo No. 29

Photo Date:
August 16, 2017

Site Location:
Hart Brook
Lower Reach 7
Location #34

Description:
Orange water was observed, it is often a type of bacteria. Bacteria takes iron dissolved in groundwater and oxidizes it, drawing energy from the process.

Photo By:
DES

Photo No. 30

Photo Date:
August 25, 2017

Site Location:
Hart Brook
Industry Reach 1
Location #37

Description:
Woody debris jam caused by the large tree trunk which have fallen into the stream and sprouted. Debris jam significantly narrows the stream channel creating significant amounts of sediment build-up and backwater.

Photo By:
DES

Photo No. 31

Photo Date:
August 25, 2017

Site Location:
Hart Brook
Industry Reach 2
Location #38

Description:
A step-pool morphology was observed in this reach. The stream consists of series of pools connected by rapids and waterfalls.

Photo By:
DES

Photo No. 32

Photo Date:
August 25, 2017

Site Location:
Hart Brook
Industry Reach 3
Location #39

Description:
Bank erosion and debris jam most likely associated with it.

Photo By:
DES

Photo No. 33

Photo Date:
August 25, 2017

Site Location:
Hart Brook
Industry Reach 3
Location #41

Description:
Debris jam, downstream from HB-4 sampling location, completely cutting of the flow and creating backwater, pooling and stagnant water conditions. View at the debris jam from downstream.

Photo By:
DES

Photo No. 34

Photo Date:
August 25, 2017

Site Location:
Hart Brook
Industry Reach 3
Location #41

Description:
Debris jam, downstream from HB-4 sampling location, completely cutting of the flow and creating backwater, pooling and stagnant water conditions. View at the debris jam from upstream.

Photo By:
DES

#	Time (EST)	Type of Site	Substrate	Visual Velocity	Channel Grade	Flood Plain	Flood Plain Available	Bankfull Width (feet)	Bankfull Depth (feet)	Bankfull Width/Depth Ratio	Stream Width (feet)	Stream Depth (feet)	Stream Width/Depth Ratio	Bank Slope	Channel Slope	Notes	Field Book Location	Reach Determination Based on Substrate	Reach Designation	Cross Section	Photo
36	8/25/2017 8:57	New_Reach	Sand	Slow	Slight	Yes	Yes	17	4	4.3	11	0.8	13.8	75	1.3	Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply.	10	NEW		X	
37	8/25/2017 9:47	Excess_Sediment_Supply	Sand	Slow	Medium	Yes	Yes	25	4.5	5.6	2	0.25	8.0	60	2.5	Excess sediment supply was noted because of the woody debris jam caused by the large tree trunk which have fallen into the stream and sprouted. The debris jam has significantly narrowed the stream channel and obstructed the flow as well as created significant amounts of sediment to be stored/backed up and pooling of water behind it. Bank erosions can contribute to the amount of sediment trapped by the debris jam.	11		Industry Reach 1	X	X
38	8/25/2017 10:55	New_Reach	Bedrock	Medium	Medium	No	No	27	4	6.8	10	1	10.0	75	3.8	BEDROCK. The bedforms are a step-pool morphology, meaning that the stream consists of a series of pools connected by rapids and waterfalls. Steep gradients and steep and narrow V-shaped valley, well entrenched and totally confined (laterally contained). High energy and high velocity flows due to inherently steep channel slopes and narrow V-shaped channel cross-sections.	12	NEW	Industry Reach 2	X	X
39	8/25/2017 12:54	New_Reach	Clay	Slow	Slight	Yes	Yes	19	5	3.8	11	0.5	22.0	90	0.2	BANK EROSION. Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and high sediment supply.	13	NEW		X	X
40	8/25/2017 13:51	New_Reach	Sand	Slow	Slight	Yes	Yes	11	3	3.7	5	0.25	20.0	80	1	Water lillies. Classic "entrench-ed, meandering" channel with accessible floodplains. Characterized by high channel width/depth ratio at the bankfull stage with high bank erosion rates and and high sediment supply.	14	NEW		X	
41	8/25/2017 14:11	Debris_Jam	Sand	Stagnant	Slight	Yes	Yes	17	3.5	4.9	12	1.2	10.0	60	2	Downstream from HB-4 sampling point water backed up in its course as compared with its normal condition of flow, caused by a natural dam created by bank erosion and a tumbled tree. A rise in stage and water stagnation are also results of the backwater. Significant amounts of sediment are also backed up. Water Quality of the stagnant water was collected.	15		Industry Reach 3	X	X

APPENDIX C

SUMMARY OF HART BROOK MONITORING AND ANALYSIS 2011-2017

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL04-VRMP	**HB-1**	6/2/2011	9:00 AM	BASE FLOW	NA	12.8	91.8	9.68									545											LOW
HART BROOK-ADL04-VRMP	**HB-1**	6/2/2011	2:30 PM	BASE FLOW	NA	14.5	104	10.69									583											LOW
HART BROOK-ADL04-VRMP	**HB-1**	6/17/2011	8:00 AM	BASE FLOW	NA	15.8	78.5	7.75									600											LOW
HART BROOK-ADL04-VRMP	**HB-1**	6/17/2011	1:32 PM	BASE FLOW	NA	18.5	93.2	8.07									600											LOW
HART BROOK-ADL04-VRMP	**HB-1**	6/17/2011	1:32 PM	BASE FLOW	Duplicate		93.2	8.07									600											
HART BROOK-ADL04-VRMP	**HB-1**	7/1/2011	8:05 AM	BASE FLOW	NA	16.8	74.6	7.18									512											LOW
HART BROOK-ADL04-VRMP	**HB-1**	7/1/2011	2:30 PM	BASE FLOW	NA	18.6	86	8.81									535											LOW
HART BROOK-ADL04-VRMP	**HB-1**	7/15/2011	8:10 AM	BASE FLOW	NA	17.3	67.3	6.44									432											LOW
HART BROOK-ADL04-VRMP	**HB-1**	7/15/2011	8:10 AM	BASE FLOW	Duplicate	17.5	66.9	6.5									440											
HART BROOK-ADL04-VRMP	**HB-1**	7/29/2011	8:05 AM	BASE FLOW	NA	18.8	67.3	6.31									440											LOW
HART BROOK-ADL04-VRMP	**HB-1**	8/12/2011	8:22 AM	BASE FLOW	NA	16.9	77	7.44									370											LOW
HART BROOK-ADL04-VRMP	**HB-1**	8/12/2011	2:00 PM	BASE FLOW	NA	19.2	89	8.15									349											LOW
HART BROOK-ADL04-VRMP	**HB-1**	7/1/2013	7:34 AM	BASE FLOW	NA	18.9	88.6	8.26									380											MED
HART BROOK-ADL04-VRMP	**HB-1**	7/15/2013	7:30 AM	BASE FLOW	NA	19.9	82.1	7.45									480											LOW
HART BROOK-ADL04-VRMP	**HB-1**	7/29/2013	7:35 AM	BASE FLOW	NA	18.5	82	7.68									440											LOW
HART BROOK-ADL04-VRMP	**HB-1**	8/12/2013	7:30 AM	BASE FLOW	NA	16.5	83.5	8.17									450											LOW
HART BROOK-ADL04-VRMP	**HB-1**	8/27/2013	7:42 AM	BASE FLOW	NA	17.8	80.7	7.67									380											LOW
HART BROOK-ADL04-VRMP	**HB-1**	6/6/2014	8:04 AM	BASE FLOW	NA	12.7	60.1	6.3																				LOW
HART BROOK-ADL04-VRMP	**HB-1**	6/6/2014	8:04 AM		Duplicate	12.7	74	6.3																				
HART BROOK-ADL04-VRMP	**HB-1**	6/20/2014	7:54 AM	BASE FLOW	NA	14.8	21.9	2.16									774											LOW
HART BROOK-ADL04-VRMP	**HB-1**	6/20/2014	7:54 AM		Duplicate	14.7	21.1	2.15									774											
HART BROOK-ADL04-VRMP	**HB-1**	7/8/2014	7:46 AM	BASE FLOW	NA	18.7	39.1	3.62	2420								650											MEDIUM
HART BROOK-ADL04-VRMP	**HB-1**	7/8/2014	7:46 AM		Duplicate	18.6	38.7	3.61									651											
HART BROOK-ADL04-VRMP	**HB-1**	7/18/2014	7:42 AM	BASE FLOW	NA	17.4	51.5	5.05	2420								409											MEDIUM
HART BROOK-ADL04-VRMP	**HB-1**	8/1/2014	7:49 AM	STORM FLOW	NA	17.4	85.6	8.2	2420								540											MEDIUM
HART BROOK-ADL04-VRMP	**HB-1**	8/15/2014	8:05 AM	BASE FLOW	NA	16.1	85.5	8.42	2420								482											MEDIUM
HART BROOK-ADL04-VRMP	**HB-1**	6/5/2015	7:58 AM	BASE FLOW	NA	11.5	95.1	10.4	308								581											LOW
HART BROOK-ADL04-VRMP	**HB-1**	6/19/2015	1:20 PM	BASE FLOW	NA	19.2	110.1	9.8									1100											MEDIUM
HART BROOK-ADL04-VRMP	**HB-1**	6/26/2015	11:22 AM		NA				291																			
HART BROOK-ADL04-VRMP	**HB-1**	7/2/2015	8:23 AM	STORM FLOW	NA	15.9	106.0	10.5	2420								385											HIGH
HART BROOK-ADL04-VRMP	**HB-1**	7/7/2015	8:53 AM	BASE FLOW	NA	17.4	84.9	8.5									561											MEDIUM
HART BROOK-ADL04-VRMP	**HB-1**	7/17/2015	9:57 AM		NA				172																			
HART BROOK-ADL04-VRMP	**HB-1**	7/24/2015	8:07 AM	BASE FLOW	NA	17.0	93.7	9.0	461								390											HIGH
HART BROOK-ADL04-VRMP	**HB-1**	7/31/2015	9:18 AM		NA				1414																			
HART BROOK-ADL04-VRMP	**HB-1**	8/7/2015	9:02 AM		NA				210																			

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL04-VRMP	**HB-1**	9/22/2015	15:30		NA	12.0		9.3									928	200.05										
HART BROOK-ADL04-VRMP	**HB-1**	5/12/2016	10:30	BASE FLOW	NA	16.3								8.9			504											
HART BROOK-ADL04-VRMP	**HB-1**	5/17/2016	8:40	BASE FLOW	NA	8.6	108.4	12.6	31	0.001	0.14	<0.3	<0.3	7.7	2.6	1	557	140	<0.005	0.0128	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL04-VRMP	**HB-1**	6/6/2016	12:10	STORM FLOW	NA	14.8	100.4	10.2	>2420	0.167	0.19	0.618	0.81	7.4	30	14	302	59	<0.005	0.0126	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL04-VRMP	**HB-1**	6/6/2016	12:15	STORM FLOW	Duplicate	14.8	100.4	10.2	>2420	0.136				7.4	30	14.5	302		<0.005	0.0124	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL04-VRMP	**HB-1**	6/20/2016	7:48	BASE FLOW	NA	15.6	85.0	8.5	238	0.001	0.35	0.631	0.98	7.3	22	22	858	190										
HART BROOK-ADL04-VRMP	**HB-1**	6/22/2016	16:10	STORM FLOW	NA	17.2	90.8	8.7	1120	0.152	0.38	0.647	1	7.3	29	19	1097	250	<0.005	0.0217	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	0.696	8.05
HART BROOK-ADL04-VRMP	**HB-1**	7/21/2016	8:00	BASE FLOW	NA	17.8	86.5	8.2	96	0.065	0.37	0.41	0.78	7.5	3.1	3.9	761	130	0.006	0.0125	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	8.83
HART BROOK-ADL04-VRMP	**HB-1**	7/21/2016	16:45	BASE FLOW	NA	21.2	109.2	9.7						7.9			810											
HART BROOK-ADL04-VRMP	**HB-1**	8/25/2016	8:15	BASE FLOW	NA	18.7	88.4	8.3	124	1.62	0.25	0.432	0.68	7.7	3.4	1	443	94										
HART BROOK-ADL04-VRMP	**HB-1**	8/25/2016	17:35	BASE FLOW	NA	21.2	93.5	8.3						7.9	-		472											8.83
HART BROOK-ADL04-VRMP	**HB-1**	9/13/2016	9:10	BASE FLOW	NA	15.2	86.4	8.7	1203	0.032	0.21	0.448	0.66	7.8	8.21	<5	369	78	0.0044 J	0.0101	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	0.112 J	8.85
HART BROOK-ADL04-VRMP	**HB-1**	9/13/2016	15:15	BASE FLOW	NA	17.7	98.5	9.4						8.2	-		390											8.87
HART BROOK-ADL04-VRMP	**HB-1**	10/18/2016	14:55	BASE FLOW	NA	11.2	84.4	9.1						-	-		585											
HART BROOK-ADL04-VRMP	**HB-1**	10/19/2016	9:35	BASE FLOW	NA	11.9	86.4	9.3						-	-		550											
HART BROOK-ADL04-VRMP	**HB-1**	11/15/2016	11:00	BASE FLOW	NA	5.0	107.3	13.7						7.7	3.6		693											8.05
HART BROOK-ADL04-VRMP	**HB-1**	11/16/2016	16:08	BASE FLOW	NA	9.5	115.0	13.1						6.9	16		245											6.19
HART BROOK-ADL04-VRMP	**HB-1**	11/22/2016	10:40	BASE FLOW	NA	3.4	104.5	13.9						8.7	6.6		423											7.05
HART BROOK-ADL04-VRMP	**HB-1**	6/29/2017	9:33	BASE FLOW	NA	16.06	88.3	8.66									422											
HART BROOK-ADL04-VRMP	**HB-1**	6/29/2017	9:30	BASE FLOW	NA	18.95	101.7	9.42									686											
HART BROOK-ADL04-VRMP	**HB-1**	7/5/2017	13:07	BASE FLOW	NA	20.63	101	9.04									304											
HART BROOK-ADL04-VRMP	**HB-1**	6/29/2017	7:55	BASE FLOW	NA	16.06	88.3	8.66						7.76			422											4.45
HART BROOK-ADL04-VRMP	**HB-1**	7/27/2017	8:15	BASE FLOW	NA	17.46	89.3	8.54	1553	0.105	0.17	0.418	0.59	7.48	22	5.8	456	89										
HART BROOK-ADL04-VRMP	**HB-1**	7/27/2017	10:13	BASE FLOW	NA	17.43	88.6	8.5						7.49	NA		337											8.35
HART BROOK-ADL04-VRMP	**HB-1**	8/22/2017	8:10	BASE FLOW	NA	18.53	75	7.03	2420	0.197	0.71	0.833	1.5	7.34	5.5	5	608	120										8.5
HART BROOK-ADL04-VRMP	**HB-1**	8/22/2017	8:10	BASE FLOW	NA	20.9	86	7.68									632											
HART BROOK-ADL04-VRMP	**HB-1**	8/22/2017	15:24	BASE FLOW	NA	20.89	86	7.68						7.42	2.8		632											8.81
HART BROOK-ADL04-VRMP	**HB-1**	8/22/2017	15:24	BASE FLOW	NA	17.68	148.5	14.13									391											
HART BROOK-ADL04-VRMP	**HB-1**	9/28/2017	8:30	BASE FLOW	NA	19.67	72	6.57	49	0.113	0.18	0.436	0.62	7.7	1.75	<1	652	160										8.83
HART BROOK-ADL04-VRMP	**HB-1**	9/28/2017	15:28	BASE FLOW	NA	19.45	92.8	8.46						8.1	1.75		752											8.85
HART BROOK-ADL04-VRMP	**HB-1**	11/2/2017	10:46	BASE FLOW	NA	10.05	104.7	11.7						7.21	6.35		614											7.96
HART BROOK-ADL04-VRMP	**HB-1**	12/8/2017	11:48	BASE FLOW	NA	1.83	112.2	15.48						7.69	7.6		509											7.7

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL14-VRMP	**HB-2**	6/2/2011	8:45 AM	BASE FLOW	NA	12.8	84	8.94									674											LOW
HART BROOK-ADL14-VRMP	**HB-2**	6/2/2011	2:00 PM	BASE FLOW	NA	14.1	99.3	10.89									646											LOW
HART BROOK-ADL14-VRMP	**HB-2**	6/17/2011	8:10 AM	BASE FLOW	NA	15.9	80.6	4.8									772											LOW
HART BROOK-ADL14-VRMP	**HB-2**	6/17/2011	1:25 PM	BASE FLOW	NA	19.1	50	4.45									763											LOW
HART BROOK-ADL14-VRMP	**HB-2**	7/1/2011	7:55 AM	BASE FLOW	NA	17.3	35.8	3.48									906											LOW
HART BROOK-ADL14-VRMP	**HB-2**	7/1/2011	2:40 PM	BASE FLOW	NA	20	41.4	3.62									862											LOW
HART BROOK-ADL14-VRMP	**HB-2**	7/15/2011	8:00 AM	BASE FLOW	NA	18	28.9	3.15									828											LOW
HART BROOK-ADL14-VRMP	**HB-2**	7/29/2011	8:15 AM	BASE FLOW	NA	19.1	36	3.15									571											LOW
HART BROOK-ADL14-VRMP	**HB-2**	7/29/2011	8:15 AM	BASE FLOW	Duplicate	19.1	36	3.15									571											
HART BROOK-ADL14-VRMP	**HB-2**	8/12/2011	8:00 AM	BASE FLOW	NA	17.3	34.4	3.29									554											LOW
HART BROOK-ADL14-VRMP	**HB-2**	8/12/2011	2:05 PM	BASE FLOW	NA	17.9	31	3.07									620											LOW
HART BROOK-ADL14-VRMP	**HB-2**	7/15/2013	7:45 AM	BASE FLOW	NA	19.6	28.6	2.6									480											LOW
HART BROOK-ADL14-VRMP	**HB-2**	7/29/2013	7:46 AM	BASE FLOW	NA	18.5	25.2	2.35									160											LOW
HART BROOK-ADL14-VRMP	**HB-2**	8/12/2013	7:42 AM	BASE FLOW	NA	16.3	41.4	4.17									560											MED
HART BROOK-ADL14-VRMP	**HB-2**	8/27/2013	7:55 AM	BASE FLOW	NA	16.9	35.7	3.4									720											MED
HART BROOK-ADL14-VRMP	**HB-2**	6/6/2014	8:31 AM	BASE FLOW	NA	12.4	60.1	6.13																				MEDIUM
HART BROOK-ADL14-VRMP	**HB-2**	6/20/2014	8:16 AM	BASE FLOW	NA	14.4	13.9	1.43									942											MEDIUM
HART BROOK-ADL14-VRMP	**HB-2**	7/1/2014	7:56 AM	BASE FLOW	NA	18.4	80	7.56									375											MED
HART BROOK-ADL14-VRMP	**HB-2**	7/8/2014	8:08 AM	BASE FLOW	NA	18.4	36.9	3.46	2420								760											MEDIUM
HART BROOK-ADL14-VRMP	**HB-2**	7/18/2014	8:05 AM	BASE FLOW	NA	17.2	38.6	3.67	2420								418											MEDIUM
HART BROOK-ADL14-VRMP	**HB-2**	8/1/2014	8:12 AM	BASE FLOW	NA	17.3	77.2	7.46	2420								548											LOW
HART BROOK-ADL14-VRMP	**HB-2**	8/15/2014	8:20 AM	BASE FLOW	NA	15.9	83.1	8.19	2420								365											LOW

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL14-VRMP	**HB-2**	6/5/2015	8:11 AM	BASE FLOW	NA	10.6	91.5	10.0	104								605											LOW
HART BROOK-ADL14-VRMP	**HB-2**	6/12/2015	9:00 AM		NA				166																			
HART BROOK-ADL14-VRMP	**HB-2**	6/19/2015	1:32 PM	BASE FLOW	NA	20.5	99.5	9.0									700											MEDIUM
HART BROOK-ADL14-VRMP	**HB-2**	6/26/2015	11:15 AM		NA				129																			
HART BROOK-ADL14-VRMP	**HB-2**	7/2/2015	8:43 AM	STORM FLOW	NA	15.9	108.1	10.7	345								375											MEDIUM
HART BROOK-ADL14-VRMP	**HB-2**	7/7/2015	8:38 AM	BASE FLOW	NA	16.8	65.1	6.5									757											LOW
HART BROOK-ADL14-VRMP	**HB-2**	7/17/2015	9:49 AM		NA				119																			
HART BROOK-ADL14-VRMP	**HB-2**	7/24/2015	8:34 AM	BASE FLOW	NA	17.5	99.8	9.5	236								275											MEDIUM
HART BROOK-ADL14-VRMP	**HB-2**	7/31/2015	9:30 AM		NA				1120																			
HART BROOK-ADL14-VRMP	**HB-2**	8/7/2015	8:41 AM		NA				548																			
HART BROOK-ADL14-VRMP	**HB-2**	10/10/2015	13:50		NA	10.2								6.6			290.7											
HART BROOK-ADL14-VRMP	**HB-2**	10/14/2015	14:37		NA	13.4								1.5			98.9											
HART BROOK-ADL14-VRMP	**HB-2**	10/15/2015	14:28		NA	10.5								7.0			302.4											
HART BROOK-ADL14-VRMP	**HB-2**	10/22/2015	16:22		NA	11.0								6.7			299.2											
HART BROOK-ADL14-VRMP	**HB-2**	10/24/2015	16:03		NA	9.1								6.9			303.2											
HART BROOK-ADL14-VRMP	**HB-2**	10/26/2015	14:49		NA	7.5								6.7			304.0											
HART BROOK-ADL14-VRMP	**HB-2**	10/29/2015	17:05		NA	13.5								6.9			217.0											
HART BROOK-ADL14-VRMP	**HB-2**	11/4/2015	14:30		NA	8.2								5.0			291.9											
HART BROOK-ADL14-VRMP	**HB-2**	11/8/2015	11:31		NA	7.5								9.2			295.8											
HART BROOK-ADL14-VRMP	**HB-2**	11/9/2015	14:40		NA	5.7								7.8			296.5											
HART BROOK-ADL14-VRMP	**HB-2**	11/12/2015	14:31		NA	6.8								7.6			298.0											
HART BROOK-ADL14-VRMP	**HB-2**	11/18/2015	15:00		NA	2.5								7.6			288.5											
HART BROOK-ADL14-VRMP	**HB-2**	11/24/2015	14:39		NA	1.7								7.9			392.0											
HART BROOK-ADL14-VRMP	**HB-2**	11/29/2015	12:53		NA	3.0								8.1			291.0											
HART BROOK-ADL14-VRMP	**HB-2**	12/1/2015	19:33		NA	3.0								7.5			250.5											
HART BROOK-ADL14-VRMP	**HB-2**	12/5/2015	15:28		NA	4.4								7.4			284.3											
HART BROOK-ADL14-VRMP	**HB-2**	12/8/2015	18:42		NA	3.2								-			315.0											
HART BROOK-ADL14-VRMP	**HB-2**	12/15/2015	14:28		NA	5.8								6.9			108.0											
HART BROOK-ADL14-VRMP	**HB-2**	12/20/2015	13:56		NA	1.1								3.2			269.9											
HART BROOK-ADL14-VRMP	**HB-2**	12/21/2015	14:38		NA	2.1								6.8			276											

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL14-VRMP	**HB-2**	5/12/2016	11:00	BASE FLOW	NA	15.7								8.5			496											
HART BROOK-ADL14-VRMP	**HB-2**	5/17/2016	8:15	BASE FLOW	NA	8.3	101.5	11.9	37	<0.002	0.16	0.316	0.48	7.4	3.2	2	442	150	<0.005	0.0137	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL14-VRMP	**HB-2**	6/6/2016	11:55	STORM FLOW	NA	14.8	97.3	9.9	>2420	0.146	0.18	0.645	0.82	7.4	24.9	13.3	344	66	<0.005	0.0124	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL14-VRMP	**HB-2**	6/20/2016	7:25	BASE FLOW	NA	15.3	71.6	7.2	228	0.004	0.26	0.378	0.64	6.9		2.6	1119	260										
HART BROOK-ADL14-VRMP	**HB-2**	6/22/2016	16:00	STORM FLOW	NA	16.8	87.8	8.5	>2420	0.237	0.27	2.04	2.3	7.1	28	32.2	799	170	<0.005	0.0178	0.021	<0.01	<0.01	<0.0002	0.029	<0.007	<0.2	4.77
HART BROOK-ADL14-VRMP	**HB-2**	7/8/2016	15:05	BASE FLOW	NA	18.2	91.8	8.6						7.2	3.6		535											
HART BROOK-ADL14-VRMP	**HB-2**	7/21/2016	7:38	BASE FLOW	NA	17.3	65.1	6.2	261	0.055	0.26	0.823	1.1	7.3	9.4	3.5	1111	210	0.0064	0.0175	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	5.33
HART BROOK-ADL14-VRMP	**HB-2**	7/21/2016	16:36	BASE FLOW	NA	20.1	100.4	9.1						7.7	8.7		1158											
HART BROOK-ADL14-VRMP	**HB-2**	8/25/2016	9:05	BASE FLOW	NA	18.2	60.1	5.7	461	0.166	0.18	0.502	0.68	7.6	7.6	4.5	795	170										
HART BROOK-ADL14-VRMP	**HB-2**	8/25/2016	17:25	BASE FLOW	NA	19.1	87.8	8.1						7.6	-		837											5.31
HART BROOK-ADL14-VRMP	**HB-2**	9/13/2016	8:50	BASE FLOW	NA	14.3	60.5	6.2	2420	0.028	0.052 J	0.548	0.55	7.6	27.3	5.9	622	130	0.0071	0.0156	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	0.109 J	5.33
HART BROOK-ADL14-VRMP	**HB-2**	9/13/2016	15:25	BASE FLOW	NA	15.0	56.0	5.6						7.7	-		722											5.33
HART BROOK-ADL14-VRMP	**HB-2**	10/18/2016	15:05	BASE FLOW	NA	10.5	74.4	8.2						-	-		1042											
HART BROOK-ADL14-VRMP	**HB-2**	11/15/2016	10:35	BASE FLOW	NA	5.1	100.8	12.8						7.5	3.6		782											5.18
HART BROOK-ADL14-VRMP	**HB-2**	6/28/2017	9:38	BASE FLOW	NA	15.1	89.0	8.9						6.7			319											5.06
HART BROOK-ADL14-VRMP	**HB-2**	7/27/2017	9:40	BASE FLOW	NA	17.81	85.4	8.09						7.6			246											5.1
HART BROOK-ADL14-VRMP	**HB-2**	7/27/2017	8:02	BASE FLOW	NA	17.69	89.3	8.5	579	0.200	0.12	0.341	0.46	7.55	8.62	6.5	270	49										5.05
HART BROOK-ADL14-VRMP	**HB-2**	8/22/2017	7:58	BASE FLOW	NA	17.95	53.5	5.03	228	0.113	<0.1	0.409	0.41	7.14	7.7	5.8	557	200										5.35
HART BROOK-ADL14-VRMP	**HB-2**	8/22/2017	15:34	BASE FLOW	NA	20.25	81.4	7.38						7.34	9.6		880											5.34
HART BROOK-ADL14-VRMP	**HB-2**	9/28/2017	8:15	BASE FLOW	NA	18.93	41.7	3.87	51	0.086	<0.1	0.7	0.7	5.45	5.21	4	1179	330										5.32
HART BROOK-ADL14-VRMP	**HB-2**	9/28/2017	15:39	BASE FLOW	NA	18.12	52.8	4.98						7.69	3.88		1354											5.31
HART BROOK-ADL14-VRMP	**HB-2**	11/2/2017	10:06	BASE FLOW	NA	9.88	94	10.62						7.05	7.85		670											5.15
HART BROOK-ADL14-VRMP	**HB-2**	12/8/2017	12:03	BASE FLOW	NA	2.13	93.2	12.81						7.46	8.6		569											5.09

