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WEDGEWIRE SCREEN SITE-SPECIFIC STUDY ENGINEERING EVALUATION

GSP SCHILLER LLC – SCHILLER STATION PORTSMOUTH, NEW HAMPSHIRE

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TABLE OF CONTENTS

LIST OF ATTACHMENTS

LIST OF ADDENDUMS

EXECUTIVE SUMMARY

In order to evaluate the effectiveness and availability of wedgewire screens at GSP Schiller LLC's Schiller Station, a Site-Specific Study was conducted consistent with the compliance condition specified in Part I.A.11.a.1 of National Pollutant Discharge Elimination System Permit No. NH0001473. Pilot wedgewire screens with 3.0 millimeter (mm) and 0.8 mm openings were simultaneously tested in the Piscataqua River in the vicinity of Schiller Station. The Wedgewire Screen Site-Specific Study had an extended test period, spanning from late 2018 to late 2019. The study observed and recorded the performance and conditions of the pilot wedgewire screens in comparison to the baseline control of the Screen House #2 withdrawal through the existing traveling water screens.

The enclosed engineering technical report was compiled throughout the test period. The main body of the report details the design, installation, and engineering analyses completed in support of the Wedgewire Screen Site-Specific Study at Schiller Station, as well as the results and conclusions of the study. The main body of the report is followed by attachments providing the equipment specifications and design drawings. Addendums to this report detailing the events and changes that occurred during the testing period are provided following the attachments. The physical conditions of the pilot wedgewire screens and equipment are analyzed in the addendums, providing an evaluation of the fouling and damage that occurred throughout the testing period. Finally, a technical availability summary concludes the results of the Wedgewire Screen Site-Specific Study at Schiller Station.

At the conclusion of the testing period, the total proportion of damaged surface area on each wedgewire screen was approximately 16% and 19% for the 3.0 mm and 0.8 mm screens, respectively. This lowered the effectiveness of the screens, due to the large openings, estimated to be 2.5 inches (in.) wide and 3.5 in. wide for the 3.0 mm screens and 0.8 mm screens, respectively. The damage on each pilot wedgewire screen was initially concentrated on the bottom regions of the screens nearest the central riser and was observed to increase rapidly outward. At the time of final inspection, the percentage of the withdrawn flow rate bypassing the screen through the damaged openings was estimated to be 23% and 45% for the 3.0 mm and 0.8 mm screens, respectively. Due to the excessive screen bypass, the samples taken following the damage were not considered when evaluating exclusionary performance. This bypass flow rate percentage is an estimate for a completely clean screen and would increase further under clogged conditions.

The peak total proportion of clogged surface area observed on the pilot wedgewire screens was 21% and 36% for the 3.0 mm and 0.8 mm screens, respectively. The fouling on each screen was distributed with no apparent pattern and was independent of the amount and location of damage. Fouling and damage are each considered to be abnormal operating conditions for cylindrical wedgewire screens. In a practical implementation of wedgewire screens, these conditions would be uncommon and would not be anticipated to be significant within the first year of operation. Based on the results of the site-specific study, it is unknown if there would be any relationship between fouling and damage at Schiller Station. Fouling and damage in combination result in increased through slot velocity and head loss, and decreased exclusion efficiency.

Based on the results of this site-specific study, significant damage and fouling of the screens is considered likely to occur on a full-scale wedgewire screen if installed at Schiller Station. The effectiveness, reliability and durability of a full-scale wedgewire screen would be uncertain given the rapid development of damage and fouling observed on both pilot wedgewire screens. The results of this site-specific study found a statistically significant number of aquatic organisms with bounding dimensions larger than the 0.8 mm wedgewire screen mesh were entrained. Excessively high ambient current velocities may have caused the entrainment of fish eggs or larvae of larger size than the screen opening due to extrusion effects.

The varied issues demonstrated during the site-specific study are indicative that similar issues would impact a full-scale wedgewire screen system due to an increase in the number of screens and an increase in affected surface area. A limited technology lifespan as brief as one year, as observed during the site-specific study, would result in frequent periods of ineffective use of the technology. Additionally, cleaning of the fouled wedgewire screens, dredging in the vicinity of the intake, repair of damaged wedgewire screens, replacement of wedgewire screens deemed beyond repair, and maintenance of new balance-of-plant equipment would make implementation an ongoing, expensive endeavor. Accordingly, the implementation of full-scale wedgewire screens at Schiller Station is considered a difficult, costly and imprudent measure which would not provide reliable, year-round operation.