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL19-VRMP	**HB-3**	6/2/2011	8:30 AM	BASE FLOW	NA	12.5	93.3	10.06									633											LOW
HART BROOK-ADL19-VRMP	**HB-3**	6/2/2011	2:20 PM	BASE FLOW	NA	16.4	99.7	10.31									624											LOW
HART BROOK-ADL19-VRMP	**HB-3**	6/2/2011	2:20 PM	BASE FLOW	Duplicate	16.3	99.6	10.27									629											
HART BROOK-ADL19-VRMP	**HB-3**	6/17/2011	7:40 AM	BASE FLOW	NA	16.4	74	7.26									826											LOW
HART BROOK-ADL19-VRMP	**HB-3**	6/17/2011	1:38 PM	BASE FLOW	NA	19.4	81.5	7.58									846											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/1/2011	7:40 AM	BASE FLOW	NA	16.4	83	8.03									970											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/1/2011	2:10 PM	BASE FLOW	NA	18.8	92.6	8.6									1008											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/15/2011	8:35 AM	BASE FLOW	NA	18.2	75.4	7.11									1063											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/29/2011	8:10 AM	BASE FLOW	NA	19	73	6.6									850											LOW
HART BROOK-ADL19-VRMP	**HB-3**	8/12/2011	8:15 AM	BASE FLOW	NA	17.1	93.2	8.97									396											LOW
HART BROOK-ADL19-VRMP	**HB-3**	8/12/2011	2:18 PM	BASE FLOW	NA	19.1	102.5	9.5									700											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/15/2013	8:00 AM	BASE FLOW	NA	20.0	86.7	7.88									900											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/29/2013	8:02 AM	BASE FLOW	NA	18.2	86.5	8.11									890											MED
HART BROOK-ADL19-VRMP	**HB-3**	8/12/2013	8:25 AM	BASE FLOW	NA	16.5	92.7	9.07									650											MED
HART BROOK-ADL19-VRMP	**HB-3**	8/27/2013	8:10 AM	BASE FLOW	NA	17.3	76	7.27									870											MED
HART BROOK-ADL19-VRMP	**HB-3**	6/20/2014	8:36 AM	BASE FLOW	NA	15.1	82.9	8.3									965											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/1/2014	8:50 AM	BASE FLOW	NA	18.0	93.4	8.86									420											MED
HART BROOK-ADL19-VRMP	**HB-3**	7/8/2014	8:29 AM	BASE FLOW	NA	18.8	85.4	8.0	308								729											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/18/2014	8:21 AM	BASE FLOW	NA	17.4	93.0	8.9	173								36											LOW
HART BROOK-ADL19-VRMP	**HB-3**	8/1/2014	8:48 AM	BASE FLOW	NA	17.1	123.5	11.9	157								512											LOW
HART BROOK-ADL19-VRMP	**HB-3**	8/15/2014	8:40 AM	BASE FLOW	NA	15.7	91.7	9.1	1300								418											LOW
HART BROOK-ADL19-VRMP	**HB-3**	6/5/2015	8:42 AM	BASE FLOW	NA	11.4	96.9	10.6									900											LOW
HART BROOK-ADL19-VRMP	**HB-3**	6/12/2015	9:10 AM		NA				579																			
HART BROOK-ADL19-VRMP	**HB-3**	6/19/2015	1:46 PM	BASE FLOW	NA	17.9	90.8	8.6									788											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/2/2015	9:07 AM	STORM FLOW	NA	16.0	110.0	10.9									360											HIGH
HART BROOK-ADL19-VRMP	**HB-3**	7/7/2015	8:08 AM	BASE FLOW	NA	16.6	87.9	8.4									869											LOW
HART BROOK-ADL19-VRMP	**HB-3**	7/7/2015	8:08 AM		FB	16.6	85.7	8.4									870											
HART BROOK-ADL19-VRMP	**HB-3**	9/22/2015	14:50		NA	14.9		8.4									992	173.39										

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL19-VRMP	**HB-3**	5/13/2016	13:00	BASE FLOW	NA	12.9	111.9	11.8						8.2			605											
HART BROOK-ADL19-VRMP	**HB-3**	5/17/2016	7:10	BASE FLOW	NA	8.4	101.7	11.9	108	<0.002	0.2	<0.3	<0.3	7.7	2.8	3.4	484	140	<0.005	0.0125	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL19-VRMP	**HB-3**	6/6/2016	11:20	STORM FLOW	NA	14.2	97.3	10.0	>2420	0.149	0.18	0.572	0.75	7.3	20.8	10.2	343	66	<0.005	0.0115	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL19-VRMP	**HB-3**	6/20/2016	7:05	BASE FLOW	NA	14.8	87.1	9.0	461	0.109	0.32	0.43	0.75	7.5	6.9	27.7	1079	260										
HART BROOK-ADL19-VRMP	**HB-3**	6/22/2016	15:30	STORM FLOW	NA	17.0	94.2	9.1	>2420	0.644	2.2	1.45	3.6	7.3	50	54.2	261	45	<0.005	0.015	<0.005	<0.01	<0.01	<0.0002	0.0104	<0.007	0.634	7.06
HART BROOK-ADL19-VRMP	**HB-3**	7/8/2016	12:15	BASE FLOW	NA	16.8	91.9	8.9						7.0	3.4		300											
HART BROOK-ADL19-VRMP	**HB-3**	7/21/2016	7:16	BASE FLOW	NA	16.7	96.0	9.3	192	0.014	0.31	0.349	0.66	7.0	6.4	2.3	1191	220	<0.005	0.0169	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	0.207	
HART BROOK-ADL19-VRMP	**HB-3**	7/21/2016	16:14	BASE FLOW	NA	19.9	105.5	9.6						7.9	5.4		1221											
HART BROOK-ADL19-VRMP	**HB-3**	8/25/2016	7:40	BASE FLOW	NA	17.6	82.4	7.9	770	0.035	0.27	0.312	0.58	7.6	6.1	2.9	922	200										
HART BROOK-ADL19-VRMP	**HB-3**	8/25/2016	7:40	BASE FLOW	Duplicate	17.6	82.4	7.9	816	0.045	0.25	0.623	0.87	7.6	6.1	5.7	922	200										
HART BROOK-ADL19-VRMP	**HB-3**	8/25/2016	17:00	BASE FLOW	NA	20.1	88.5	8.0						7.8	-		987											3.75
HART BROOK-ADL19-VRMP	**HB-3**	9/13/2016	8:10	BASE FLOW	NA	13.7	66.7	6.9	>2420	0.018	0.039 J	0.442	0.44	7.7	6.86	<5	742	150	0.0082	0.0166	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	0.075 J	3.7
HART BROOK-ADL19-VRMP	**HB-3**	9/13/2016	15:48	BASE FLOW	NA	16.2	80.3	7.9						7.5	-		856											3.7
HART BROOK-ADL19-VRMP	**HB-3**	10/18/2016	15:25	BASE FLOW	NA	10.8	74.0	8.2						-	-		1233											
HART BROOK-ADL19-VRMP	**HB-3**	11/15/2016	9:46	BASE FLOW	NA	5.6	106.8	13.4						7.3	2.9		743											3.66
HART BROOK-ADL19-VRMP	**HB-3**	7/27/2017	7:50	BASE FLOW	NA	18.18	91.5	8.62	365	0.245	0.11	0.328	0.44	7.76	10.3	5.8	207	35										3.51
HART BROOK-ADL19-VRMP	**HB-3**	8/22/2017	7:42	BASE FLOW	NA	17.4	80.5	7.69	365	0.038	0.26	0.462	0.72	7.02	5.5	2.8	1074	250										3.6
HART BROOK-ADL19-VRMP	**HB-3**	8/22/2017	15:53	BASE FLOW	NA	19.85	88.5	8.04						7.43	5.2		1209											3.62
HART BROOK-ADL19-VRMP	**HB-3**	9/28/2017	7:50	BASE FLOW	NA	19.01	59.6	5.55	48	0.176	0.18	0.393	0.57	7.46	5.75	1	904	230										3.61
HART BROOK-ADL19-VRMP	**HB-3**	9/28/2017	15:53	BASE FLOW	NA	17.63	71.1	6.75						7.71	3.24		1168											3.62

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL28-VRMP	**HB-4**	6/2/2011	7:35 AM	BASE FLOW	NA	12.8	88.9	9.58									486											LOW
HART BROOK-ADL28-VRMP	**HB-4**	6/2/2011	2:06 PM	BASE FLOW	NA	17.8	95.7	9.09									630											LOW
HART BROOK-ADL28-VRMP	**HB-4**	6/17/2011	7:30 AM	BASE FLOW	NA	15.4	58	5.75									643											LOW
HART BROOK-ADL28-VRMP	**HB-4**	6/17/2011	1:45 PM	BASE FLOW	NA	27.4	65.7	5.23									732											LOW
HART BROOK-ADL28-VRMP	**HB-4**	7/1/2011	8:20 AM	BASE FLOW	NA	17	88.4	8.52									794											LOW
HART BROOK-ADL28-VRMP	**HB-4**	7/1/2011	2:20 PM	BASE FLOW	NA	26.5	112.7	9.04									765											LOW
HART BROOK-ADL28-VRMP	**HB-4**	7/15/2011	8:20 AM	BASE FLOW	NA	19.4	68.2	6.22																				LOW
HART BROOK-ADL28-VRMP	**HB-4**	7/29/2011	8:20 AM	BASE FLOW	NA	20.2											1140											LOW
HART BROOK-ADL28-VRMP	**HB-4**	8/12/2011	8:08 AM	BASE FLOW	NA	16.4																						LOW
HART BROOK-ADL28-VRMP	**HB-4**	8/12/2011	2:24 PM	BASE FLOW	NA	24.1	23.4	2.76									778											LOW
HART BROOK-ADL28-VRMP	**HB-4**	7/1/2013	8:23 AM	BASE FLOW	NA	18.3	72.6	6.82									320											MED
HART BROOK-ADL28-VRMP	**HB-4**	7/15/2013	8:10 AM	BASE FLOW	NA	19.8	61.9	5.67									680											LOW
HART BROOK-ADL28-VRMP	**HB-4**	7/15/2013	8:10 AM		Duplicate	19.8	62.3	5.67									780											
HART BROOK-ADL28-VRMP	**HB-4**	7/29/2013	8:14 AM	BASE FLOW	NA	19.5	22.5	2.09									990											MED
HART BROOK-ADL28-VRMP	**HB-4**	8/12/2013	8:33 AM	BASE FLOW	NA	16.2	65.9	6.48									650											MED
HART BROOK-ADL28-VRMP	**HB-4**	8/12/2013	8:33 AM		Duplicate	16.2	66	6.47									900											
HART BROOK-ADL28-VRMP	**HB-4**	8/27/2013	8:25 AM	BASE FLOW	NA	18.4	16.2	1.52									890											MED
HART BROOK-ADL28-VRMP	**HB-4**	6/6/2014	8:58 AM	BASE FLOW	NA	14.0	79.7	8.2																				LOW
HART BROOK-ADL28-VRMP	**HB-4**	6/27/2014	8:21 AM	BASE FLOW	NA	14.1	49.9	5.1									558											LOW
HART BROOK-ADL28-VRMP	**HB-4**	7/11/2014	8:16 AM	BASE FLOW	NA	17.2	38.0	3.6	61								728											LOW
HART BROOK-ADL28-VRMP	**HB-4**	7/25/2014	7:49 AM	BASE FLOW	NA	16.7	19.5	1.8	105								672											LOW
HART BROOK-ADL28-VRMP	**HB-4**	8/15/2014	9:03 AM	BASE FLOW	NA	16.4	85.9	8.4	248								326											MEDIUM
HART BROOK-ADL28-VRMP	**HB-4**	8/22/2014	8:41 AM	BASE FLOW	NA	17.7	92.0	8.6	59								483											LOW

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL28-VRMP	**HB-4**	4/10/2015	8:30		NA	1.8		9.0						6.7	100		238											
HART BROOK-ADL28-VRMP	**HB-4**	5/29/2015	8:39 AM	BASE FLOW	NA	18.8	51.5	4.7									718											LOW
HART BROOK-ADL28-VRMP	**HB-4**	6/5/2015	8:55 AM		NA				161																			
HART BROOK-ADL28-VRMP	**HB-4**	6/12/2015	8:45 AM		NA				186																			
HART BROOK-ADL28-VRMP	**HB-4**	6/26/2015	10:51 AM	BASE FLOW	NA	18.2	61.7	5.4	123								1200											LOW
HART BROOK-ADL28-VRMP	**HB-4**	7/2/2015	9:36 AM		NA				1414																			
HART BROOK-ADL28-VRMP	**HB-4**	7/17/2015	8:30 AM	BASE FLOW	NA	16.5	83.4	8.8	88								956											MEDIUM
HART BROOK-ADL28-VRMP	**HB-4**	7/24/2015	8:55 AM		NA				45																			
HART BROOK-ADL28-VRMP	**HB-4**	7/31/2015	9:00 AM	BASE FLOW	NA				308																			LOW
HART BROOK-ADL28-VRMP	**HB-4**	8/7/2015	9:10 AM		NA				68																			
HART BROOK-ADL28-VRMP	**HB-4**	5/12/2016	11:30	BASE FLOW	NA	19.5								7.8			355											
HART BROOK-ADL28-VRMP	**HB-4**	5/17/2016	7:55	BASE FLOW	NA	8.2	85.7	10.1	130	<0.002	0.13	0.433	0.56	7.2	3.4	1.2	440	110	<0.005	<0.01	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL28-VRMP	**HB-4**	6/6/2016	11:05	STORM FLOW	NA	15.5	90.3	9.0	866	0.084	0.15	0.642	0.79	7.2	14.6	9.2	334	60	0.0053	0.0105	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL28-VRMP	**HB-4**	6/20/2016	6:42	BASE FLOW	NA	15.6	65.8	6.5	38	0.012	<0.1	0.345	0.34	7.4	18	4.8	898	200										
HART BROOK-ADL28-VRMP	**HB-4**	6/22/2016	14:50	STORM FLOW	NA	18.6	84.7	7.9	>2420	0.514	0.22	1.22	1.4	7.1	80	26.8	392	78	<0.005	0.0108	<0.005	<0.01	<0.01	<0.0002	0.0104	<0.007	0.317	3.6
HART BROOK-ADL28-VRMP	**HB-4**	7/21/2016	6:45	BASE FLOW	NA	16.9	59.0	5.7	172	0.081	0.15	0.519	0.67	7.2	22	14.6	808	160	0.0116	0.0161	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	4.17
HART BROOK-ADL28-VRMP	**HB-4**	7/21/2016	15:45	BASE FLOW	NA	28.7	191.7	14.6						8.4	19		848											
HART BROOK-ADL28-VRMP	**HB-4**	8/25/2016	7:05	BASE FLOW	NA	18.2	20.4	1.9	51	0.147	<0.1	0.446	0.45	7.5	9.6	6.6	794	170										
HART BROOK-ADL28-VRMP	**HB-4**	8/25/2016	16:40	BASE FLOW	NA	26.7	39.6	3.2						7.7	-		819											4.1
HART BROOK-ADL28-VRMP	**HB-4**	9/13/2016	7:30	BASE FLOW	NA	13.2	27.5	3.0	1986	0.031	0.039 J	0.522	0.52	7.5	11.8	<5	673	130	0.018	0.0154	<0.005	<0.01	0.0023 J	<0.0002	<0.01	<0.007	0.173 J	4.15
HART BROOK-ADL28-VRMP	**HB-4**	9/13/2016	7:30	BASE FLOW	Duplicate	13.2	27.5	3.0		0.021	0.054 J	1.42	1.4	7.5	11.8	7.3	673	130	0.016	0.0154	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	0.194 J	4.15
HART BROOK-ADL28-VRMP	**HB-4**	9/13/2016	16:18	BASE FLOW	NA	24.3	57.0	4.8						7.6	-		749											4.15
HART BROOK-ADL28-VRMP	**HB-4**	11/15/2016	8:59	BASE FLOW	NA	5.4	89.4	11.3						7.4	2.3		591											4.15
HART BROOK-ADL28-VRMP	**HB-4**	6/28/2017	10:21	BASE FLOW	NA	17.7	95.2	9.4						7.1			321											4.05
HART BROOK-ADL28-VRMP	**HB-4**	7/27/2017	8:50	BASE FLOW	NA	18.01	62	5.85	517	0.075	<0.1	<0.3	<0.3	7.42	7.48	2.8	947	190										4.26
HART BROOK-ADL28-VRMP	**HB-4**	8/22/2017	7:24	BASE FLOW	NA	18.68	61.8	5.75	291	0.075	<0.1	0.408	0.41	7.3	11	6	766	160										4.3
HART BROOK-ADL28-VRMP	**HB-4**	8/22/2017	16:18	BASE FLOW	NA	23.98	84.4	7.08						7.67	23		815											-
HART BROOK-ADL28-VRMP	**HB-4**	9/28/2017	7:35	BASE FLOW	NA	19.79	25.7	2.34	64	0.163	<0.1	0.926	0.93	7.94	18.5	19.6	1016	200										-
HART BROOK-ADL28-VRMP	**HB-4**	9/28/2017	16:35	BASE FLOW	NA	22	71	6.2						7.91	10.7		983											2.61
HART BROOK-ADL28-VRMP	**HB-4**	11/2/2017	8:25	BASE FLOW	NA	10.51	73.5	8.16						7.25	9.17		511											2.61
HART BROOK-ADL28-VRMP	**HB-4**	12/8/2017	12:45	BASE FLOW	NA	2.82	77.2	10.44						7.43	7.7		431											2.44

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADLUA04-VRMP	**HB-5**	6/2/2011	8:00 AM	BASE FLOW	NA	12.6	67.5	7.3									406											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	6/2/2011	1:50 PM	BASE FLOW	NA	13.6	69	7.1									412											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	6/17/2011	7:50 AM	BASE FLOW	NA	14.7	89.5	8.9									367											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	6/17/2011	1:17 PM	BASE FLOW	NA	16.5	89.2	8.71									331											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/1/2011	8:16 AM	BASE FLOW	NA	15.7	91	9.08									331											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/1/2011	2:00 PM	BASE FLOW	NA	17.6	93	8.66									312											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/15/2011	7:53 AM	BASE FLOW	NA	16.4	92	9.06									271											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/29/2011	8:00 AM	BASE FLOW	NA	18.5	89	8.34									194											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	8/12/2011	7:45 AM	BASE FLOW	NA	16.3	94.1	9.09									191											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	8/12/2011	2:32 PM	BASE FLOW	NA	18.4	94	8.7									200											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/15/2013	8:30 AM	BASE FLOW	NA	18.7	90.4	8.46									360											MED
HART BROOK-ADLUA04-VRMP	**HB-5**	7/29/2013	8:30 AM	BASE FLOW	NA	18.7	90.5	8.51									830											MED
HART BROOK-ADLUA04-VRMP	**HB-5**	8/12/2013	7:56 AM	BASE FLOW	NA	15.8	91.4	9.01									380											MED
HART BROOK-ADLUA04-VRMP	**HB-5**	8/27/2013	8:37 AM	BASE FLOW	NA	17.6	85.4	8.12									310											MED
HART BROOK-ADLUA04-VRMP	**HB-5**	6/20/2014	8:54 AM	BASE FLOW	NA	13.6	84.1	8.8									381											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/1/2014	9:04 AM	BASE FLOW	NA	17.7	88.4	8.46									400											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/8/2014	8:46 AM	BASE FLOW	NA	18.2	85.3	8.0	206								349											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/18/2014	8:40 AM	BASE FLOW	NA	16.6	84.4	8.2	687								303											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	8/1/2014	9:07 AM	BASE FLOW	NA	18.2	95.2	8.9	365								561											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	8/8/2014	8:58 AM	BASE FLOW	NA	16.5	107.2	10.5	135								365											LOW

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADLUA04-VRMP	**HB-5**	6/5/2015	8:26 AM	BASE FLOW	NA	10.5	87.5	9.4									281											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	6/19/2015	1:55 PM	BASE FLOW	NA	17.2	93.4	8.9									404											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/2/2015	9:23 AM	STORM FLOW	NA	15.7	96.7	9.6									244											MEDIUM
HART BROOK-ADLUA04-VRMP	**HB-5**	7/7/2015	7:50 AM	BASE FLOW	NA	16.0	69.4	6.5									243											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	7/24/2015	9:42 AM	BASE FLOW	NA	16.7	89.9	8.8									283											LOW
HART BROOK-ADLUA04-VRMP	**HB-5**	9/22/2015	14:20		NA	14.7		8.1									254	42.85										
HART BROOK-ADLUA04-VRMP	**HB-5**	5/12/2016	12:00	BASE FLOW	NA	16.9								8.2			445											
HART BROOK-ADLUA04-VRMP	**HB-5**	5/17/2016	7:40	BASE FLOW	NA	7.5	100.8	12.1	23	0.179	0.78	0.353	1.1	7.7	1.9	4.2	320	81										
HART BROOK-ADLUA04-VRMP	**HB-5**	6/6/2016	11:40	STORM FLOW	NA	14.2	83.4	8.6	411	0.171	0.52	0.734	1.2	7.3	11.4	4.5	342	62	<0.005	0.0103	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADLUA04-VRMP	**HB-5**	6/20/2016	7:22	BASE FLOW	NA	14.1	90.2	9.3	31	0.343	0.61	0.33	0.94	7.7	1.4	8.6	328	61										
HART BROOK-ADLUA04-VRMP	**HB-5**	6/20/2016	7:22	BASE FLOW	Duplicate	14.1	90.2	9.3	21	0.305	0.61	0.337	0.95	7.7	1.4	4.1	328	61										
HART BROOK-ADLUA04-VRMP	**HB-5**	6/22/2016	15:45	STORM FLOW	NA	18.1	84.2	8.0	1203	0.698	0.36	1.41	1.8	7.3	55	39.8	159	23	<0.005	0.0109	<0.005	<0.01	<0.01	<0.0002	0.0104	<0.007	0.791	
HART BROOK-ADLUA04-VRMP	**HB-5**	7/21/2016	7:20	BASE FLOW	NA	16.3	101.2	9.9	99	0.468	0.68	0.319	1	7.6	1.9	9.4	300	52	0.0069	<0.01	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADLUA04-VRMP	**HB-5**	7/21/2016	7:20	BASE FLOW	Duplicate	16.3	101.2	9.9	93	0.436	0.68	<0.3	0.68	7.6	1.9	5.2	300	52	0.0055	<0.01	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADLUA04-VRMP	**HB-5**	7/21/2016	16:25	BASE FLOW	NA	21.2	99.8	8.8						8.3	7		226											
HART BROOK-ADLUA04-VRMP	**HB-5**	8/25/2016	7:55	BASE FLOW	NA	17.8	85.4	7.9	152	0.528	0.66	<0.3	0.66	7.9	2	1	230	41										
HART BROOK-ADLUA04-VRMP	**HB-5**	8/25/2016	17:18	BASE FLOW	NA	20.4	90.5	8.2						8.2	-		234											
HART BROOK-ADLUA04-VRMP	**HB-5**	9/13/2016	8:30	BASE FLOW	NA	13.7	87.8	9.1	435	0.136	0.51	3.32	3.8	7.9	2.38	<5	232	42	0.0056	0.0049 J	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	0.0585 J	
HART BROOK-ADLUA04-VRMP	**HB-5**	9/13/2016	15:35	BASE FLOW	NA	17.2	83.0	8.0						7.9	-		231											
HART BROOK-ADLUA04-VRMP	**HB-5**	11/15/2016	9:35	BASE FLOW	NA	6.5	89.0	10.9						7.7	2.5		257											
HART BROOK-ADLUA04-VRMP	**HB-5**	7/27/2017	7:35	BASE FLOW	NA	16.65	83.1	8.08	1553	0.359	0.69	<0.3	0.69	7.75	5.92	3.1	347	64										
HART BROOK-ADLUA04-VRMP	**HB-5**	8/22/2017	7:26	BASE FLOW	NA	17.57	79	7.52	435	0.367	0.6	<0.3	0.6	6.58	1	<1	309	58										
HART BROOK-ADLUA04-VRMP	**HB-5**	8/22/2017	15:42	BASE FLOW	NA	20.27	79	7.1						7.66	3.3		322											
HART BROOK-ADLUA04-VRMP	**HB-5**	9/28/2017	7:38	BASE FLOW	NA	19.36	70.8	6.46	488	0.584	0.47	0.356	0.83	7.7	3.92	6.9	263	54										
HART BROOK-ADLUA04-VRMP	**HB-5**	9/28/2017	16:09	BASE FLOW	NA	17.67	72	6.88						8.08	2.02		313											

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL23-VRMP	**HB-6**	6/6/2014	9:28 AM	BASE FLOW	NA	12.7	86.8	9.11																				LOW
HART BROOK-ADL23-VRMP	**HB-6**	6/27/2014	8:10 AM	BASE FLOW	NA	14.5	86.7	8.83									429											LOW
HART BROOK-ADL23-VRMP	**HB-6**	7/11/2014	7:44 AM	BASE FLOW	NA	17.9	89.7	8.47	194								673											LOW
HART BROOK-ADL23-VRMP	**HB-6**	7/25/2014	8:16 AM	BASE FLOW	NA	17.4	86.3	7.86	308								614											LOW
HART BROOK-ADL23-VRMP	**HB-6**	8/8/2014	8:42 AM	BASE FLOW	NA	16.7	111.1	10.84	308								416											LOW
HART BROOK-ADL23-VRMP	**HB-6**	8/22/2014	8:18 AM	BASE FLOW	NA	17.6	86.6	8.38	72								487											LOW
HART BROOK-ADL23-VRMP	**HB-6**	5/29/2015	8:08 AM	BASE FLOW	NA	17.9	75.1	6.8									786											LOW
HART BROOK-ADL23-VRMP	**HB-6**	6/12/2015	7:50 AM	BASE FLOW	NA	18.0	88.4	8.4									719											LOW
HART BROOK-ADL23-VRMP	**HB-6**	6/26/2015	10:24 AM	BASE FLOW	NA	16.6	103.8	10.1									700											LOW
HART BROOK-ADL23-VRMP	**HB-6**	7/17/2015	9:20 AM	BASE FLOW	NA	16.5	109.9	10.7									276											HIGH
HART BROOK-ADL23-VRMP	**HB-6**	7/24/2015	9:23 AM	BASE FLOW	NA	17.6	83.8	8.1									619											LOW
HART BROOK-ADL23-VRMP	**HB-6**	7/24/2015	9:23 AM		FB	17.4	83.4	7.9									586											
HART BROOK-ADL23-VRMP	**HB-6**	5/12/2016	12:30	BASE FLOW	NA	16.3								8.2			369											
HART BROOK-ADL23-VRMP	**HB-6**	5/17/2016	6:50	BASE FLOW	NA	8.3	105.3	12.2	238	0.045	0.2	0.305	0.5	7.6	3.5	4.8	378	96	<0.005	<0.01	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL23-VRMP	**HB-6**	6/6/2016	10:35	STORM FLOW	NA	14.3	96.2	9.8	>2420	0.172	0.15	0.685	0.84	6.9	22.5	13.6	260	48	0.0051	0.0108	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL23-VRMP	**HB-6**	6/20/2016	6:53	BASE FLOW	NA	15.6	83.0	8.3	816	0.075	0.32	0.487	0.81	7.5	5.5	49.6	831	180										
HART BROOK-ADL23-VRMP	**HB-6**	6/22/2016	15:05	STORM FLOW	NA	18.1	87.3	8.2	1553	0.631	0.34	1.66	2	7.3	45	42.9	271	48	0.0076	0.0135	<0.005	<0.01	<0.01	<0.0002	0.0104	<0.007	0.615	10.37
HART BROOK-ADL23-VRMP	**HB-6**	6/22/2016	15:05	STORM FLOW	Duplicate	18.1	87.3	8.2	1414	0.665	0.33	1.76	2.1	7.3	45	40.5	271	53	0.007	0.0131	<0.005	<0.01	<0.01	<0.0002	0.0104	<0.007	0.651	10.37
HART BROOK-ADL23-VRMP	**HB-6**	7/21/2016	7:00	BASE FLOW	NA	16.9	80.7	7.8	166	0.058	0.2	0.464	0.66	7.2	7.7	9.1	972	150	0.0107	0.013	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	10.61
HART BROOK-ADL23-VRMP	**HB-6**	7/21/2016	15:56	BASE FLOW	NA	21.3	137.8	12.2						8.1	7.3		1040											
HART BROOK-ADL23-VRMP	**HB-6**	8/25/2016	7:25	BASE FLOW	NA	17.7	71.0	6.8	326	0.026	0.15	0.439	0.59	7.5	6.7	2.6	705	130										
HART BROOK-ADL23-VRMP	**HB-6**	8/25/2016	16:50	BASE FLOW	NA	21.8	93.9	8.2						7.8	-		721											10.61
HART BROOK-ADL23-VRMP	**HB-6**	9/13/2016	7:50	BASE FLOW	NA	13.9	50.0	5.2	2420	0.031	0.041 J	3.71	3.7	7.6	7.83	<5	531	96	0.0096	0.0113	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	0.141 J	10.64
HART BROOK-ADL23-VRMP	**HB-6**	9/13/2016	16:00	BASE FLOW	NA	18.2	58.5	5.5						7.5	-		607											10.64
HART BROOK-ADL23-VRMP	**HB-6**	11/15/2016	9:20	BASE FLOW	NA	5.6	103.8	13.0						7.4	3.3		499											10.53
HART BROOK-ADL23-VRMP	**HB-6**	7/27/2017	7:15	BASE FLOW	NA	17.05	69.8	6.72	91	0.230	0.22	0.446	0.67	7.63	16.9	3.2	895	180										10.62
HART BROOK-ADL23-VRMP	**HB-6**	8/22/2017	7:47	BASE FLOW	NA	17.83	70.2	6.65	72	0.057	0.25	0.416	0.67	7.26	8.4	4.8	799	160										10.4
HART BROOK-ADL23-VRMP	**HB-6**	8/22/2017	16:02	BASE FLOW	NA	22.61	103.1	8.87						7.74	6.2		827											10.74
HART BROOK-ADL23-VRMP	**HB-6**	9/28/2017	7:22	BASE FLOW	NA	18.45	34.6	3.26	579	0.226	0.27	0.482	0.75	7.08	5.49	2.8	933	210										10.76
HART BROOK-ADL23-VRMP	**HB-6**	9/28/2017	16:18	BASE FLOW	NA	17.33	62	5.92						7.55	4.75		1030											10.66

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADLUB02-VRMP	**HB-7**	6/6/2014	9:59 AM	BASE FLOW	NA	12.9	87.6	9.29																				LOW
HART BROOK-ADLUB02-VRMP	**HB-7**	6/27/2014	7:50 AM	BASE FLOW	NA	13.9	86.9	8.97									570											MEDIUM
HART BROOK-ADLUB02-VRMP	**HB-7**	6/27/2014	7:50 AM		Duplicate	13.9	87.1	8.95									542											
HART BROOK-ADLUB02-VRMP	**HB-7**	7/11/2014	8:00 AM	BASE FLOW	NA	17.1	94.4	8.93	816								572											LOW
HART BROOK-ADLUB02-VRMP	**HB-7**	7/25/2014	8:28 AM	BASE FLOW	NA	17.6	89.9	8.59	326								564											LOW
HART BROOK-ADLUB02-VRMP	**HB-7**	7/25/2014	8:28 AM		Duplicate	17.6	90.5	8.6	326								708											
HART BROOK-ADLUB02-VRMP	**HB-7**	8/8/2014	8:31 AM	BASE FLOW	NA	16.9	109.6	10.64	144								481											MEDIUM
HART BROOK-ADLUB02-VRMP	**HB-7**	8/22/2014	8:29 AM	BASE FLOW	NA	17.5	84.8	8.19	186								482											LOW
HART BROOK-ADLUB02-VRMP	**HB-7**	5/29/2015	8:19 AM	BASE FLOW	NA	16.2	94.5	9.3									260											LOW
HART BROOK-ADLUB02-VRMP	**HB-7**	6/12/2015	7:58 AM	BASE FLOW	NA	15.7	98.1	9.7									600											LOW
HART BROOK-ADLUB02-VRMP	**HB-7**	6/12/2015	7:58 AM		FB	15.7	98.2	9.8									500											
HART BROOK-ADLUB02-VRMP	**HB-7**	6/26/2015	10:35 AM	BASE FLOW	NA	15.2	99.3	10.0									400											LOW
HART BROOK-ADLUB02-VRMP	**HB-7**	6/26/2015	10:35 AM		FB	15.1	100.6	10.1									400											
HART BROOK-ADLUB02-VRMP	**HB-7**	7/17/2015	8:59 AM	BASE FLOW	NA	16.1	101.3	10.2									372											MEDIUM
HART BROOK-ADLUB02-VRMP	**HB-7**	10/10/2015	13:40		NA	10.8								6.5			244.9											
HART BROOK-ADLUB02-VRMP	**HB-7**	10/14/2015	14:20		NA	14.2								6.8			264.8											
HART BROOK-ADLUB02-VRMP	**HB-7**	10/15/2015	14:16		NA	11.7								7.0			262.3											
HART BROOK-ADLUB02-VRMP	**HB-7**	10/22/2015	16:08		NA	12.0								6.8			234.2											
HART BROOK-ADLUB02-VRMP	**HB-7**	10/24/2015	15:53		NA	10.4								6.6			232.1											
HART BROOK-ADLUB02-VRMP	**HB-7**	10/26/2015	14:38		NA	9.2								5.8			191.0											
HART BROOK-ADLUB02-VRMP	**HB-7**	10/29/2015	16:55		NA	13.4								6.8			133.0											
HART BROOK-ADLUB02-VRMP	**HB-7**	11/4/2015	14:20		NA	10.3								8.9			244.8											
HART BROOK-ADLUB02-VRMP	**HB-7**	11/8/2015	11:31		NA	8.2								9.9			225.5											
HART BROOK-ADLUB02-VRMP	**HB-7**	11/9/2015	14:30		NA	8.1								8.8			211.0											
HART BROOK-ADLUB02-VRMP	**HB-7**	11/12/2015	14:24		NA	7.6								7.5			209.9											
HART BROOK-ADLUB02-VRMP	**HB-7**	11/18/2015	15:15		NA	4.7								7.5			180.8											
HART BROOK-ADLUB02-VRMP	**HB-7**	11/24/2015	14:23		NA	3.7								7.0			212.0											
HART BROOK-ADLUB02-VRMP	**HB-7**	11/29/2015	12:46		NA	4.3								8.2			161.0											
HART BROOK-ADLUB02-VRMP	**HB-7**	12/1/2015	15:24		NA	3.5								7.8			171.7											
HART BROOK-ADLUB02-VRMP	**HB-7**	12/5/2015	15:16		NA	5.9								7.8			176.3											
HART BROOK-ADLUB02-VRMP	**HB-7**	12/8/2015	18:32		NA	4.6								-			153.0											
HART BROOK-ADLUB02-VRMP	**HB-7**	12/15/2015	14:16		NA	6.0								6.8			107.0											
HART BROOK-ADLUB02-VRMP	**HB-7**	12/20/2015	13:49		NA	2.7								7.6			164.3											
HART BROOK-ADLUB02-VRMP	**HB-7**	12/21/2015	14:30		NA	3.3								7.2			170.8											

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADLUB02-VRMP	**HB-7**	5/12/2016	13:00	BASE FLOW	NA	14.7								7.5			318											
HART BROOK-ADLUB02-VRMP	**HB-7**	5/17/2016	6:30	BASE FLOW	NA	8.5	102.1	11.9	613	0.023	0.43	0.359	0.79	7.3	2.4	1.8	276	68										
HART BROOK-ADLUB02-VRMP	**HB-7**	6/6/2016	10:15	STORM FLOW	NA	14.4	89.6	9.2	>2420	0.237	0.2	1.28	1.5	6.5	20.3	13.4	178	30	<0.005	<0.01	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADLUB02-VRMP	**HB-7**	6/20/2016	6:13	BASE FLOW	NA	14.8	83.6	8.5	387	0.148	0.89	0.466	1.4	6.9	7.8	20.7	570	110										
HART BROOK-ADLUB02-VRMP	**HB-7**	6/22/2016	14:25	STORM FLOW	NA	19.1	91.9	8.5	>2420	1.29	0.35	3.36	3.7	6.8	70	88.6	105	9.5	<0.005	0.0136	<0.005	<0.01	<0.01	<0.0002	0.0104	<0.007	1.51	7.8
HART BROOK-ADLUB02-VRMP	**HB-7**	7/21/2016	6:15	BASE FLOW	NA	16.9	90.3	8.8	435	0.058	1	0.368	1.4	6.8	5.1	6.6	619	100	0.0075	0.0125	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	8.1
HART BROOK-ADLUB02-VRMP	**HB-7**	7/21/2016	16:05	BASE FLOW	NA	19.3	99.2	9.1						8.1	5		697											
HART BROOK-ADLUB02-VRMP	**HB-7**	8/25/2016	6:20	BASE FLOW	NA	18.2	83.4	7.9	93	0.03	1.1	0.432	1.5	7.6	6.4	3.6	571	100										
HART BROOK-ADLUB02-VRMP	**HB-7**	8/25/2016	16:20	BASE FLOW	NA	20.7	89.1	8.0						7.8	-		604											8
HART BROOK-ADLUB02-VRMP	**HB-7**	9/13/2016	6:30	BASE FLOW	NA	14.1	68.8	7.1	727	0.02	0.61	2.59	3.2	7.4	4.65	<5	507	87	0.0078	0.012	<0.005	0.002 J	<0.01	<0.0002	<0.01	<0.007	0.098 J	8.05
HART BROOK-ADLUB02-VRMP	**HB-7**	9/13/2016	16:10	BASE FLOW	NA	17.0	66.1	6.4						7.6	-		610											8.2
HART BROOK-ADLUB02-VRMP	**HB-7**	11/15/2016	9:09	BASE FLOW	NA	7.6	97.5	11.6						7.5	4.1		419											8
HART BROOK-ADLUB02-VRMP	**HB-7**	6/28/2017	10:53	BASE FLOW	NA	15.7	87.7	8.7						7.5			185											7.9
HART BROOK-ADLUB02-VRMP	**HB-7**	7/27/2017	8:15	BASE FLOW	NA	17.8	78	7.4	326	0.117	0.95	0.622	1.6	7.36	11.9	9	669	130										8.23
HART BROOK-ADLUB02-VRMP	**HB-7**	8/22/2017	6:43	BASE FLOW	NA	16.03	90.2	8.52	186	0.040	1.1	0.344	1.4	7.13	5.4	2.7	662	130										7.9
HART BROOK-ADLUB02-VRMP	**HB-7**	8/22/2017	16:08	BASE FLOW	NA	19.06	83.1	7.69						7.71	8.1		794											8.15
HART BROOK-ADLUB02-VRMP	**HB-7**	9/28/2017	6:50	BASE FLOW	NA	18.97	71.2	6.6	1553	0.165	1.1	0.676	1.8	7.55	5.22	6.4	734	140										8.1
HART BROOK-ADLUB02-VRMP	**HB-7**	9/28/2017	16:26	BASE FLOW	NA	17.12	79.3	7.64						7.83	3.54		788											8.11
HART BROOK-ADLUB02-VRMP	**HB-7**	11/2/2017	9:27	BASE FLOW	NA	11.77	91.6	9.9						7.14	4.81		381											8.03
HART BROOK-ADLUB02-VRMP	**HB-7**	12/8/2017	12:20	BASE FLOW	NA	3.05	95.8	12.87						7.61	5.7		320											7.94

VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
HART BROOK-ADL30-VRMP	**HB-8**	6/6/2014	10:13 AM	BASE FLOW	NA	13.5	88.5	9.3																				LOW
HART BROOK-ADL30-VRMP	**HB-8**	6/27/2014	8:32 AM	BASE FLOW	NA	14	86.8	8.95									507											LOW
HART BROOK-ADL30-VRMP	**HB-8**	7/11/2014	8:30 AM	BASE FLOW	NA	16.3	92.4	9.03	150								515											LOW
HART BROOK-ADL30-VRMP	**HB-8**	8/8/2014	8:10 AM	BASE FLOW	NA	16.1	106.9	10.37	276								374											LOW
HART BROOK-ADL30-VRMP	**HB-8**	8/8/2014	8:10 AM		Duplicate	15.9	106.5	10.53	1986								384											
HART BROOK-ADL30-VRMP	**HB-8**	4/10/2015	8:00		NA	3.8		9.0						6.4	32		244											
HART BROOK-ADL30-VRMP	**HB-8**	5/29/2015	8:32 AM	BASE FLOW	NA	16.6	85.1	8.2									862											LOW
HART BROOK-ADL30-VRMP	**HB-8**	6/12/2015	8:18 AM	BASE FLOW	NA	16.9	82.1	7.9									1000											LOW
HART BROOK-ADL30-VRMP	**HB-8**	6/26/2015	11:00 AM	BASE FLOW	NA	15.9	105.7	10.5									700											LOW
HART BROOK-ADL30-VRMP	**HB-8**	7/17/2015	8:45 AM	BASE FLOW	NA	15.1	80.6	8.1									1390											LOW
HART BROOK-ADL30-VRMP	**HB-8**	5/12/2016	13:30	BASE FLOW	NA	17.9								7.7			273											
HART BROOK-ADL30-VRMP	**HB-8**	5/13/2016	14:00	BASE FLOW	NA	14.6	99.6	10.1						8.1			352											
HART BROOK-ADL30-VRMP	**HB-8**	5/17/2016	7:25	BASE FLOW	NA	8.1	92.8	11.0	10	0.009	<0.1	<0.3	<0.3	6.7	2.6	1.4	402	91										
HART BROOK-ADL30-VRMP	**HB-8**	5/17/2016	7:25	BASE FLOW	Duplicate	8.1	92.8	11.0	12	0.002	<0.1	0.43	0.43	6.7	2.6	2.2	402	91										
HART BROOK-ADL30-VRMP	**HB-8**	6/6/2016	10:50	STORM FLOW	NA	14.1	88.2	9.1	687	0.07	<0.1	0.527	0.53	7.0	11.8	6.8	314	62	<0.005	<0.01	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
HART BROOK-ADL30-VRMP	**HB-8**	6/20/2016	6:14	BASE FLOW	NA	14.5	70.1	7.1	82	0.038	0.14	7.14	7.3	7.2	18	8.3	849	190										
HART BROOK-ADL30-VRMP	**HB-8**	6/22/2016	14:40	STORM FLOW	NA	16.2	85.4	8.4	>2420	0.183	<0.1	0.771	0.77	6.9	19	14.3	411	84	<0.005	<0.01	<0.005	<0.01	<0.01	0.00029	0.0104	<0.007	<0.2	
HART BROOK-ADL30-VRMP	**HB-8**	7/8/2016	10:45	BASE FLOW	NA	16.3	67.8	6.6						6.1	4		816											
HART BROOK-ADL30-VRMP	**HB-8**	7/21/2016	6:30	BASE FLOW	NA	16.6	85.6	8.3	46	0.024	0.14	0.334	0.47	7.1	4.8	6.2	722	140	0.0104	<0.01	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	3.15
HART BROOK-ADL30-VRMP	**HB-8**	7/21/2016	15:36	BASE FLOW	NA	18.4	76.6	7.2						7.4	4.4		849											
HART BROOK-ADL30-VRMP	**HB-8**	8/25/2016	6:45	BASE FLOW	NA	17.7	74.6	7.1	548	0.009	0.12	0.317	0.44	7.7	10	4.5	525	100										
HART BROOK-ADL30-VRMP	**HB-8**	8/25/2016	16:35	BASE FLOW	NA	19.1	85.5	7.9						7.9	-		532											3.11
HART BROOK-ADL30-VRMP	**HB-8**	9/13/2016	7:16	BASE FLOW	NA	13.2	72.2	7.6	>2420	0.012	0.11	1.94	2	7.6	10.8	7.8	398	73	0.0079	0.0081 J	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	0.143 J	3.12
HART BROOK-ADL30-VRMP	**HB-8**	9/13/2016	16:23	BASE FLOW	NA	15.4	72.0	7.2						7.9	-		387											3.16
HART BROOK-ADL30-VRMP	**HB-8**	10/18/2016	15:35	BASE FLOW	NA	10.8	22.8	2.5						-	-		569											
HART BROOK-ADL30-VRMP	**HB-8**	11/15/2016	8:03	BASE FLOW	NA	4.5	96.0	12.4						7.1	6.9		559											3.06
HART BROOK-ADL30-VRMP	**HB-8**	7/27/2017	8:35	BASE FLOW	NA	16.56	68.6	6.63	435	0.073	0.15	0.359	0.51	7.38	22	23.5	801	160										3.2
HART BROOK-ADL30-VRMP	**HB-8**	8/22/2017	7:04	BASE FLOW	NA	17.64	76.3	7.26	548	0.080	0.11	0.491	0.6	7.27	11	6.6	553	100										3
HART BROOK-ADL30-VRMP	**HB-8**	8/22/2017	16:38	BASE FLOW	NA	18.25	67.5	6.32						7.82	5.1		584											3.2
HART BROOK-ADL30-VRMP	**HB-8**	9/28/2017	7:15	BASE FLOW	NA	19.11	22	2.05	50	0.117	<0.1	3.66	3.7	7.39	2.84	5	862	160										3.2
HART BROOK-ADL30-VRMP	**HB-8**	9/28/2017	16:42	BASE FLOW	NA	17.52	24	2.25						7.82	5.34		867											2.21

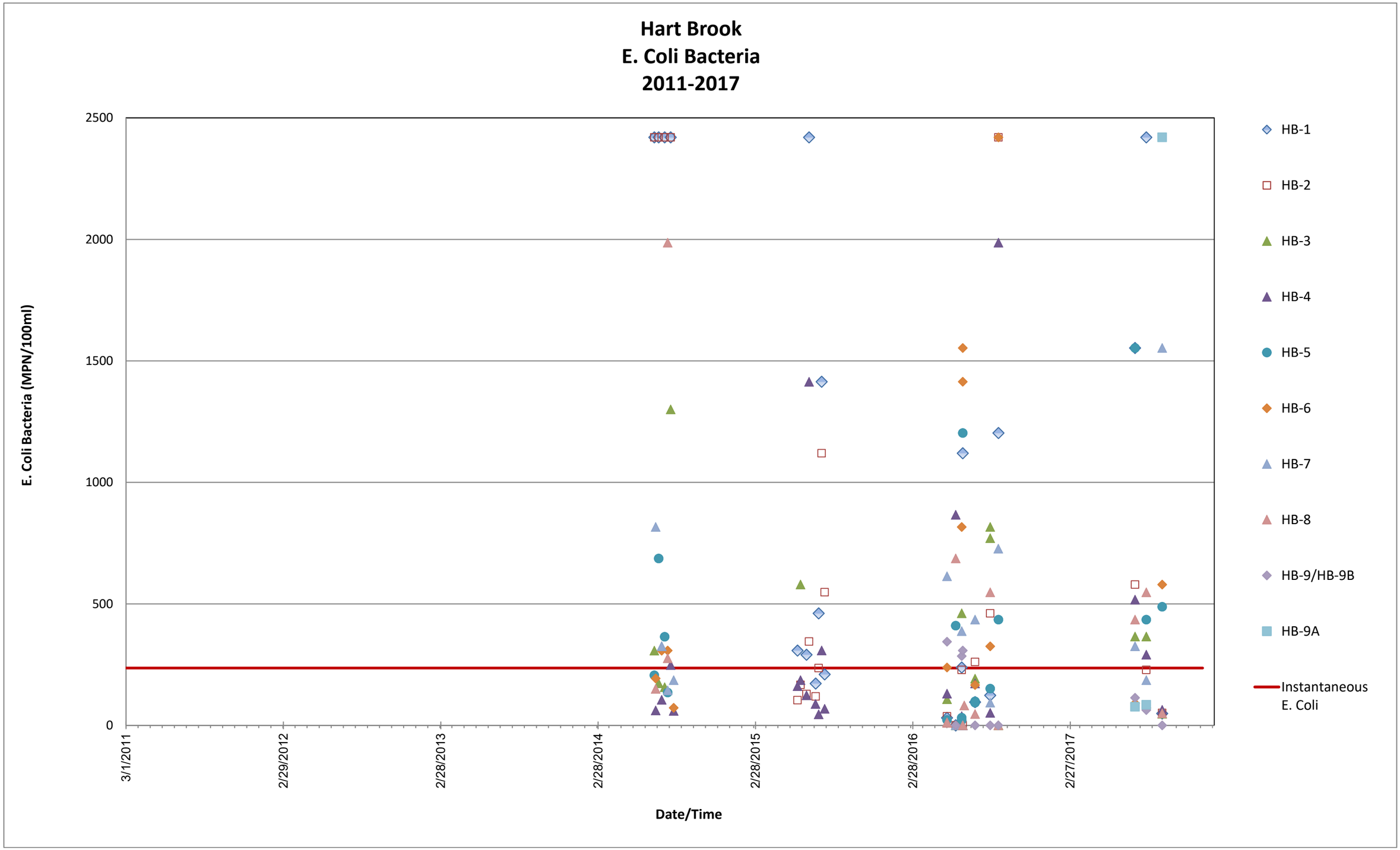
VRMP Site ID	Organization Site Code	Date	Time	Event Type	Sample Type Qualifier	Water Temp (DEG C)	D.O. Sat. (%)	D.O. (MG/L)	E Coli Bacteria (MPN / 100ML)	Phosphorus (mg/L)	Nitrogen, Nitrate/ Nitrite (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Total Nitrogen (mg/L)	pH (STU)	Turbidity (NTU)	TSS (mg/L)	Specific Conductivity (µS/cm)	Chloride (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)	Stage (ft./dtw)
-	**Regulatory Standard**	-	-	-	-	-	**75%[1]**	**7[1]**	**236 (instant)[1]**	**0.03[267]**	-	-	-	-	-	-	**2735 (acute)1**	-	**0.150 (CCC)[4]**	-	**0.08 (CCC)[4]**	**23.1 (CCC)[4]**	**0.0041 (CCC)[4]**	**0.00091 (chronic)[5]**	**0.005 (CCC)[4]**	-	-	-
-	**Regulatory Standard**	-	-	-	-	-			**64 (geo mean)[1]**		-	-	-	-	-	-	**835 (chronic)1**	-	**0.340 (CMC)[3]**	-	**0.42 (CMC)[3]**	**483 (CMC)[3]**	**0.1052 (CMC)[3]**	**0.0017 (acute)[5]**	-	**0.0023 (CMC)[3]**	-	-
NA	**HB-9 / HB-9A**	5/12/2016	14:00	BASE FLOW	NA	19.3								7.4			220											
NA	**HB-9 / HB-9A**	5/17/2016	6:00	BASE FLOW	NA	7.1	98.7	9.2	344	<0.002	0.11	0.349	0.46	7.2	2.83	11.8	111	25										
NA	**HB-9 / HB-9A**	6/6/2016	9:55	STORM FLOW	NA	14.7	80.7	8.2	>2420	0.154	<0.1	0.676	0.68	6.1	14.5	4.4	88	10	<0.005	<0.01	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	
NA	**HB-9 / HB-9A**	6/20/2016	5:55	BASE FLOW	NA	12.9	85.1	8.6	285	0.682	1.1	0.867	2	6.7	19	173.2	417	83										
NA	**HB-9 / HB-9A**	6/22/2016	14:10	STORM FLOW	NA	17.9	90.8	8.5	308	1.66	0.59	4.49	5.1	6.8	85	98	286	45	0.0051	0.0268	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	3.81	5.32
NA	**HB-9 / HB-9A**	7/21/2016	15:25	BASE FLOW	NA	19.7	107.3	9.8						7.6	5.5		665											
NA	**HB-9 / HB-9A**	7/21/2016	6:00	BASE FLOW	NA	15.2	87.3	8.8	>2420	0.121	1.3	0.655	2	6.5	4.4	49.5	578	110	0.0079	0.0118	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.007	<0.2	5.45
NA	**HB-9 / HB-9A**	8/25/2016	5:55	BASE FLOW	NA	17.1	60.7	5.8	>2420	0.09	1.2	0.732	1.9	7.5	26	29.7	826	200										
NA	**HB-9 / HB-9A**	8/25/2016	16:10	BASE FLOW	NA	20.9	84.0	7.5						8.1	-		648											5.2
NA	**HB-9 / HB-9A**	9/13/2016	6:00	BASE FLOW	NA	13.4	49.1	5.1	>2420	0.644	1	8.69	9.7	7.2	64.8	330	634	120	0.0116	0.0383	<0.005	0.014	0.022	<0.0002	<0.01	<0.007	0.696	5.2
NA	**HB-9 / HB-9A**	9/13/2016	16:35	BASE FLOW	NA	18.8	53.5	5.0						7.6	-		595											5.2
NA	**HB-9 / HB-9A**	11/15/2016	7:47	BASE FLOW	NA	3.6	91.0	12.0						7.3	3.9		224											<5.25
NA	**HB-9 / HB-9A**	7/27/2017	7:21	BASE FLOW	NA	15.24	88.6	8.86	113	0.000	1.6	<0.3	1.6	7.1	16	<1	533	84										>5.55
NA	**HB-9 / HB-9A**	8/22/2017	6:25	BASE FLOW	NA	16.75	80.9	7.85	63	0.042	1.1	<0.3	1.1	6.91	5.9	4	641	150										5
NA	**HB-9 / HB-9A**	8/22/2017	16:50	BASE FLOW	NA	19.43	63.7	5.82						7.57	8.7		614											5.29
NA	**HB-9 / HB-9A**	9/28/2017	6:30	BASE FLOW	NA	18.63	22.2	2.07	>2420	0.099	0.81	10.4	11	7.14	5.32	46.8	1120	270										> 4.9
NA	**HB-9 / HB-9A**	9/28/2017	16:52	BASE FLOW	NA	17.31	28.2	2.75						7.76	3.79		870											
NA	**HB-9B**	7/27/2017	6:56	BASE FLOW	NA	16.46	55.2	5.36	77	0.052	0.94	0.525	1.5	6.62	9.02	6.4	178.9	170										
NA	**HB-9B**	8/22/2017	6:12	BASE FLOW	NA	17.27	43.3	4.15	85	0.106	0.5	0.723	1.2	6.48	15	20	3699	230										
NA	**HB-9B**	9/28/2017	6:15	BASE FLOW	NA	18.59	23.3	2.17	2420	0.261	0.14	14.6	15	7	9.47	17.7	1293	240										
NA	**HB-9B**	9/28/2017	16:52	BASE FLOW	NA																							

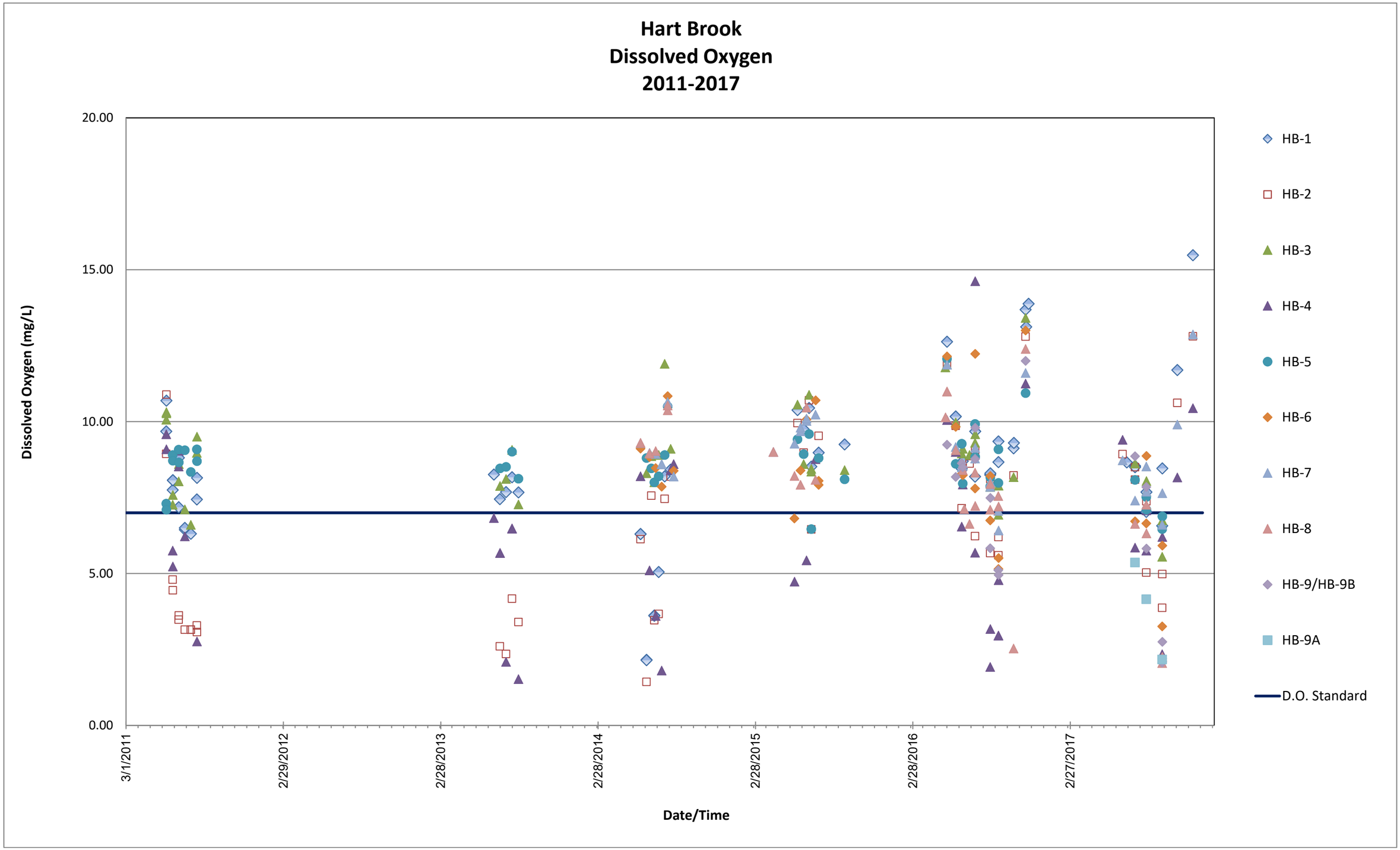
NOTES:

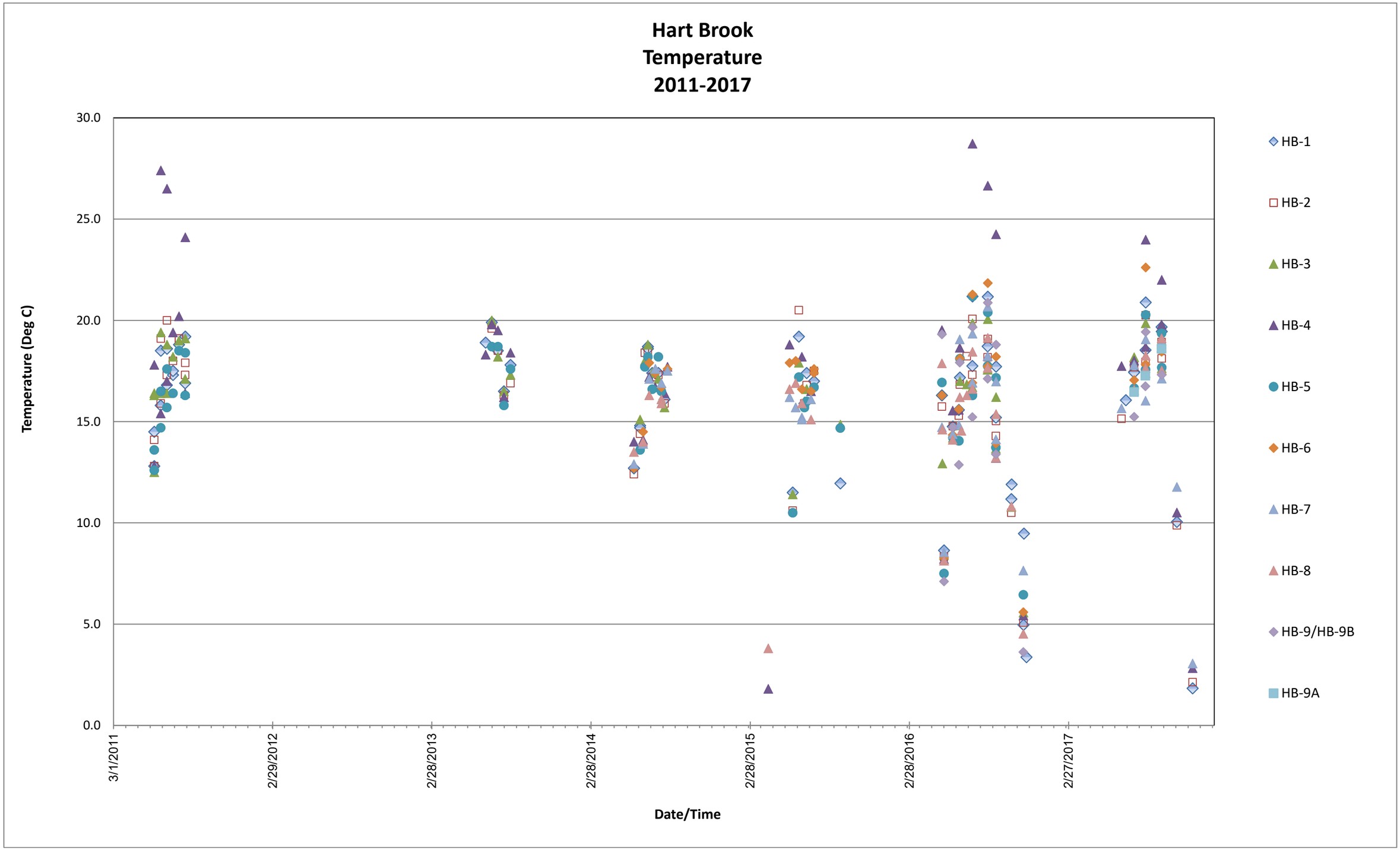
1. Dissolved Oxygen and E. Coli Standards as defined in Title 38 MRSA Chapter 465
2. Average phosphorous concentration as defined in the Proposed Nutrient Criteria
3. Criteria Maximum Concentration - The maximum instantaneous (acute) concentration as defined in 06-096 CMR 584
4. Criteria Continuous Concentration - The maximum average concentration (chronic) as defined in 06-096 CMR 584
5. Acute and chronic concentrations as defined in Title 38 MRSA Section 420
6. If a value is below the detection limit than the detection limit value was used for calculating the mean
7. Average Phosphorus is calculated for each HB location for 2016 - if the average exceeded the regulatory standard all values included in the calculation are shaded

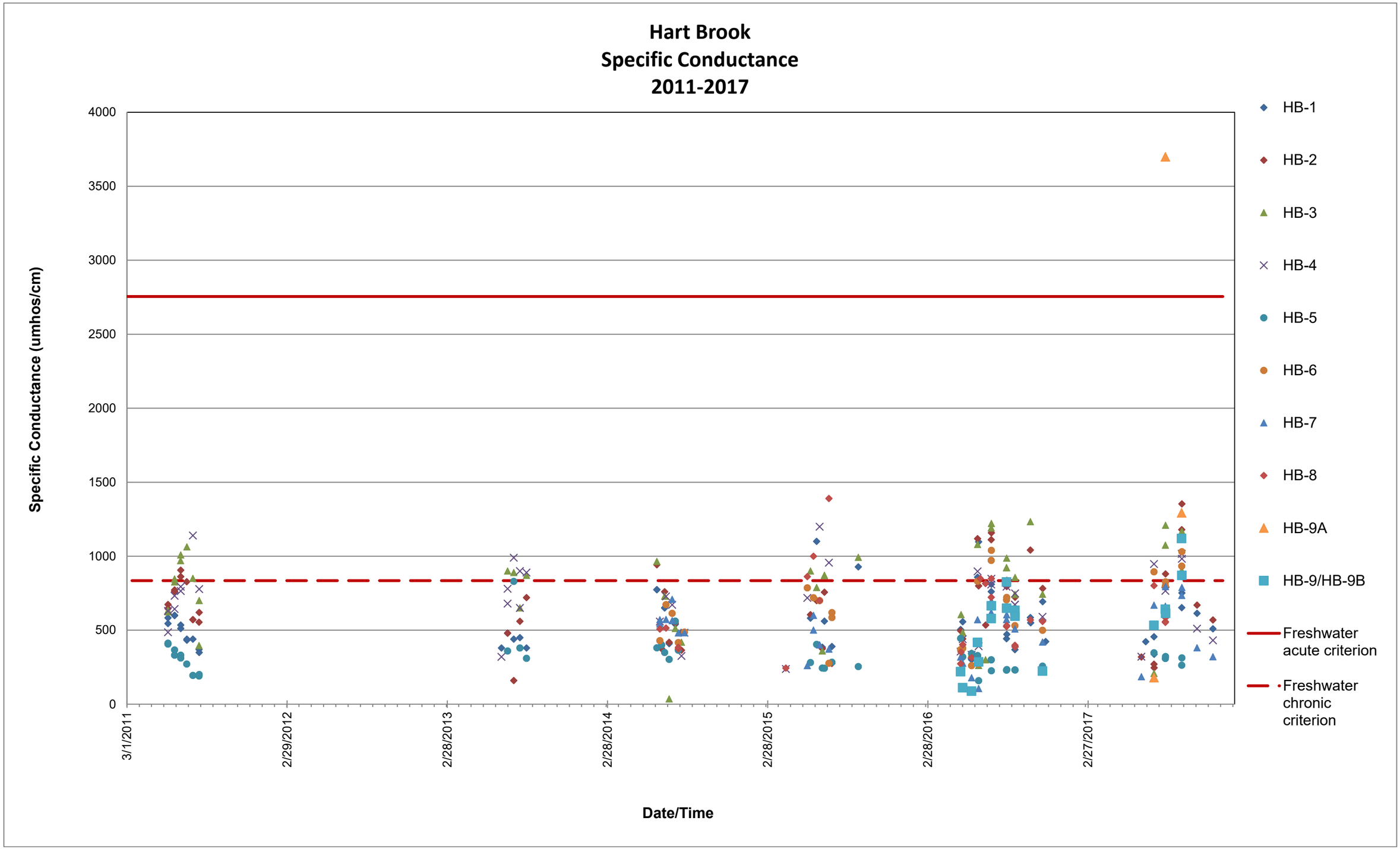
APPENDIX D

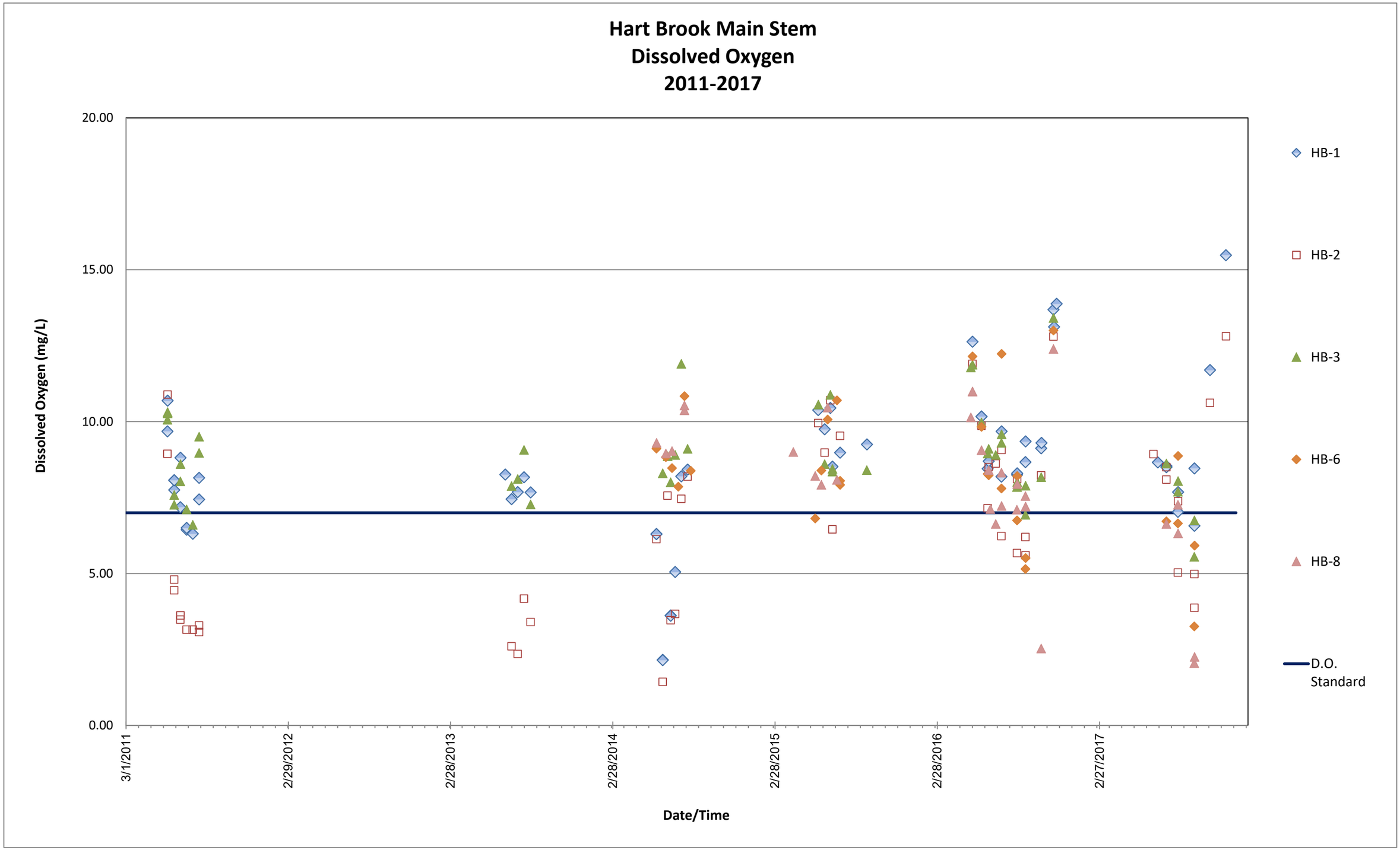
CHARTS OF HART BROOK MONITORING AND ANALYSIS CONCENTRATION VS. TIME 2011-2017

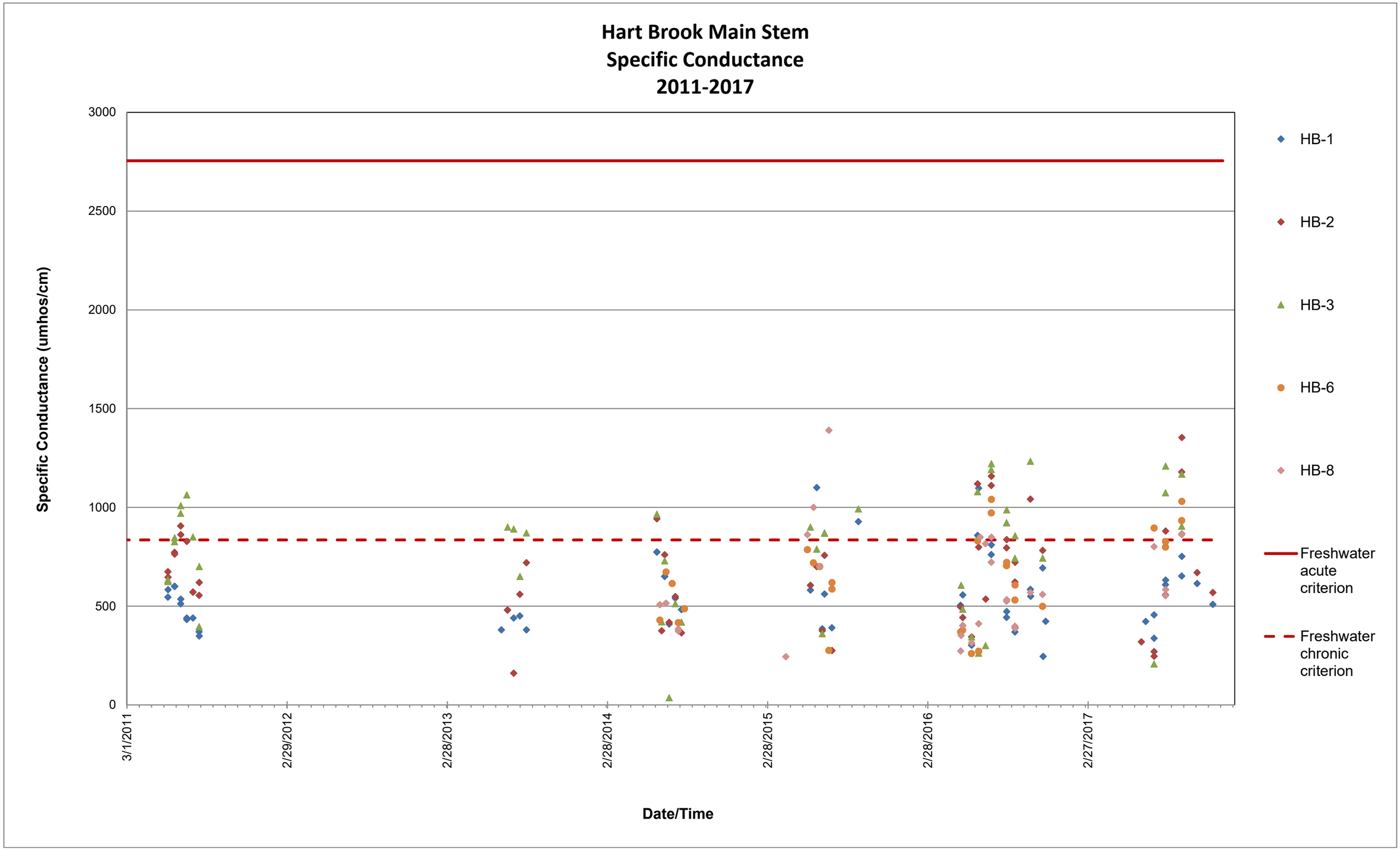

Hart Brook
E. Coli Bacteria
2011-2017
E. Coli Bacteria (MPN/100ml)
2500
2000
1500
1000
500
0
3/1/2011
2/29/2012
2/28/2013
2/28/2014
2/28/2015
2/28/2016
2/27/2017
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9/HB-9B
HB-9A
Instantaneous E. Coli

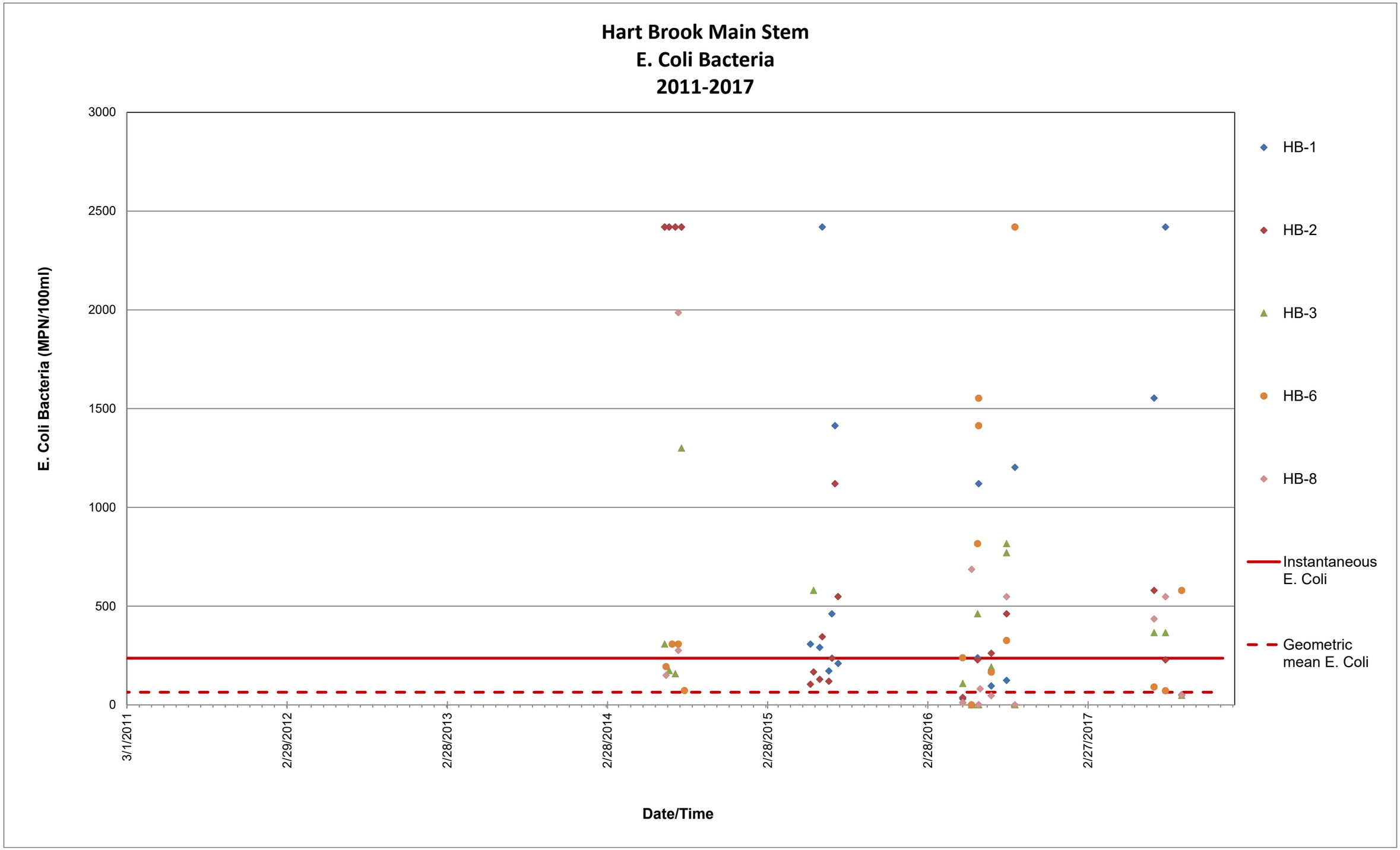

Hart Brook
Dissolved Oxygen
2011-2017
Dissolved Oxygen (mg/L)
20.00
15.00
10.00
5.00
0.00
3/1/2011
2/29/2012
2/28/2013
2/28/2014
2/28/2015
2/28/2016
2/27/2017
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9/HB-9B
HB-9A
D.O. Standard


Hart Brook
Temperature
2011-2017
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Temperature (Deg C)
3/1/2011
2/29/2012
2/28/2013
2/28/2014
2/28/2015
2/28/2016
2/27/2017
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9/HB-9B
HB-9A


Hart Brook
Specific Conductance
2011-2017
Specific Conductance (umhos/cm)
4000
3500
3000
2500
2000
1500
1000
500
0
3/1/2011
2/29/2012
2/28/2013
2/28/2014
2/28/2015
2/28/2016
2/27/2017
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9A
HB-9/HB-9B
Freshwater acute criterion
Freshwater chronic criterion

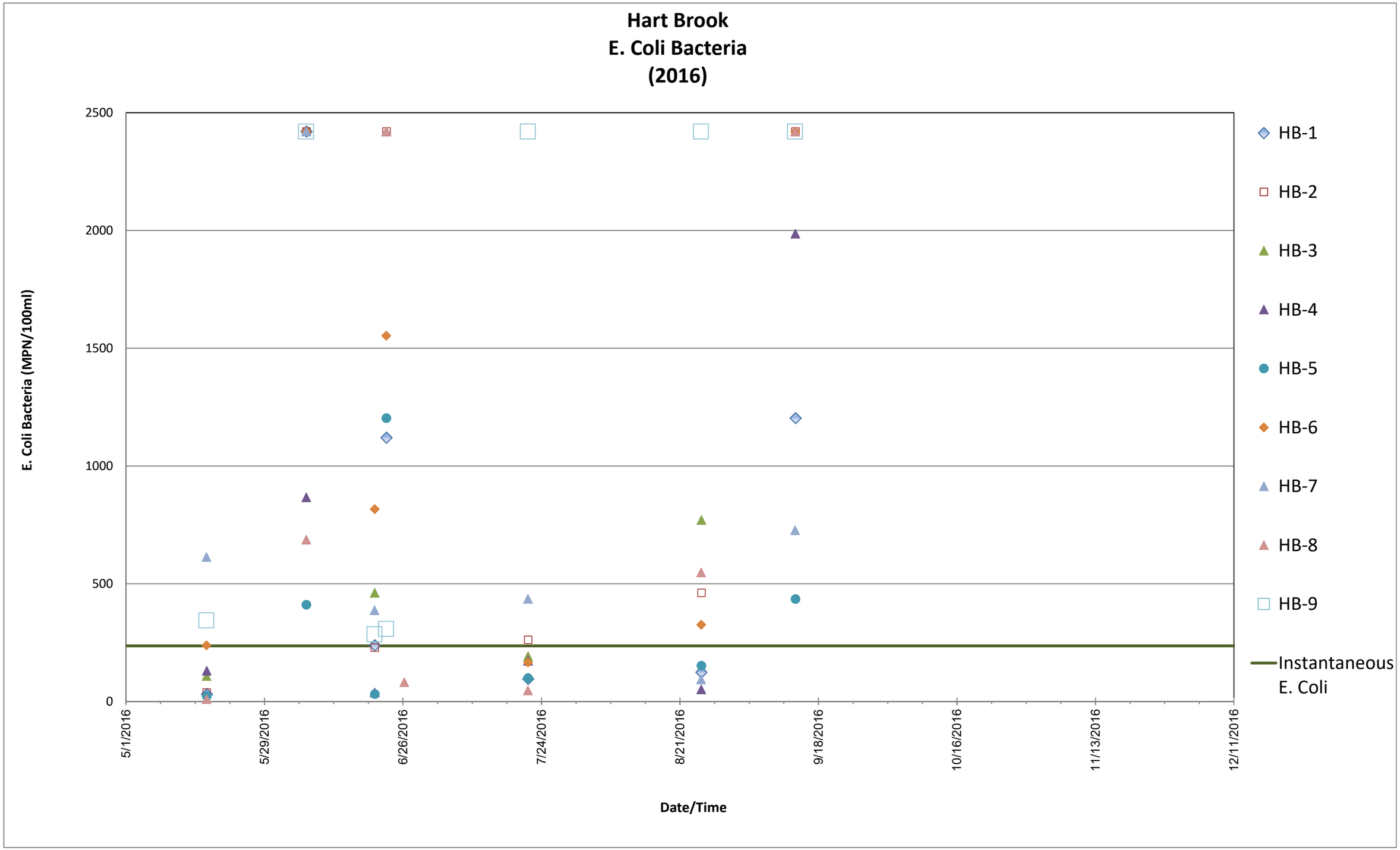

Hart Brook Main Stem
Dissolved Oxygen
2011-2017
20.00
15.00
10.00
5.00
0.00
Dissolved Oxygen (mg/L)
3/1/2011
2/29/2012
2/28/2013
2/28/2014
2/28/2015
2/28/2016
2/27/2017
Date/Time
HB-1
HB-2
HB-3
HB-6
HB-8
D.O. Standard

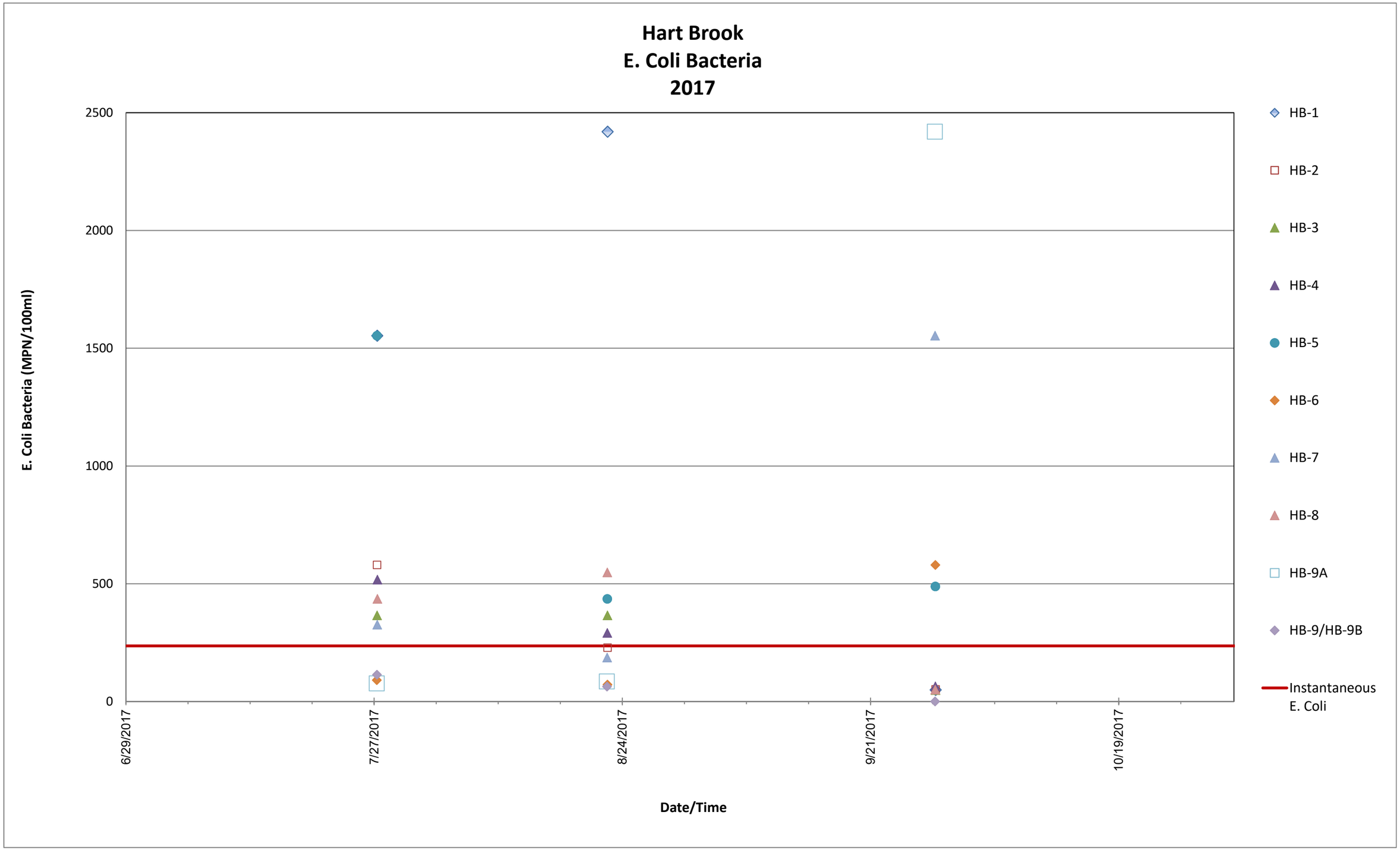

Hart Brook Main Stem
Specific Conductance
2011-2017
Specific Conductance (umhos/cm)
3000
2500
2000
1500
1000
500
0
3/1/2011
2/29/2012
2/28/2013
2/28/2014
2/28/2015
2/28/2016
2/27/2017
Date/Time
HB-1
HB-2
HB-3
HB-6
HB-8
Freshwater acute criterion
Freshwater chronic criterion

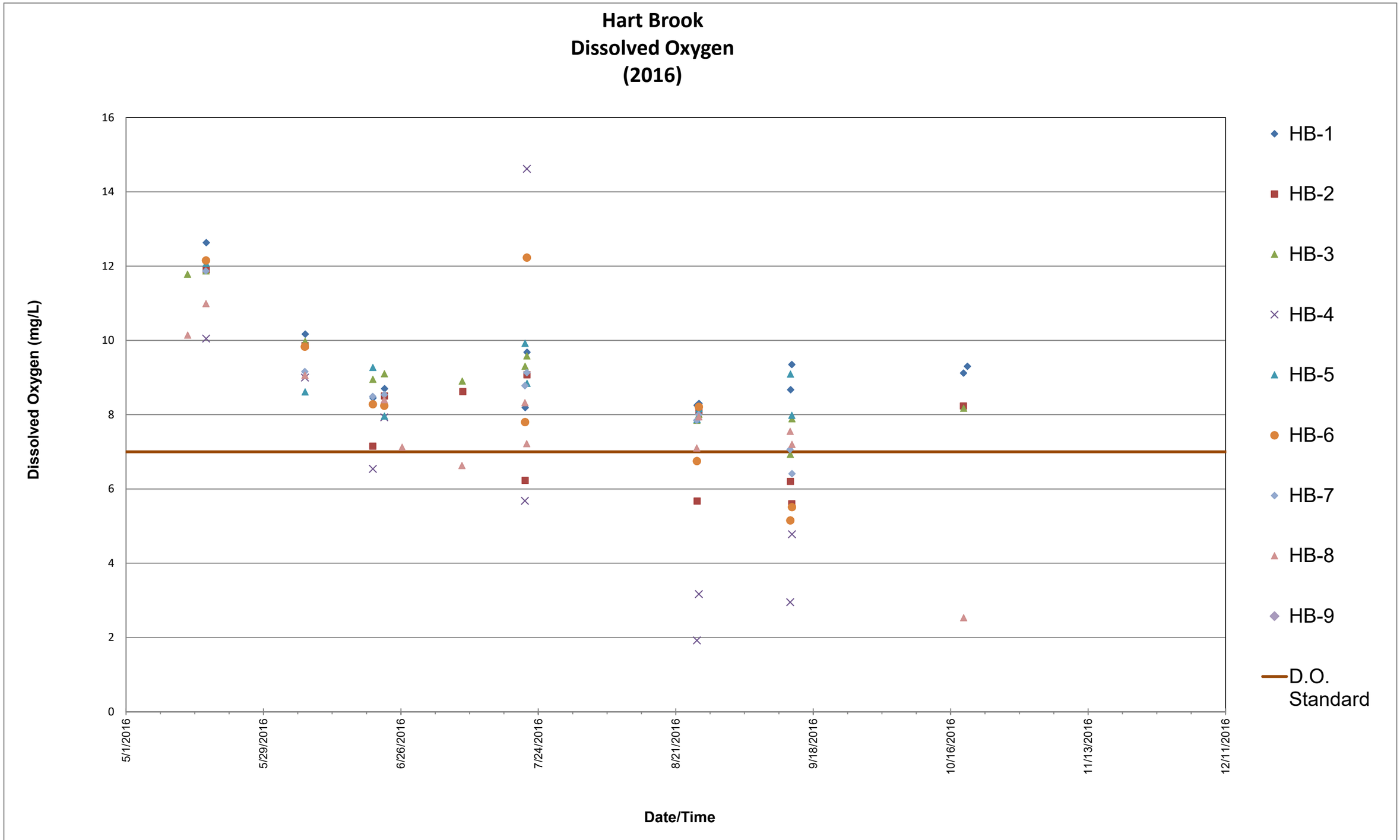

Hart Brook Main Stem
E. Coli Bacteria
2011-2017
E. Coli Bacteria (MPN/100ml)
3000
2500
2000
1500
1000
500
0
3/1/2011
2/29/2012
2/28/2013
2/28/2014
2/28/2015
2/28/2016
2/27/2017
Date/Time
HB-1
HB-2
HB-3
HB-6
HB-8
Instantaneous E. Coli
Geometric mean E. Coli

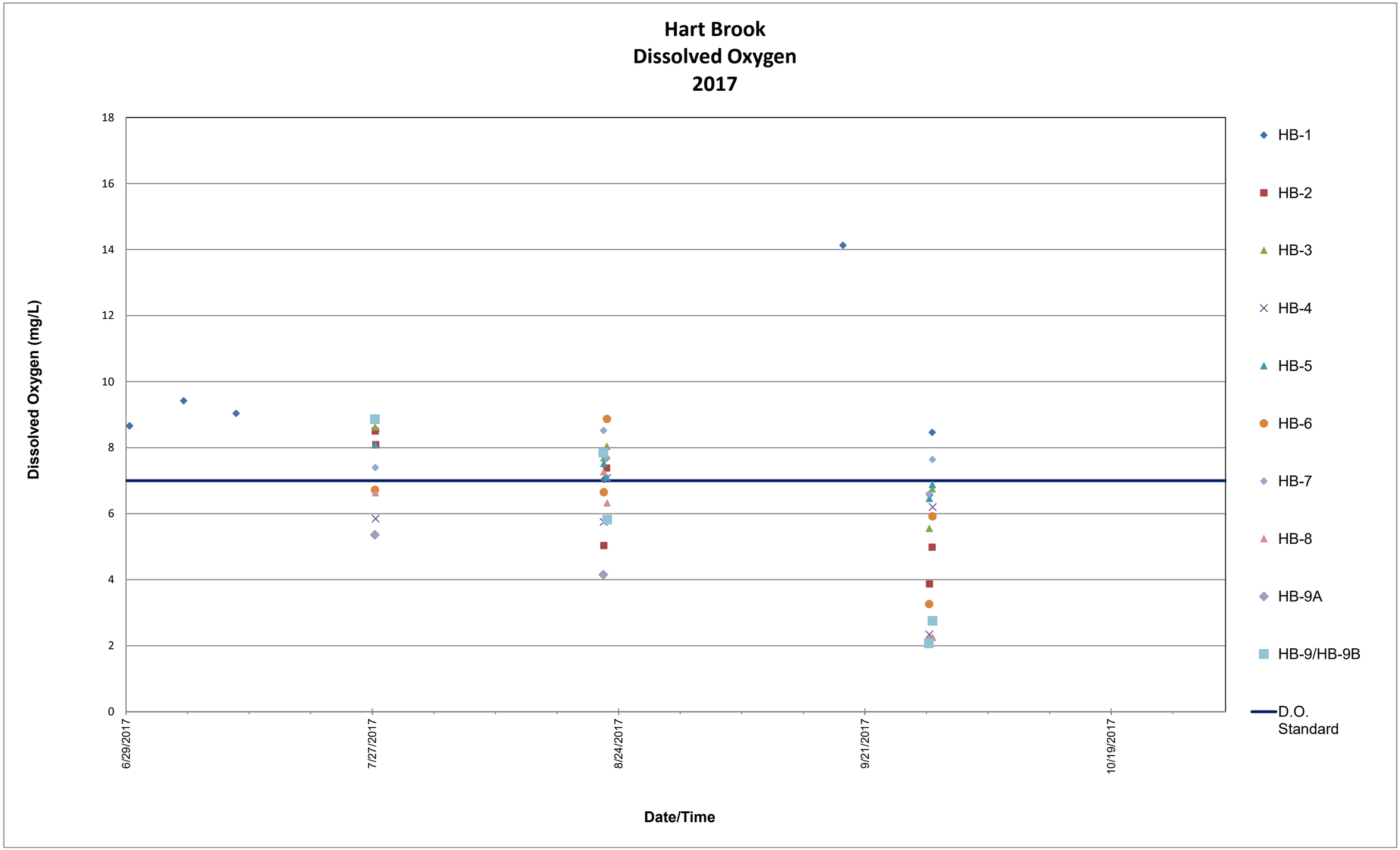
APPENDIX E

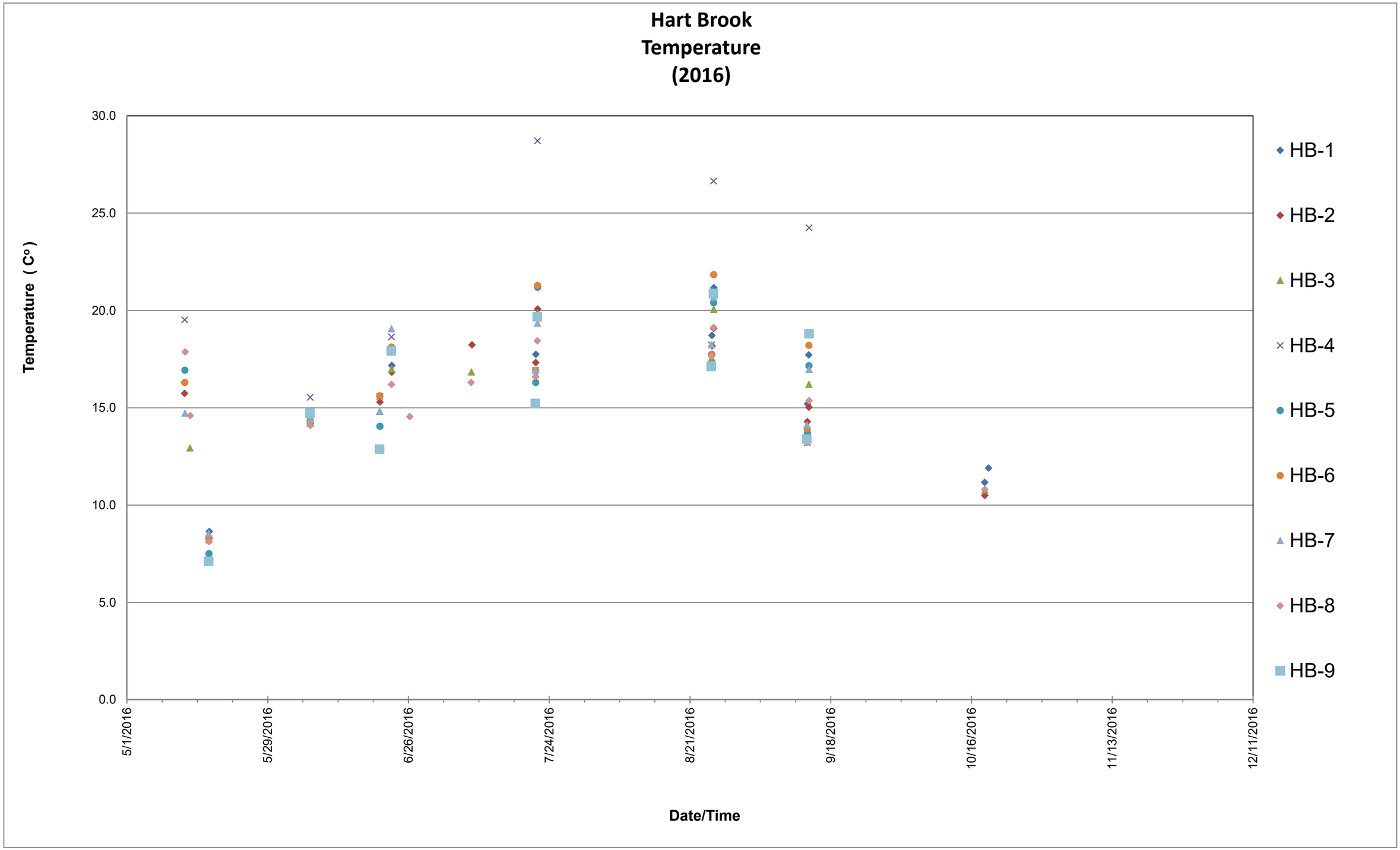
CHARTS OF HART BROOK MONITORING AND ANALYSIS CONCENTRATION VS. TIME 2016 AND 2017

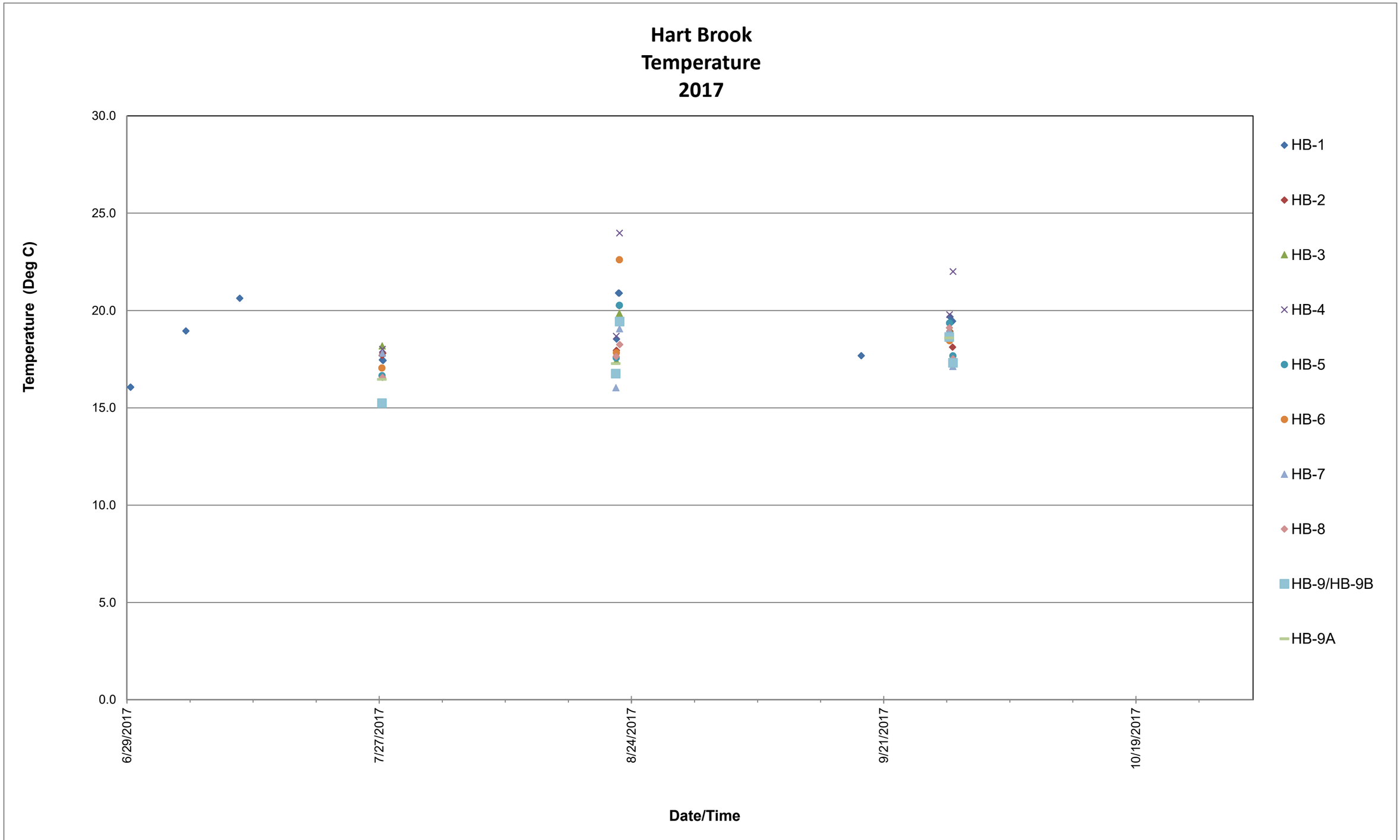

Hart Brook
E. Coli Bacteria
(2016)
E. Coli Bacteria (MPN/100ml)
2500
2000
1500
1000
500
0
5/1/2016
5/29/2016
6/26/2016
7/24/2016
8/21/2016
9/18/2016
10/16/2016
11/13/2016
12/11/2016
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9
Instantaneous E. Coli

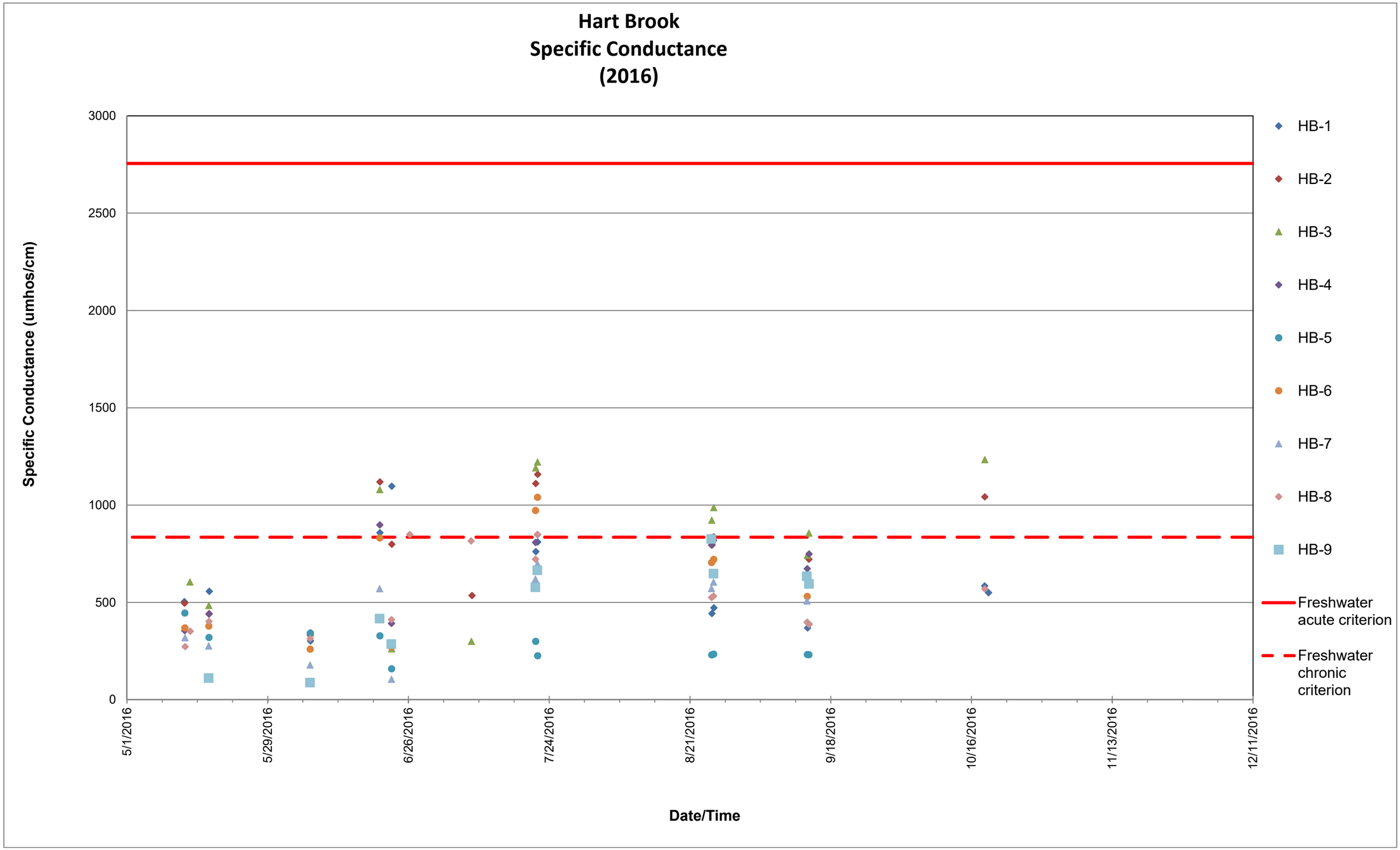

Hart Brook
E. Coli Bacteria
2017
E. Coli Bacteria (MPN/100ml)
2500
2000
1500
1000
500
0
6/29/2017
7/27/2017
8/24/2017
9/21/2017
10/19/2017
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9A
HB-9/HB-9B
Instantaneous E. Coli

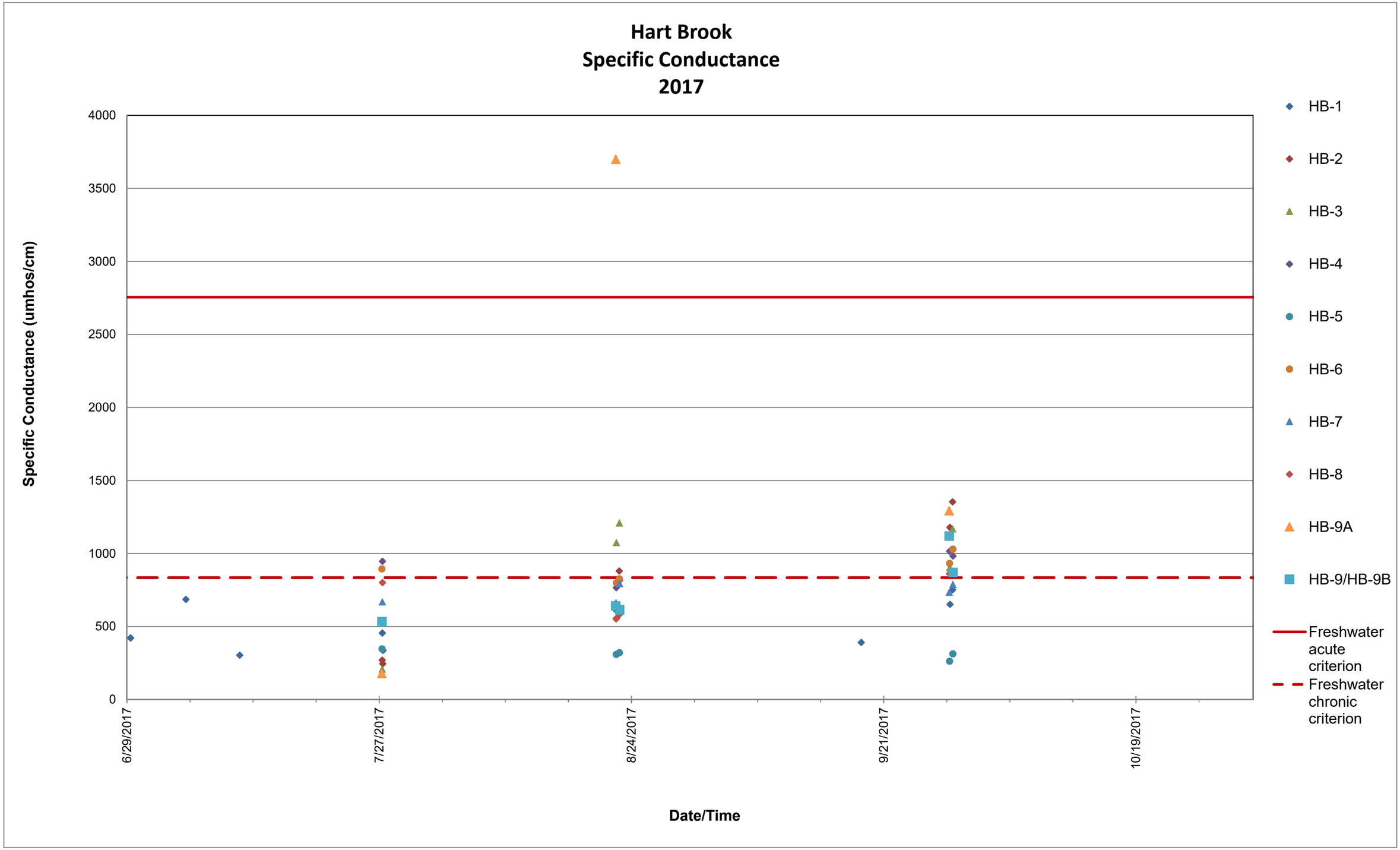

Hart Brook
Dissolved Oxygen
(2016)
Dissolved Oxygen (mg/L)
16
14
12
10
8
6
4
2
0
5/1/2016
5/29/2016
6/26/2016
7/24/2016
8/21/2016
9/18/2016
10/16/2016
11/13/2016
12/11/2016
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9
D.O. Standard


Hart Brook
Dissolved Oxygen
2017
Dissolved Oxygen (mg/L)
18
16
14
12
10
8
6
4
2
0
6/29/2017
7/27/2017
8/24/2017
9/21/2017
10/19/2017
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9A
HB-9/HB-9B
D.O. Standard


Hart Brook
Temperature
(2016)
Temperature (C°)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
5/1/2016
5/29/2016
6/26/2016
7/24/2016
8/21/2016
9/18/2016
10/16/2016
11/13/2016
12/11/2016
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9

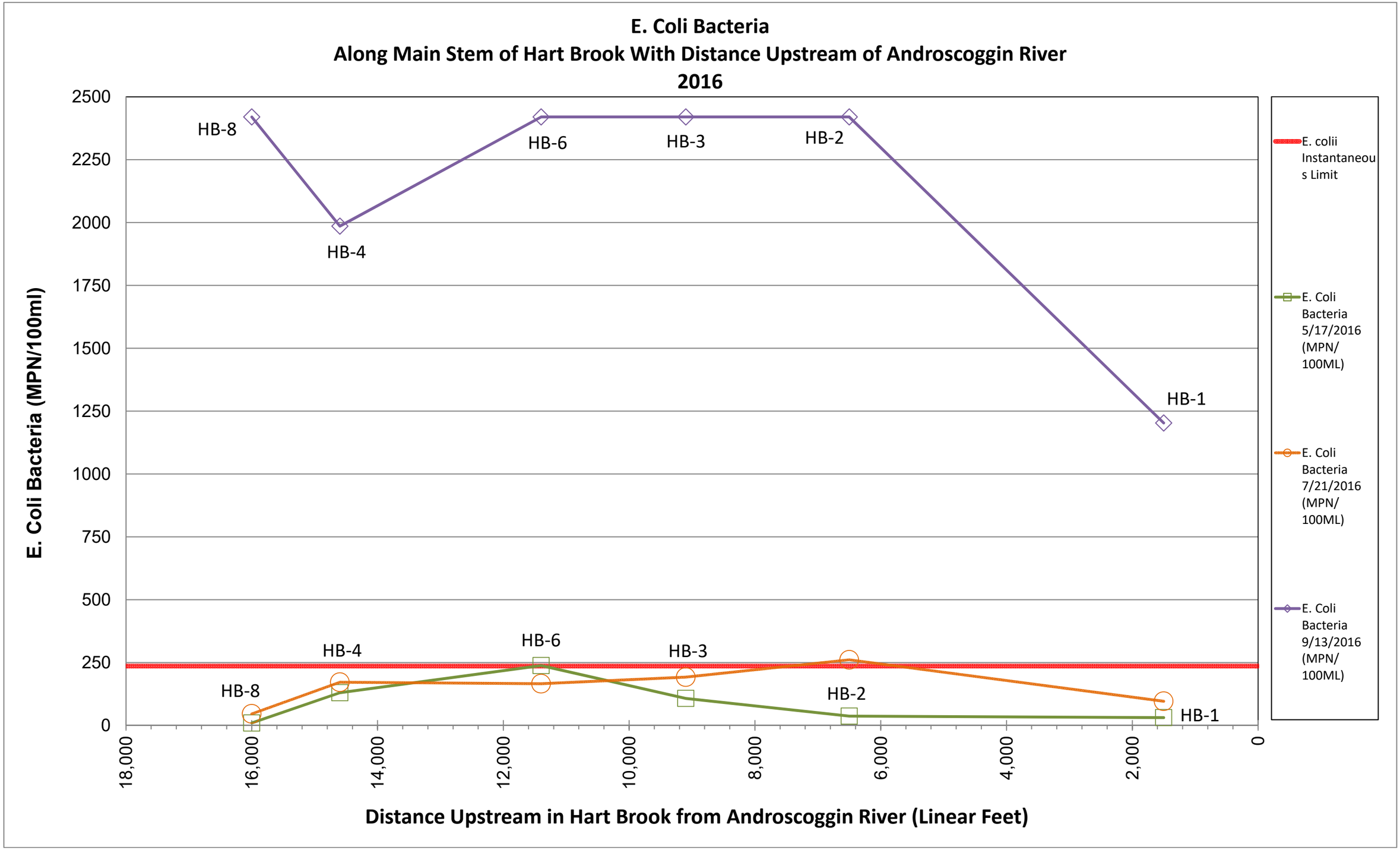

Hart Brook
Temperature
2017
Temperature (Deg C)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
6/29/2017
7/27/2017
8/24/2017
9/21/2017
10/19/2017
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9/HB-9B
HB-9A

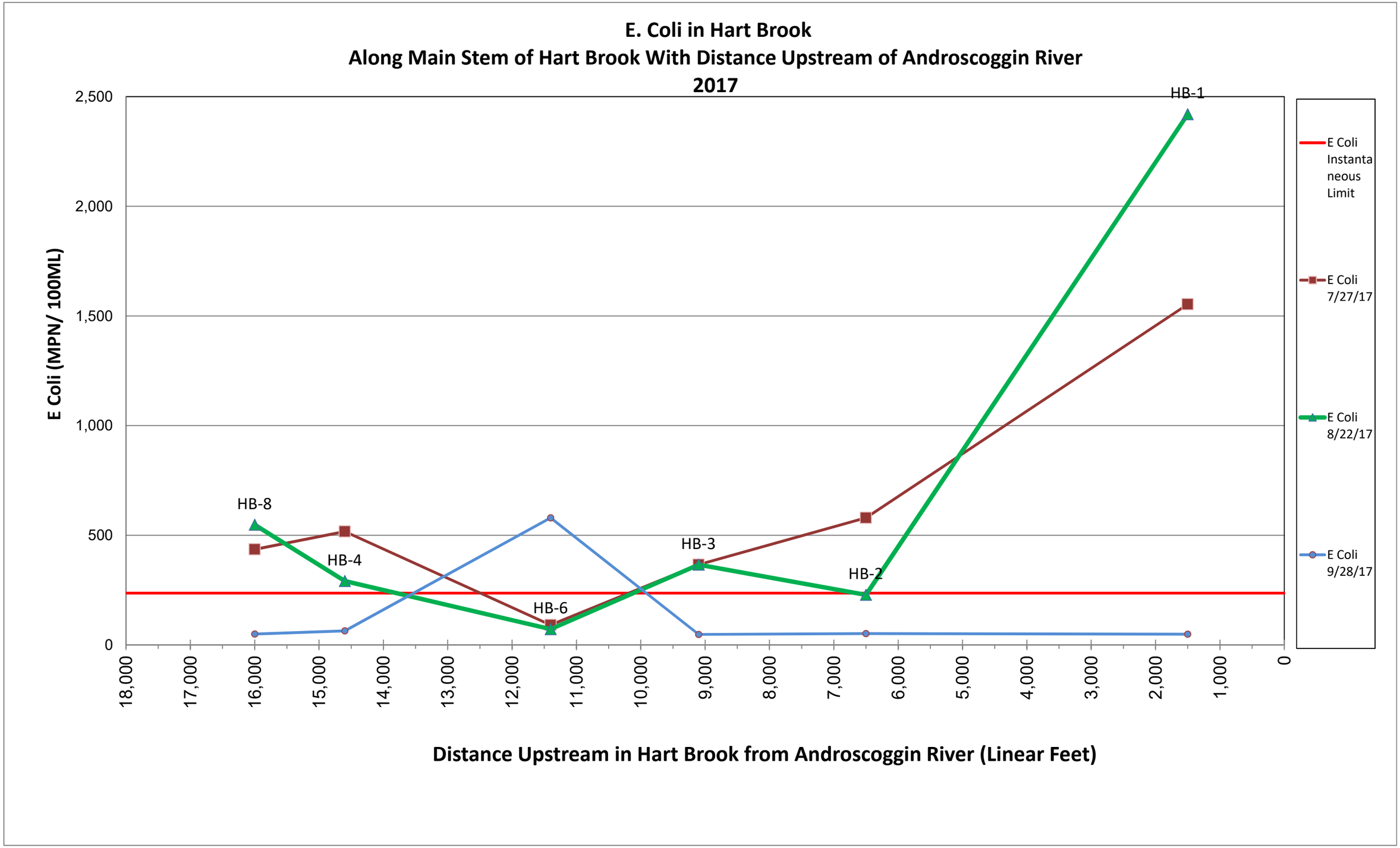

Hart Brook
Specific Conductance
(2016)
Specific Conductance (umhos/cm)
3000
2500
2000
1500
1000
500
0
5/1/2016
5/29/2016
6/26/2016
7/24/2016
8/21/2016
9/18/2016
10/16/2016
11/13/2016
12/11/2016
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9
Freshwater acute criterion
Freshwater chronic criterion

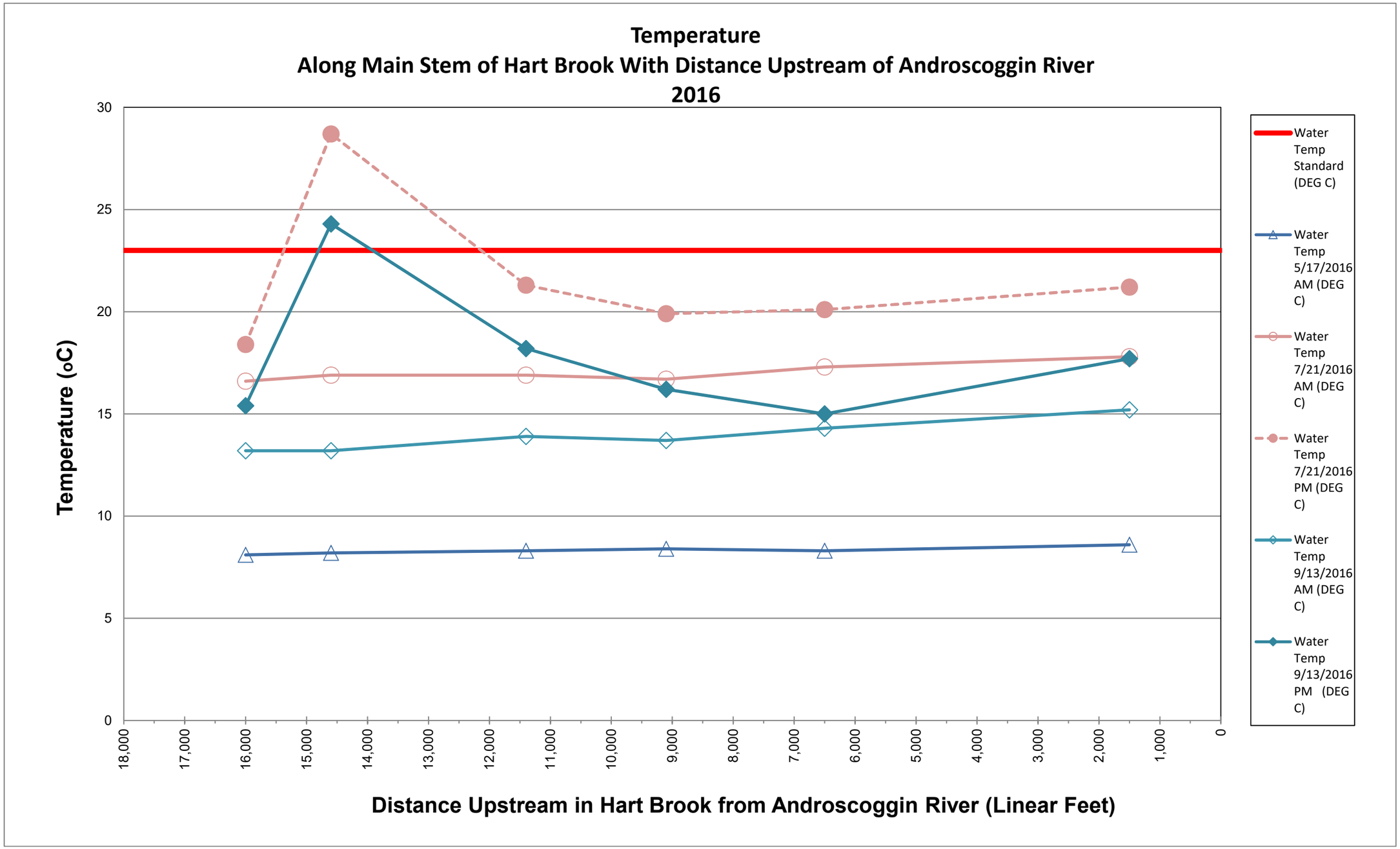

Hart Brook
Specific Conductance
2017
Specific Conductance (umhos/cm)
4000
3500
3000
2500
2000
1500
1000
500
0
6/29/2017
7/27/2017
8/24/2017
9/21/2017
10/19/2017
Date/Time
HB-1
HB-2
HB-3
HB-4
HB-5
HB-6
HB-7
HB-8
HB-9A
HB-9/HB-9B
Freshwater acute criterion
Freshwater chronic criterion

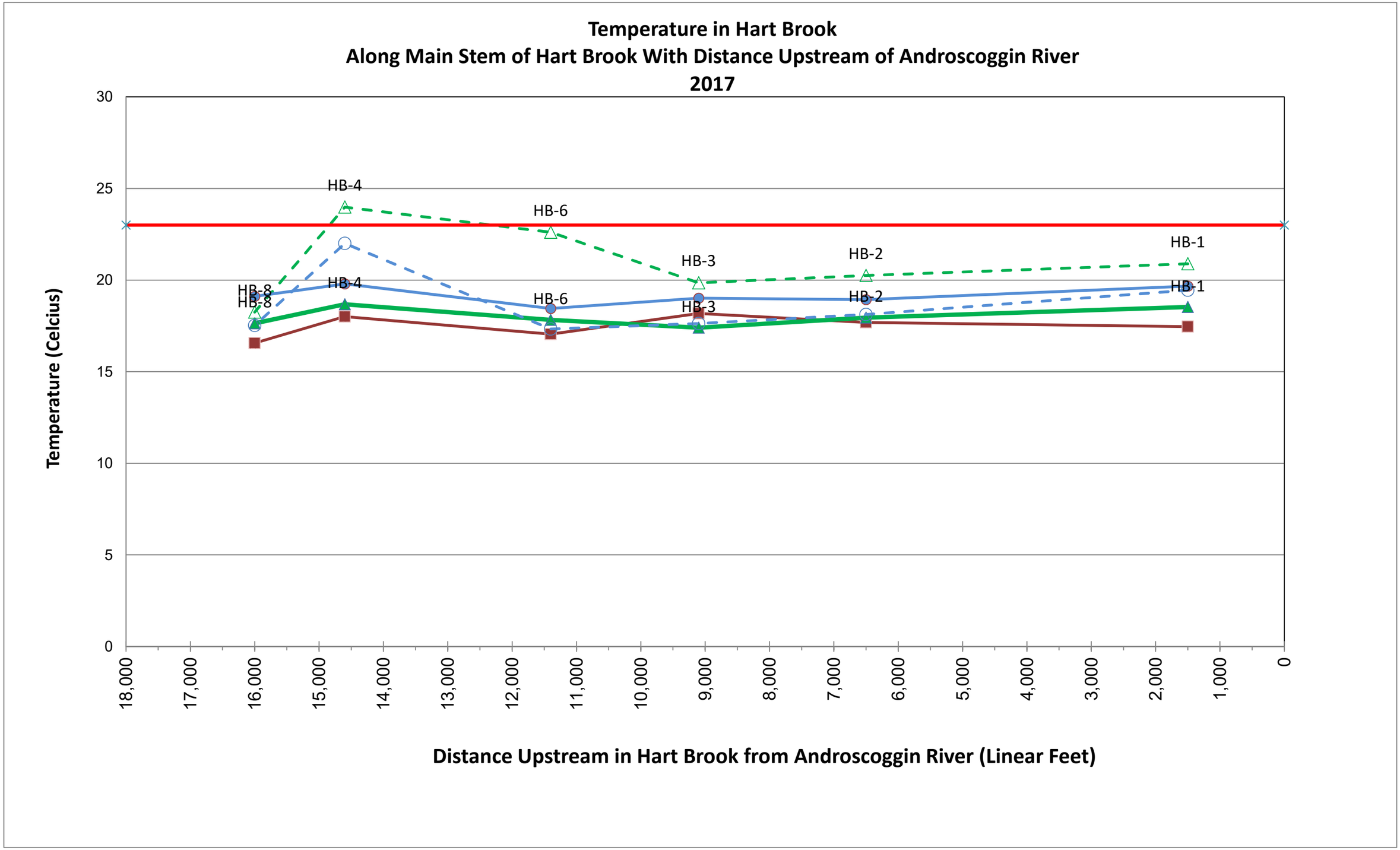
APPENDIX F

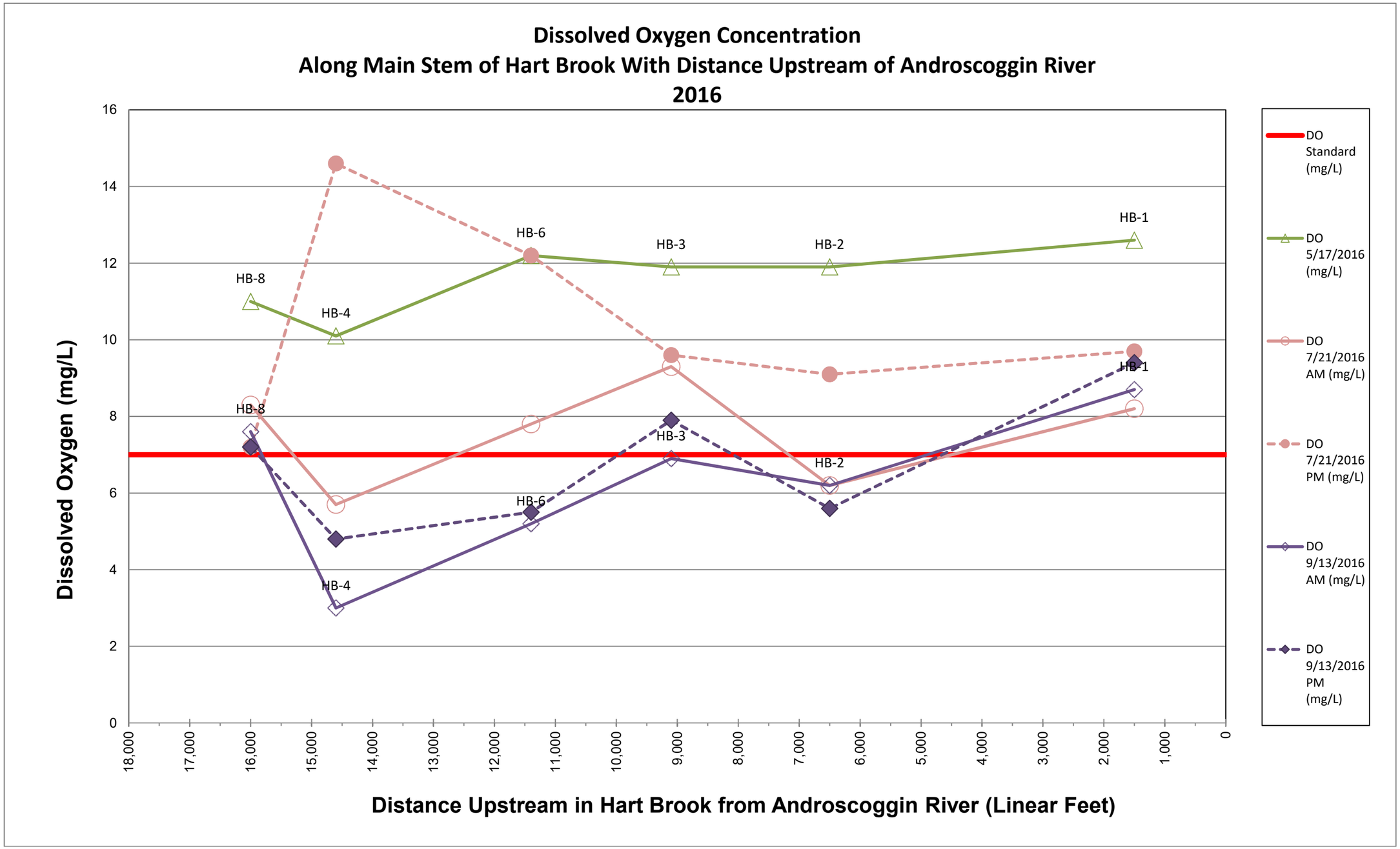
CHARTS OF HART BROOK MONITORING AND ANALYSIS
CONCENTRATION VS. DISTANCE FROM ANDROSCOGGIN RIVER 2016 AND 2017

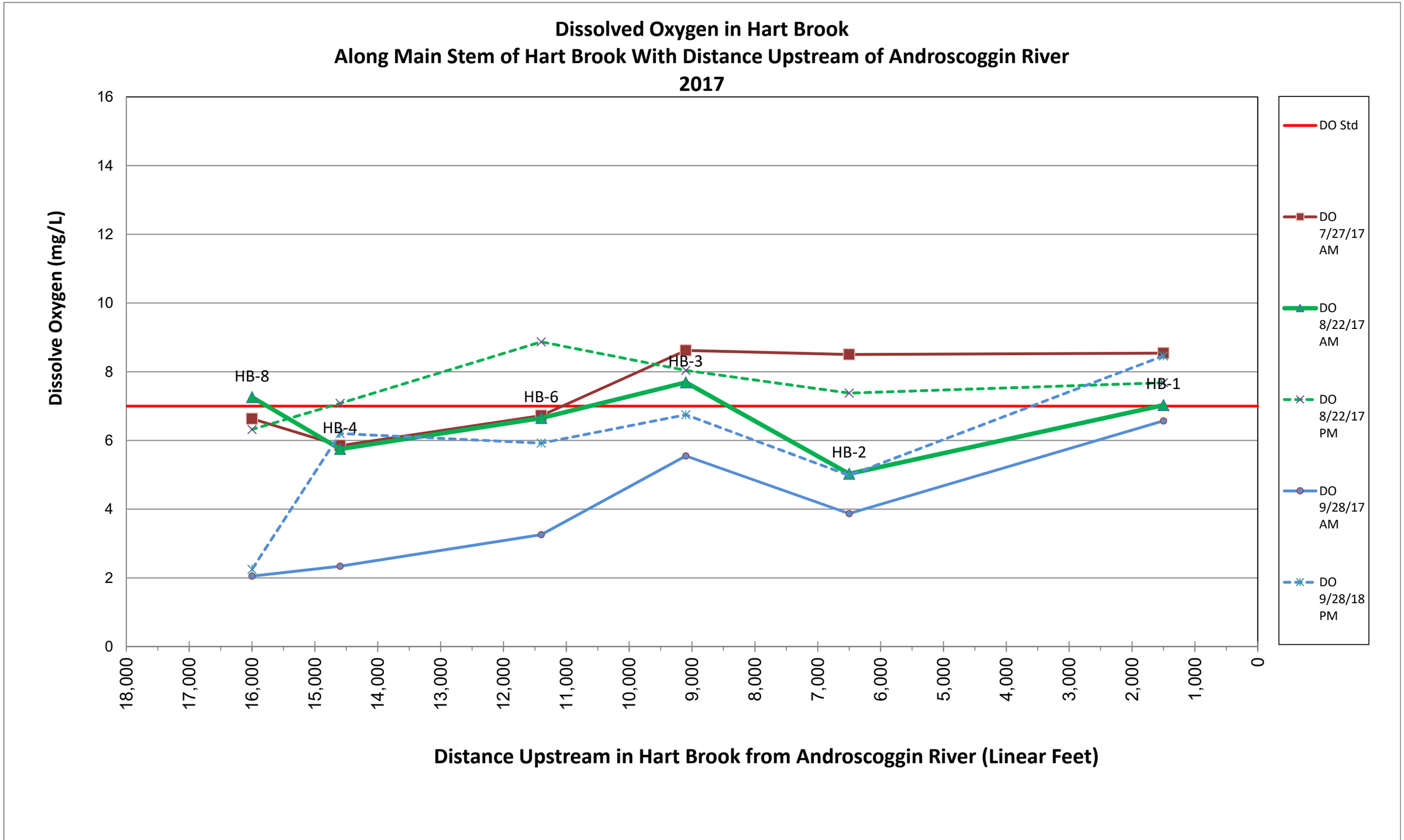

E. Coli Bacteria
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2016
E. Coli Bacteria (MPN/100ml)
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
HB-8
HB-4
HB-6
HB-3
HB-2
HB-1
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)
E. colii Instantaneous Limit
E. Coli Bacteria 5/17/2016 (MPN/ 100ML)
E. Coli Bacteria 7/21/2016 (MPN/ 100ML)
E. Coli Bacteria 9/13/2016 (MPN/ 100ML)

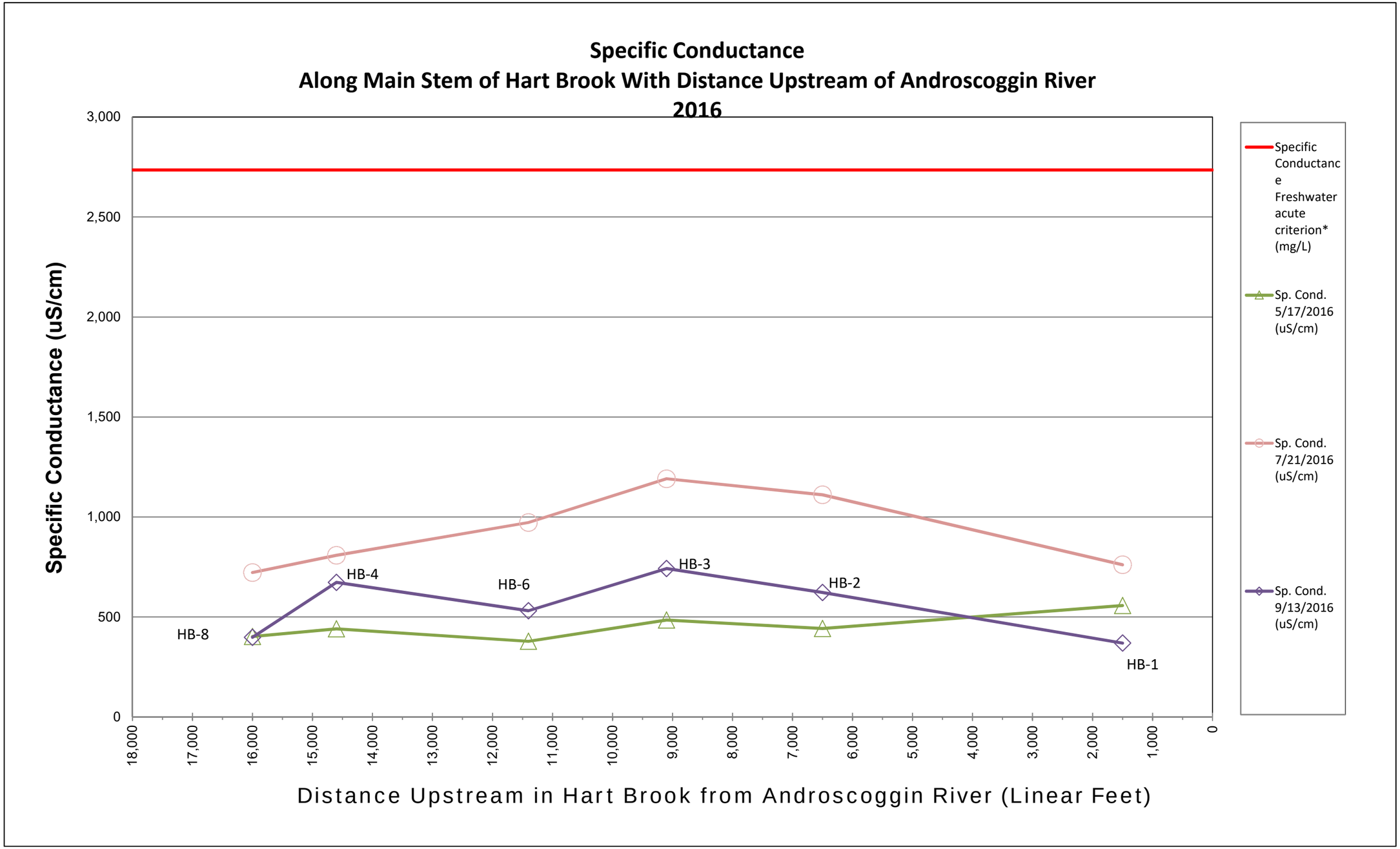

E. Coli in Hart Brook
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2017
E Coli (MPN/ 100ML)
2,500
2,000
1,500
1,000
500
0
HB-1
HB-8
HB-4
HB-6
HB-3
HB-2
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)
E Coli Instantaneous Limit
E Coli 7/27/17
E Coli 8/22/17
E Coli 9/28/17

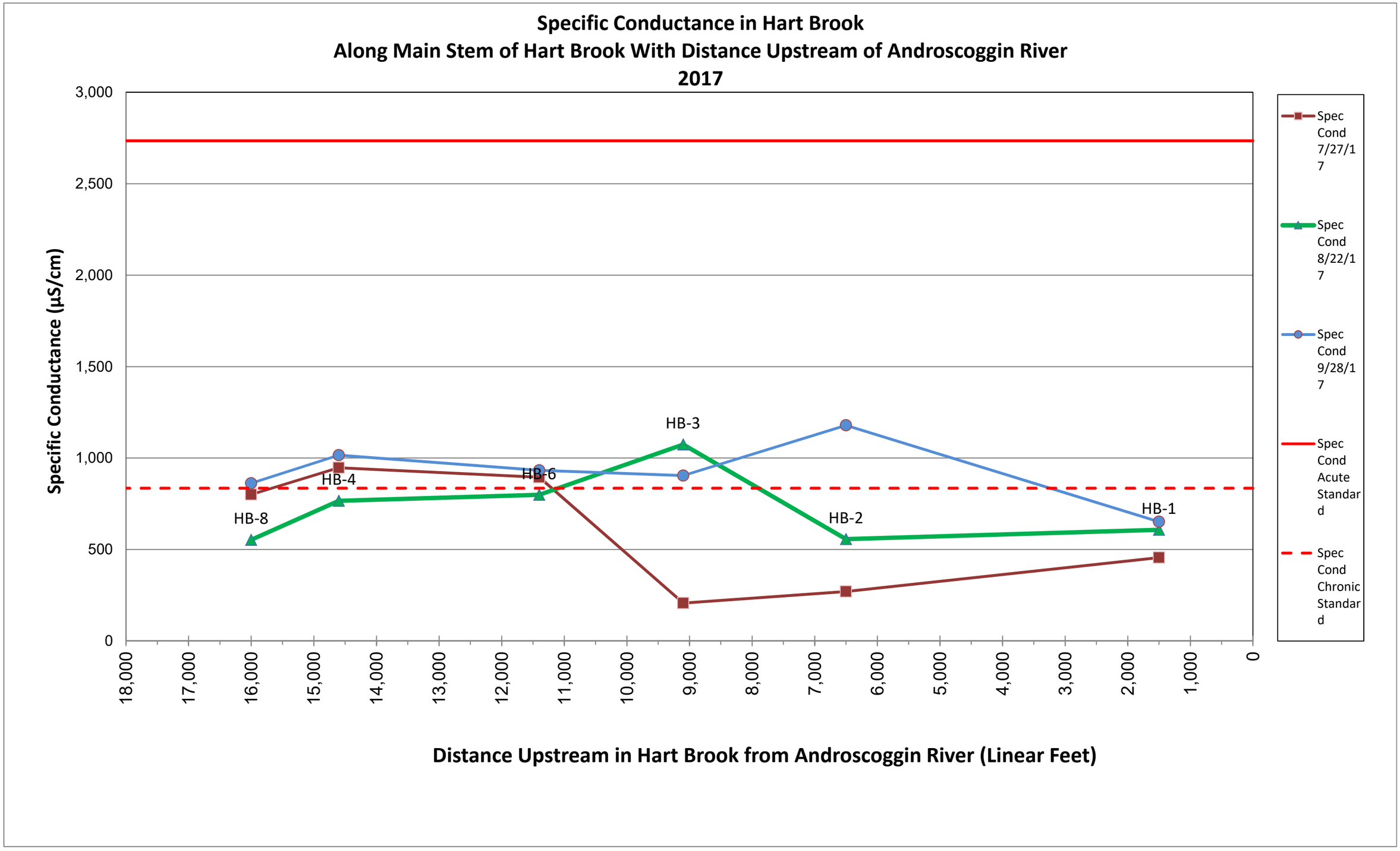

Temperature
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2016
Temperature (oC)
30
25
20
15
10
5
0
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)
Water Temp Standard (DEG C)
Water Temp 5/17/2016 AM (DEG C)
Water Temp 7/21/2016 AM (DEG C)
Water Temp 7/21/2016 PM (DEG C)
Water Temp 9/13/2016 AM (DEG C)
Water Temp 9/13/2016 PM (DEG C)

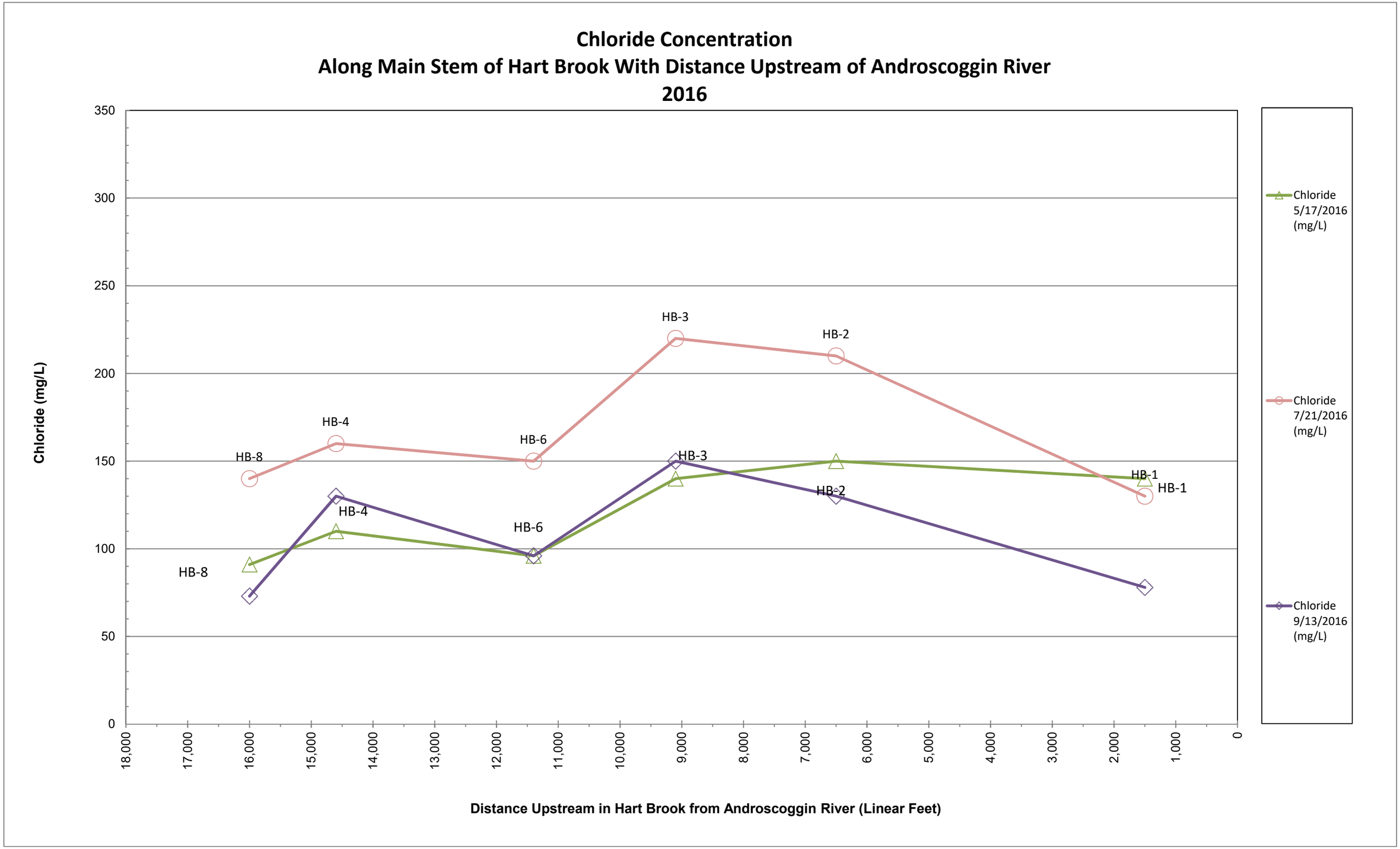

Temperature in Hart Brook
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2017
Temperature (Celcius)
30
25
20
15
10
5
0
HB-4
HB-6
HB-3
HB-2
HB-1
HB-8
HB-8
HB-4
HB-6
HB-3
HB-2
HB-1
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)

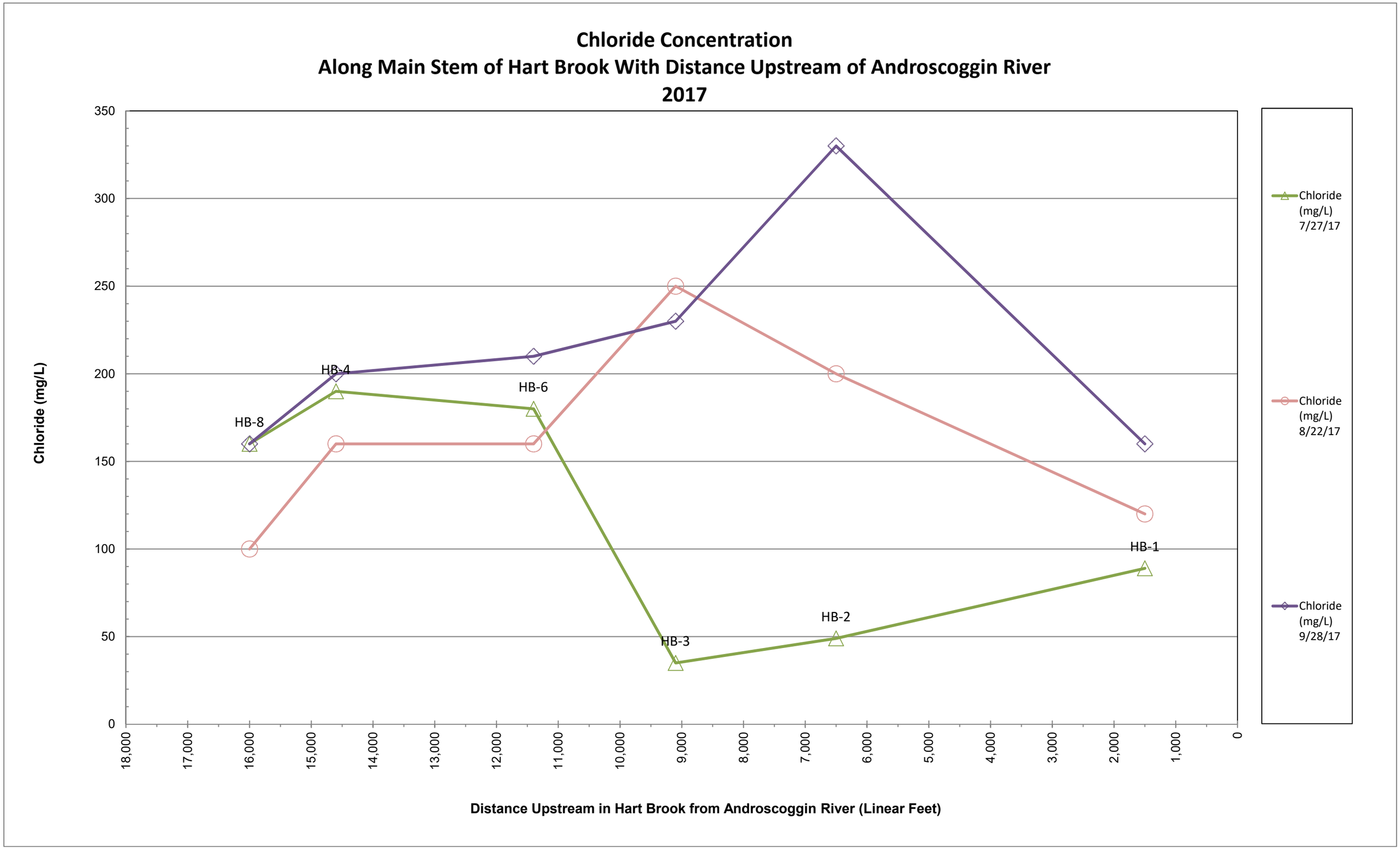

Dissolved Oxygen Concentration
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2016
Dissolved Oxygen (mg/L)
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)
HB-8
HB-4
HB-6
HB-3
HB-2
HB-1
DO Standard (mg/L)
DO 5/17/2016 (mg/L)
DO 7/21/2016 AM (mg/L)
DO 7/21/2016 PM (mg/L)
DO 9/13/2016 AM (mg/L)
DO 9/13/2016 PM (mg/L)


Dissolved Oxygen in Hart Brook
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2017
Dissolve Oxygen (mg/L)
16
14
12
10
8
6
4
2
0
HB-8
HB-4
HB-6
HB-3
HB-2
HB-1
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)
DO Std
DO 7/27/17 AM
DO 8/22/17 AM
DO 8/22/17 PM
DO 9/28/17 AM
DO 9/28/18 PM


Specific Conductance
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2016
Specific Conductance (uS/cm)
3,000
2,500
2,000
1,500
1,000
500
0
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
HB-8
HB-4
HB-6
HB-3
HB-2
HB-1
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)
Specific Conductance Freshwater acute criterion* (mg/L)
Sp. Cond. 5/17/2016 (uS/cm)
Sp. Cond. 7/21/2016 (uS/cm)
Sp. Cond. 9/13/2016 (uS/cm)

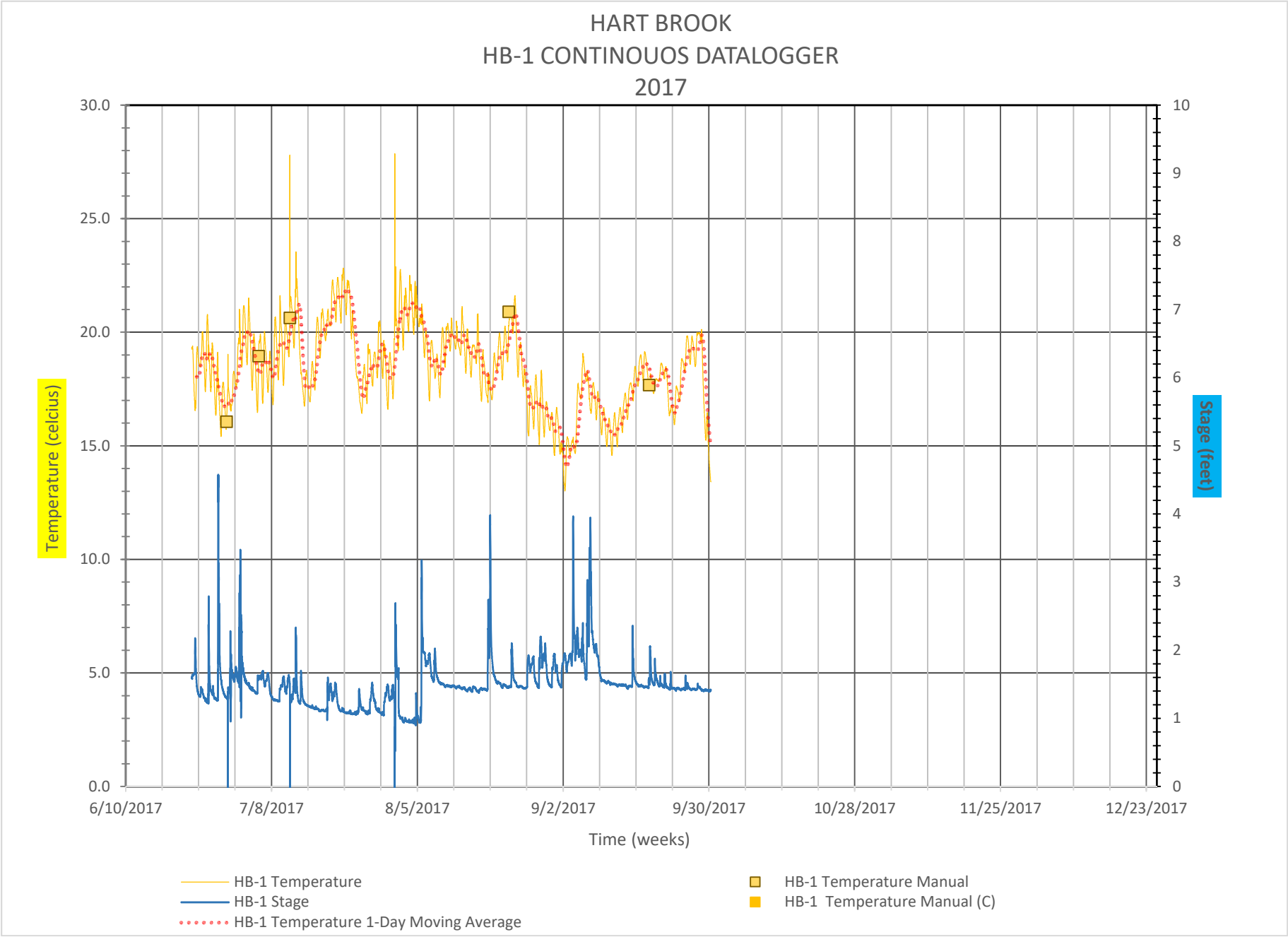

Specific Conductance in Hart Brook
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2017
Specific Conductance (µS/cm)
3,000
2,500
2,000
1,500
1,000
500
0
HB-8
HB-4
HB-6
HB-3
HB-2
HB-1
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)
Spec Cond 7/27/17
Spec Cond 8/22/17
Spec Cond 9/28/17
Spec Cond Acute Standard
Spec Cond Chronic Standard

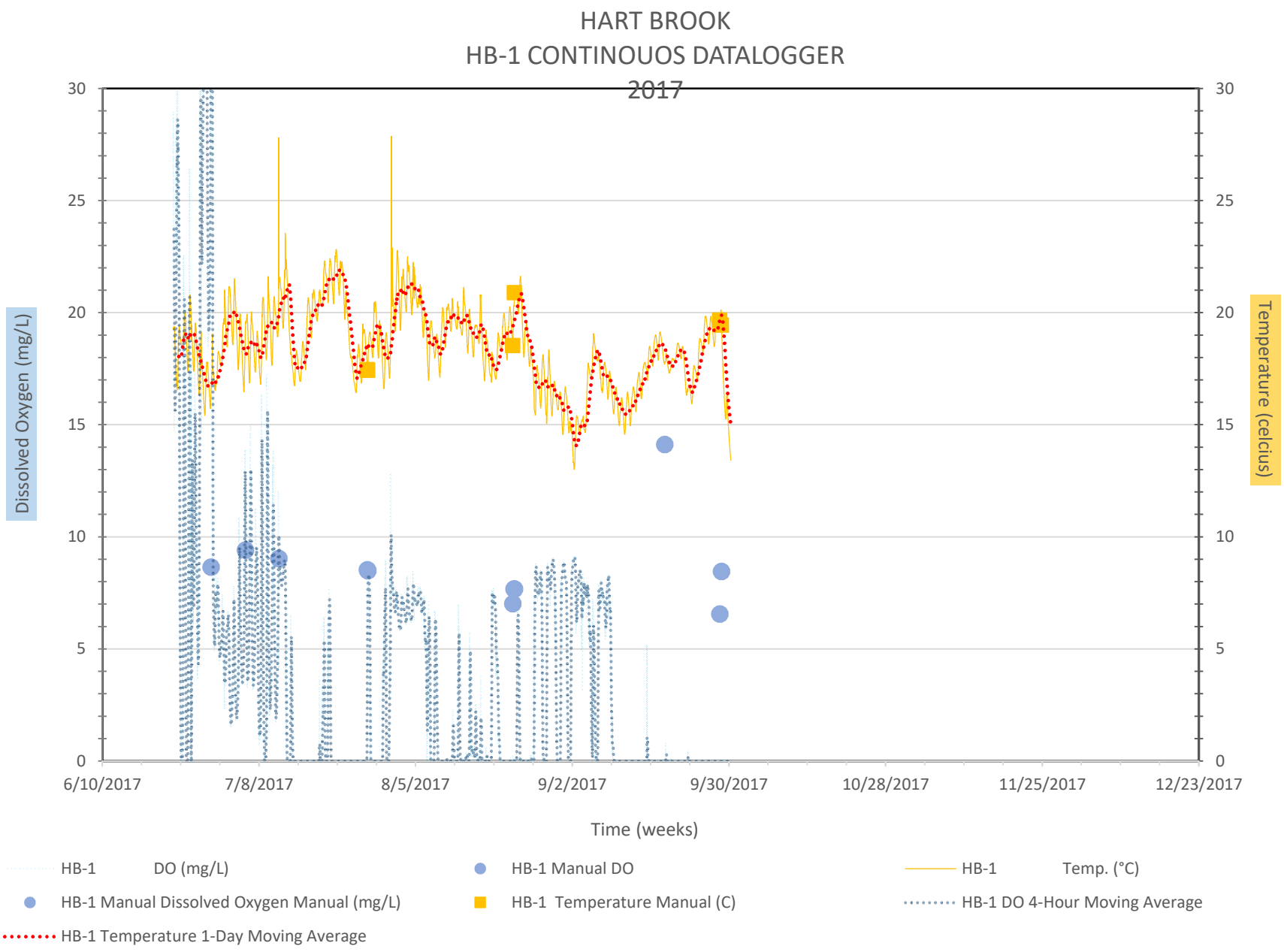

Chloride Concentration
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2016
Chloride (mg/L)
350
300
250
200
150
100
50
0
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
HB-8
HB-4
HB-6
HB-3
HB-2
HB-1
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)
Chloride 5/17/2016 (mg/L)
Chloride 7/21/2016 (mg/L)
Chloride 9/13/2016 (mg/L)

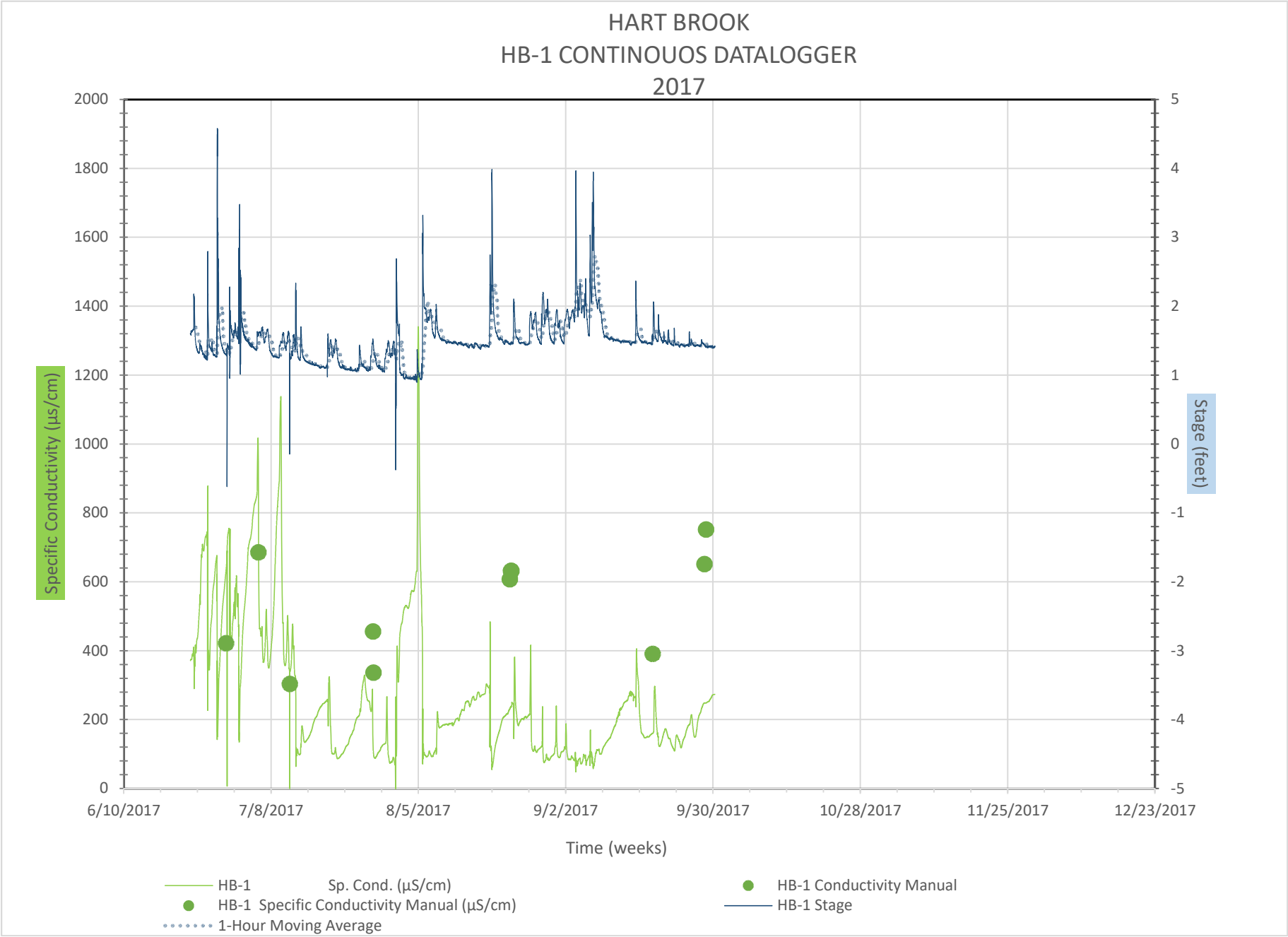

Chloride Concentration
Along Main Stem of Hart Brook With Distance Upstream of Androscoggin River
2017
Chloride (mg/L)
350
300
250
200
150
100
50
0
HB-8
HB-4
HB-6
HB-3
HB-2
HB-1
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Distance Upstream in Hart Brook from Androscoggin River (Linear Feet)
Chloride (mg/L) 7/27/17
Chloride (mg/L) 8/22/17
Chloride (mg/L) 9/28/17

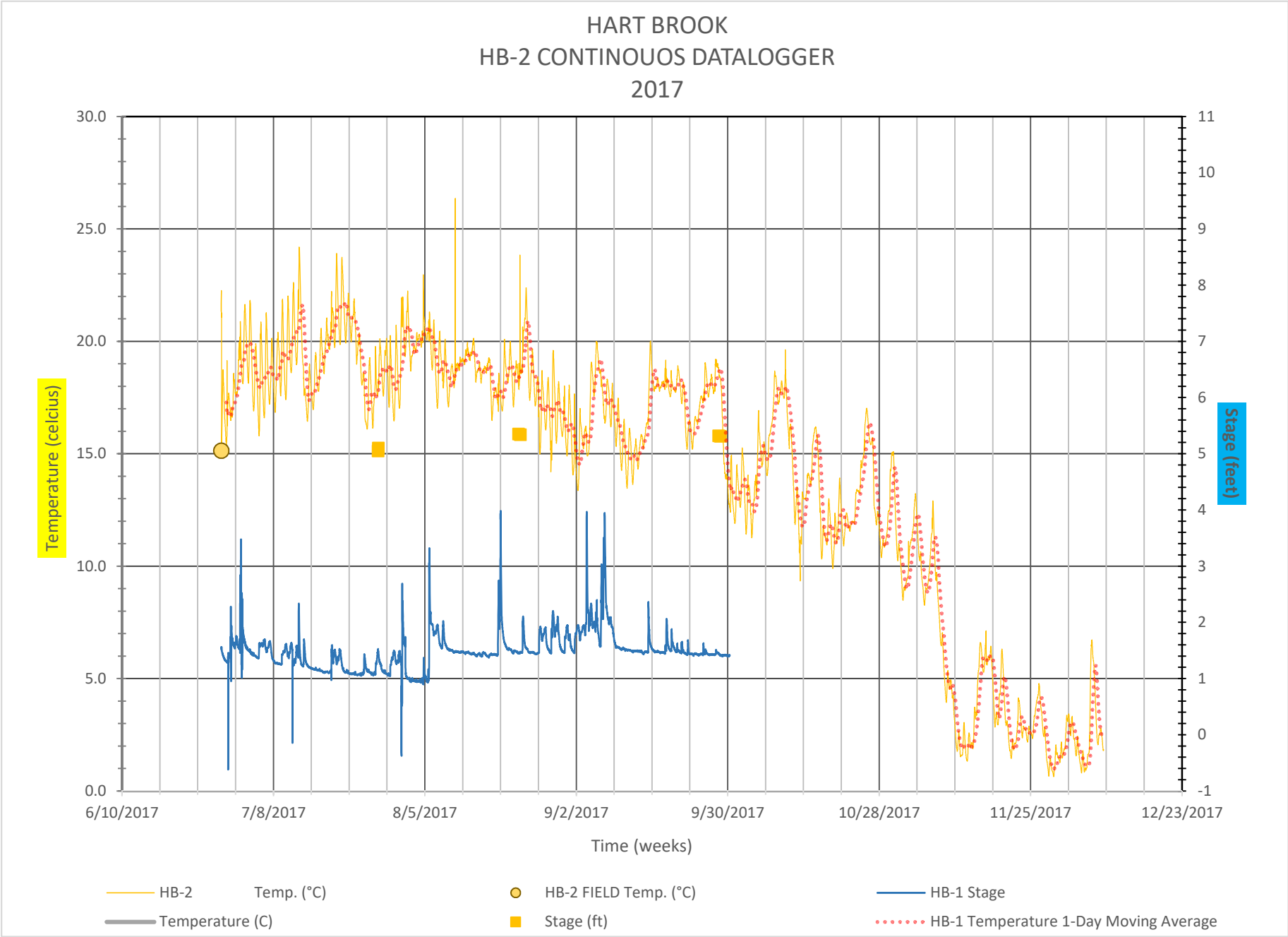
APPENDIX G

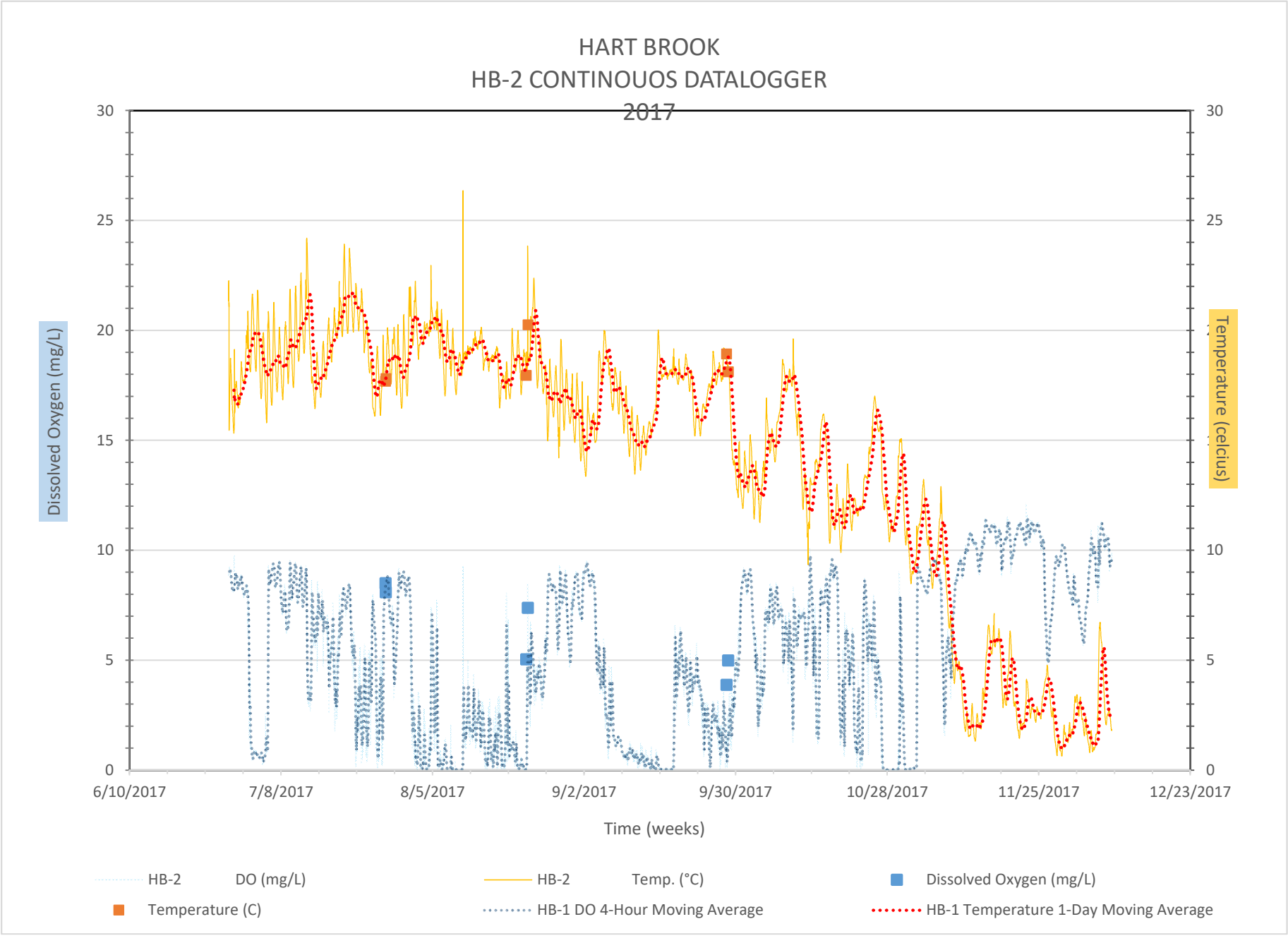
CHARTS OF HART BROOK DATALOGGERS DISSOLVED OXYGEN, TEMPERATURE, SPECIFIC CONDUCTANCE AND STAGE 2017

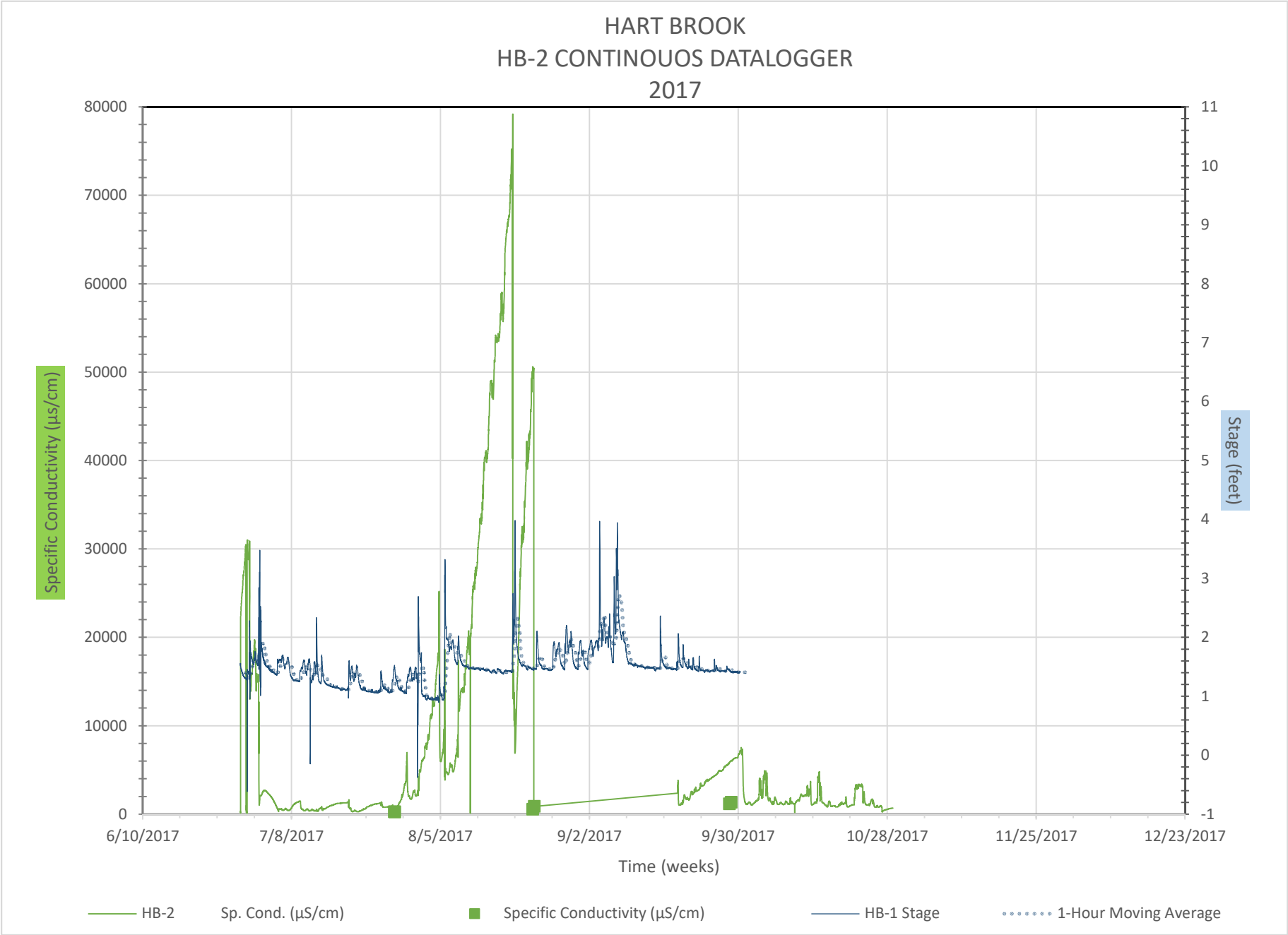

HART BROOK
HB-1 CONTINOUOS DATALOGGER
2017
Temperature (celcius)
Stage (feet)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
10
9
8
7
6
5
4
3
2
1
0
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
Time (weeks)
HB-1 Temperature
HB-1 Stage
HB-1 Temperature 1-Day Moving Average
HB-1 Temperature Manual
HB-1 Temperature Manual (C)

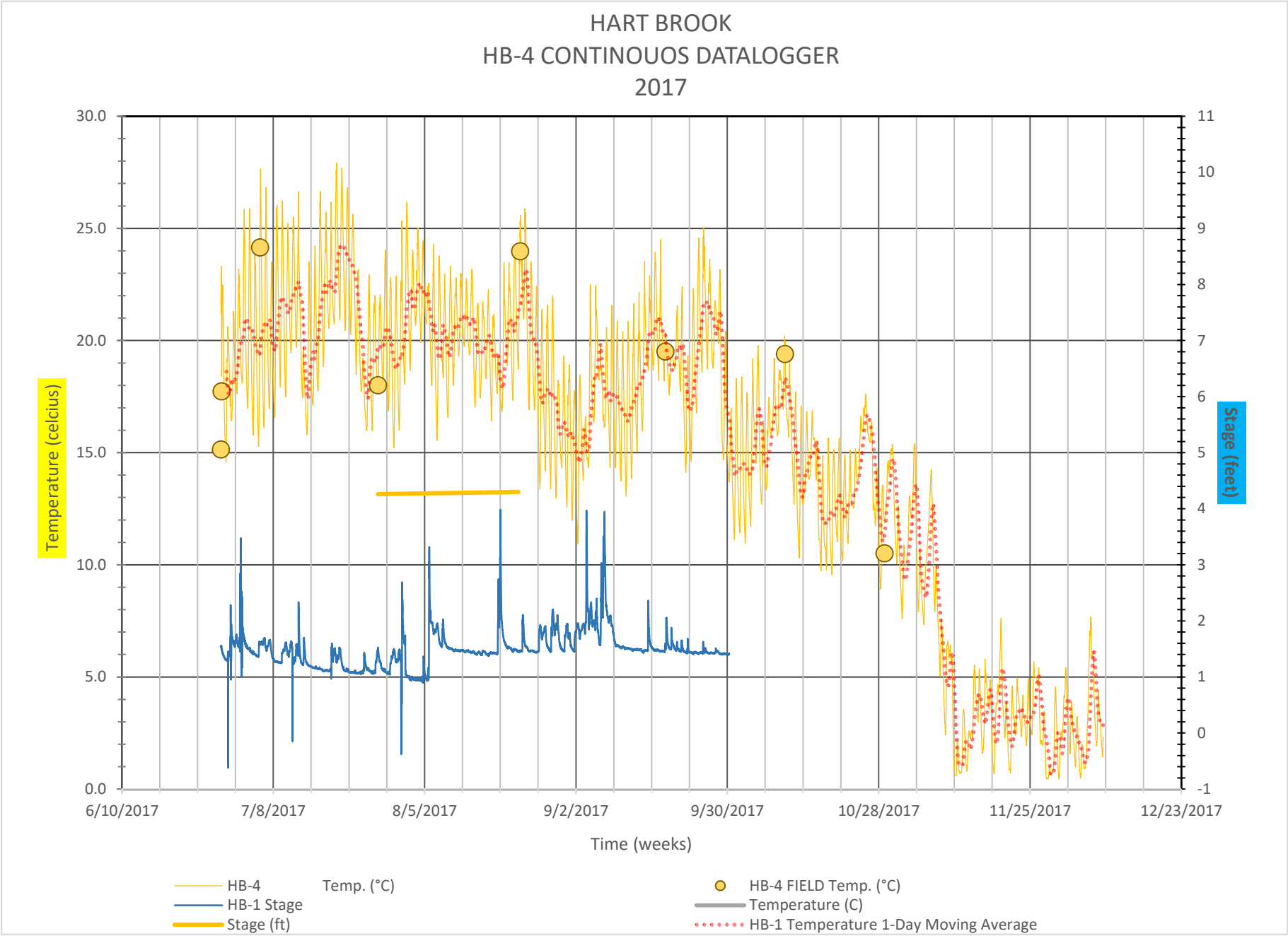

HART BROOK
HB-1 CONTINOUOS DATALOGGER
2017
Dissolved Oxygen (mg/L)
Temperature (celcius)
30
25
20
15
10
5
0
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
Time (weeks)
HB-1 DO (mg/L)
HB-1 Manual DO
HB-1 Temp. (°C)
HB-1 Manual Dissolved Oxygen Manual (mg/L)
HB-1 Temperature Manual (C)
HB-1 DO 4-Hour Moving Average
HB-1 Temperature 1-Day Moving Average

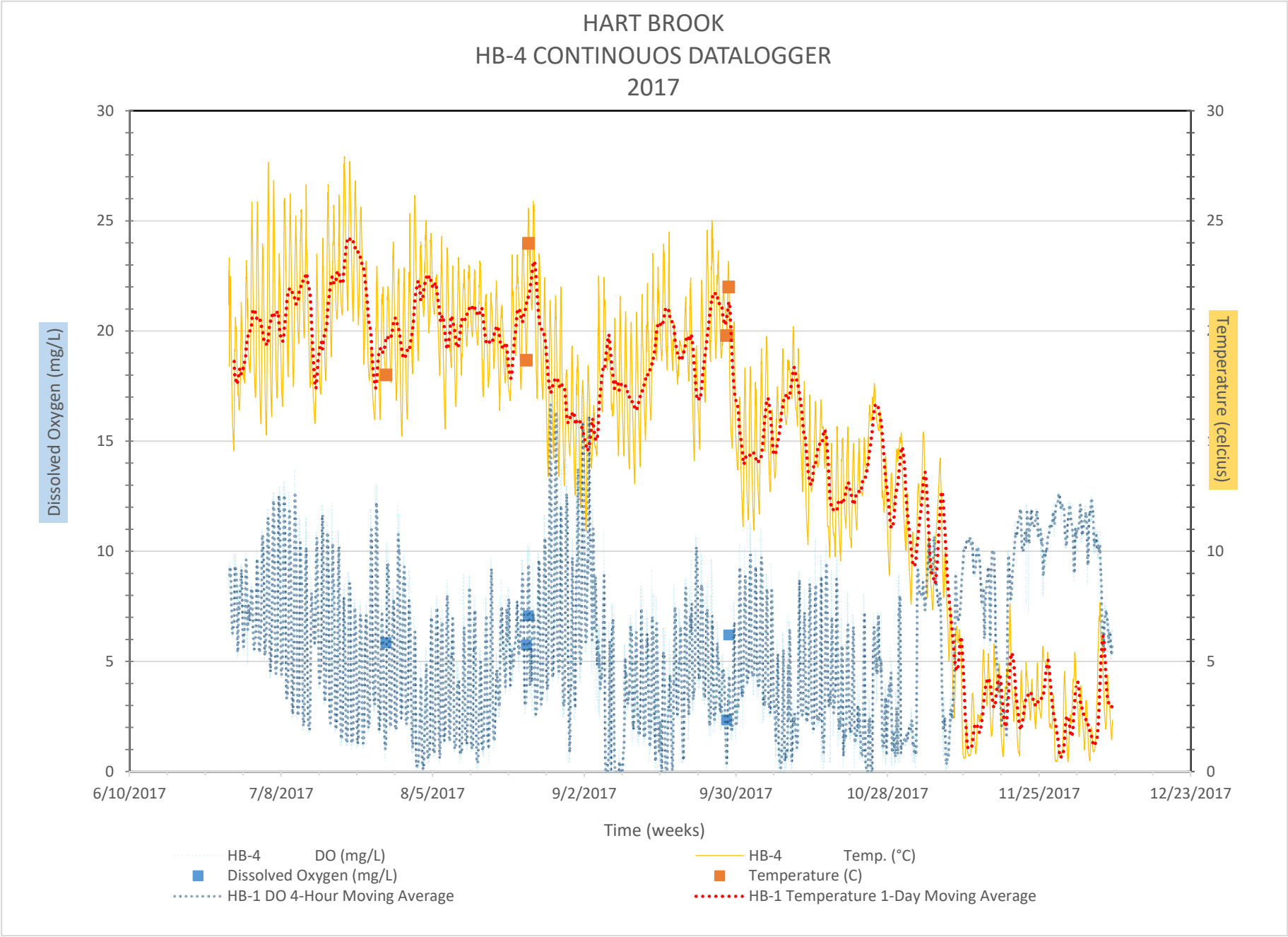

HART BROOK
HB-1 CONTINOUOS DATALOGGER
2017
Specific Conductivity (µs/cm)
Stage (feet)
Time (weeks)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
5
4
3
2
1
0
-1
-2
-3
-4
-5
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
HB-1 Sp. Cond. (µS/cm)
HB-1 Specific Conductivity Manual (µS/cm)
1-Hour Moving Average
HB-1 Conductivity Manual
HB-1 Stage

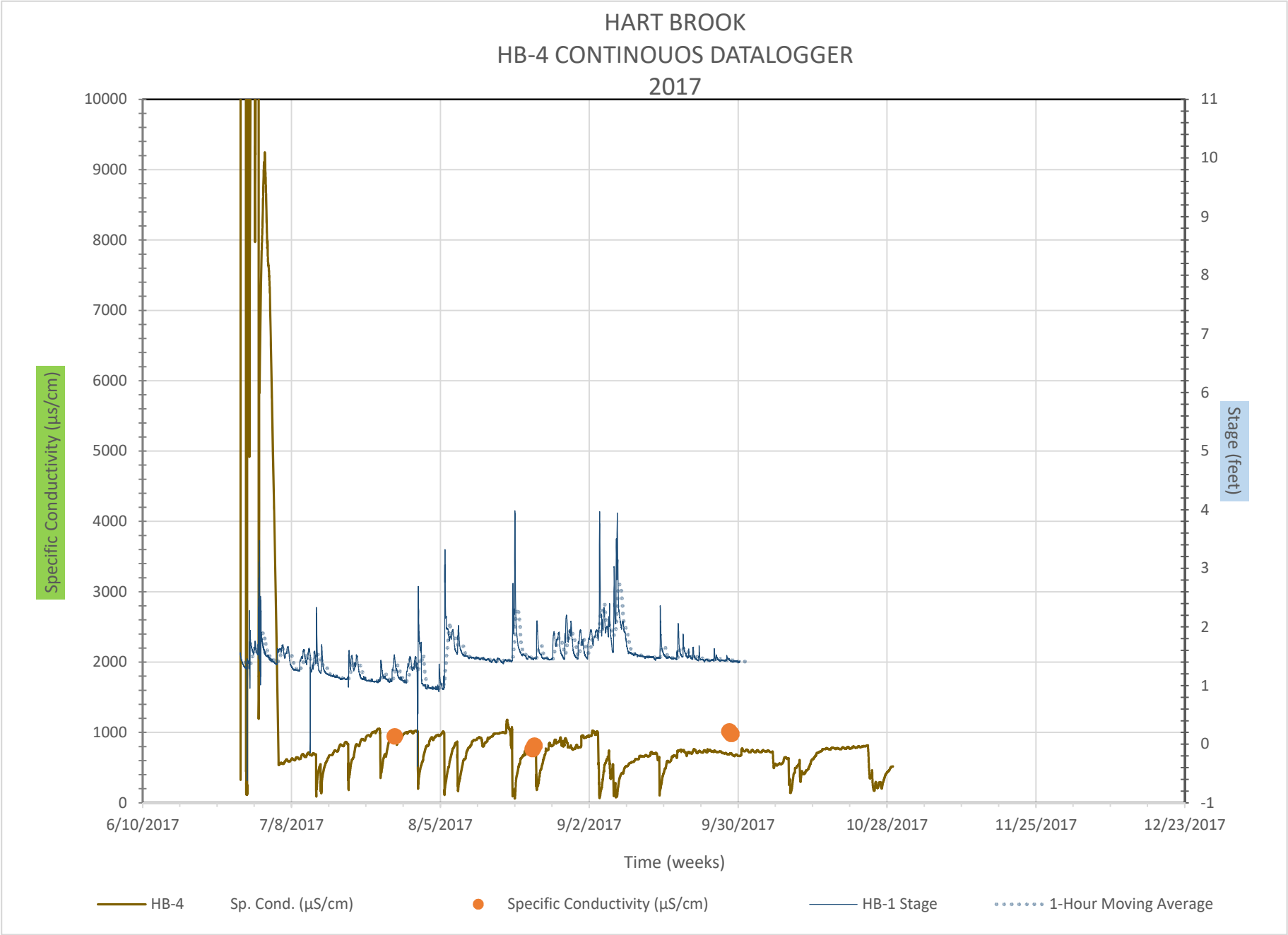

HART BROOK
HB-2 CONTINOUOS DATALOGGER
2017
Temperature (celcius)
Stage (feet)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
11
10
9
8
7
6
5
4
3
2
1
0
-1
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
Time (weeks)
HB-2 Temp. (°C)
HB-2 FIELD Temp. (°C)
HB-1 Stage
Temperature (C)
Stage (ft)
HB-1 Temperature 1-Day Moving Average

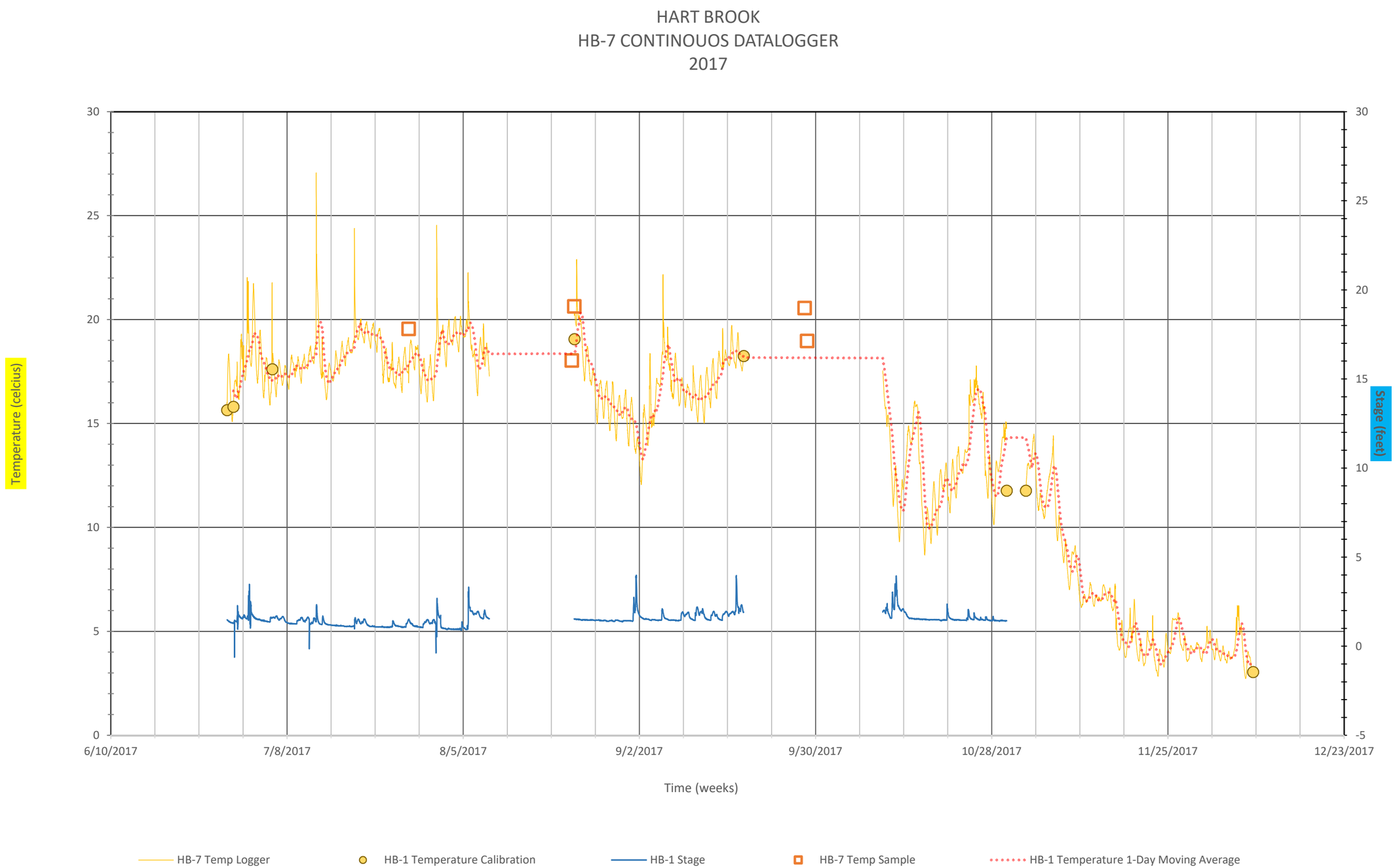

HART BROOK
HB-2 CONTINOUOS DATALOGGER
2017
Dissolved Oxygen (mg/L)
Temperature (celcius)
30
25
20
15
10
5
0
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
Time (weeks)
HB-2 DO (mg/L)
HB-2 Temp. (°C)
Dissolved Oxygen (mg/L)
Temperature (C)
HB-1 DO 4-Hour Moving Average
HB-1 Temperature 1-Day Moving Average


HART BROOK
HB-2 CONTINOUOS DATALOGGER
2017
Specific Conductivity (µs/cm)
Stage (feet)
80000
70000
60000
50000
40000
30000
20000
10000
0
11
10
9
8
7
6
5
4
3
2
1
0
-1
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
Time (weeks)
HB-2 Sp. Cond. (µS/cm)
Specific Conductivity (µS/cm)
HB-1 Stage
1-Hour Moving Average


HART BROOK
HB-4 CONTINOUOS DATALOGGER
2017
Temperature (celcius)
Stage (feet)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
11
10
9
8
7
6
5
4
3
2
1
0
-1
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
Time (weeks)
HB-4 Temp. (°C)
HB-1 Stage
Stage (ft)
HB-4 FIELD Temp. (°C)
Temperature (C)
HB-1 Temperature 1-Day Moving Average


HART BROOK
HB-4 CONTINOUOS DATALOGGER
2017
Dissolved Oxygen (mg/L)
Temperature (celcius)
30
25
20
15
10
5
0
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
Time (weeks)
HB-4 DO (mg/L)
Dissolved Oxygen (mg/L)
HB-1 DO 4-Hour Moving Average
HB-4 Temp. (°C)
Temperature (C)
HB-1 Temperature 1-Day Moving Average

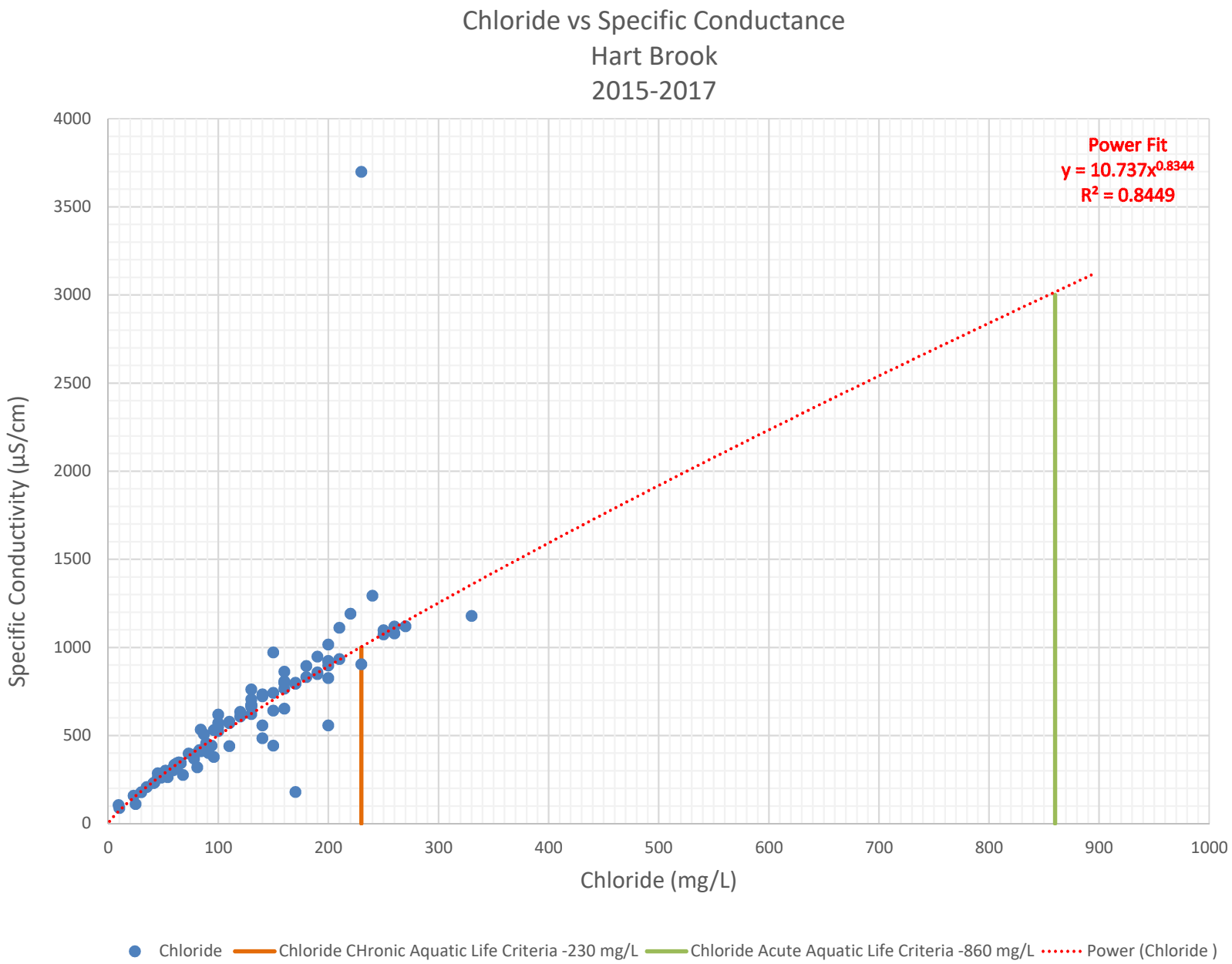

HART BROOK
HB-4 CONTINOUOS DATALOGGER
2017
Specific Conductivity (µs/cm)
Stage (feet)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
11
10
9
8
7
6
5
4
3
2
1
0
-1
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
Time (weeks)
HB-4 Sp. Cond. (µS/cm)
Specific Conductivity (µS/cm)
HB-1 Stage
1-Hour Moving Average


HART BROOK
HB-7 CONTINOUOS DATALOGGER
2017
Temperature (celcius)
Stage (feet)
30
25
20
15
10
5
0
30
25
20
15
10
5
0
-5
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
Time (weeks)
HB-7 Temp Logger
HB-1 Temperature Calibration
HB-1 Stage
HB-7 Temp Sample
HB-1 Temperature 1-Day Moving Average

HART BROOK
HB-7 CONTINOUOS DATALOGGER
2017
Specific Conductivity (µs/cm)
Stage (feet)
Time (weeks)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
5
4
3
2
1
0
-1
-2
-3
-4
-5
6/10/2017
7/8/2017
8/5/2017
9/2/2017
9/30/2017
10/28/2017
11/25/2017
12/23/2017
HB-7 Spec Cond Logger
HB-7 Spec Cond Calibration
HB-7 Spec Cond Sample
HB-1 Stage
1-Hour Moving Average

APPENDIX H

CHARTS OF HART BROOK SPECIFIC CONDUCTIVITY VS. CHLORIDE RELATIONSHIP


Chloride vs Specific Conductance
Hart Brook
2015-2017
Power Fit
y = 10.737x^0.8344
R² = 0.8449
Specific Conductivity (µS/cm)
Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
0
100
200
300
400
500
600
700
800
900
1000
Chloride
Chloride CHronic Aquatic Life Criteria -230 mg/L
Chloride Acute Aquatic Life Criteria -860 mg/L
Power (Chloride)