1.0 BACKGROUND

This document provides the installation instructions, equipment specifications, post-testing conditions, and conclusions of the Wedgewire Screen Site-Specific Study at Schiller Station, owned and operated by GSP Schiller LLC (GSP). As described in the "Wedgewire Screen Site-Specific Study Scope Description", submitted in July 2018 (Ref. 6.5), further design efforts and testing occurred at Schiller Station through 2019 in compliance with National Pollutant Discharge Elimination System (NPDES) Permit No. NH0001473. Attached to this document are specifications for performance dependent components (Attachment 1), the bill of materials (Attachment 2), specified pump internals [redacted] (Attachment 3), system design drawings (Attachment 4), civil engineering calculations (Attachment 5), change of equipment specification (Addendum A), abnormal operating event report (Addendum B), damage and fouling reports (Addenda C through E), and conclusions based on the results of the site-specific study (Technical Availability Summary).

2.0 INSTALLATION INSTRUCTIONS

2.1 PILOT WEDGEWIRE SCREENS

Prior to the installation of the pilot wedgewire screens, preliminary water velocity and bathymetry studies were performed via vessel-mounted Acoustic Doppler Current Profilers (ADCPs) and a standalone ADCP deployment in the Piscataqua River. The data collected from the ADCPs was used to determine the predominant river flow direction and guide the alignment of the longitudinal axis of the screens.

The pilot wedgewire screen system was designed to test the availability of half cylinder wedgewire screens at Schiller Station. Half cylinder wedgewire screens were selected using a similar methodology as used at Merrimack Station (Reference 6.14). The pilot wedgewire screens and supporting systems were designed, constructed, and installed to similar specifications, aside from the key differences described in the following two paragraphs. Each pilot wedgewire screen was a Johnson Intake Screens Model T-12HC high capacity intake cylindrical wedgewire screen [redacted] to reduce the amount of surface area clogged by fouling. Each screen had cone style closures to deflect waterborne debris and aquatic organisms away from the screen. The following differences are considered negligible, controlled details and are not believed to have influenced the results of the site-specific study. Differences in screen performance are attributed to the difference in wedgewire screen slot width.

[redacted] The 0.8 mm screen was procured from the vendor without the tripod support legs. The [redacted] legs were fabricated and assembled as shown on GSPL-00001-SK-001, which includes turning down one end of each SS leg and welding the other end at an angle to a SS baseplate. The length of each leg was cut such that only one SS base plate was needed at the footing, allowing clearance for the short radius elbow atop the concrete pad. A coupler was fabricated according to the detail on GSPL-00001-SK-001. Non-conductive sleeves were required for the interfaces between the coupler, through bolts, etc. and the [redacted] portions of the screen.

The assembled screen with tripod legs and base plate was mounted to the pre-cast concrete pad, as shown on the drawing, using the anchor bolts and identified embedment depth.

[redacted]

The 3.0 mm screen and tripod legs were repurposed from a prior Site-Specific Study at GSP's Merrimack Station. The screen assembly was inspected to be in suitable physical condition for reuse. The 3.0 mm screen tripod support [redacted] legs, included with screen, were attached with the vendor provided coupler equipment. Drawing GSPL-00001-SK-002, illustrates dimensions of the fabricated coupler. The screen was attached to the concrete pad using anchor bolts. Through holes were drilled in each base plate to accommodate the anchor bolts. An analysis of the structural components of the screen supports are found in Section 3.4.

The pilot wedgewire screens were installed on relatively level ground. The distance from the base of the concrete pad to the centerline of the screens was measured to be [redacted] The screens were oriented such that the long axis of the screens was aligned with the predominant direction of the river current based on the data gathered from the preliminary ADCP studies.

As shown by the analysis provided in Section 3.1, the pilot wedgewire screens were at a suitable location at the river bottom, in the vicinity of where a full-scale screen would be installed. [redacted]

The relocation of the pilot wedgewire screens resulted in a brief delay in the completion of installation.

The screens included a 90° short radius elbow welded to the pipe outlet. A six-inch threaded piping nipple was used to mate the screen to the suction piping. The six-inch piping nipple was cut such that the threads were completely removed from one end. The cut end of the pipe was connected to the 90° elbow using a six-inch clamp-on pipe connector. [redacted]

A cam lock adapter was screwed on to the pipe nipple, which provided the means to connect the suction hose to the screen assembly. The pipe-elbow-nipple was assembled and connected to the hose on-shore, prior to lowering the screens into the river. As described in Addendum A, the suction hose was anchored to the riverbed with ten sets of anchors and tie wires, spaced equally along the portion of the hose that was resting on the riverbed.

Approximately two months after the installation of the pilot wedgewire screens, it was discovered that the 3.0 mm wedgewire screen was misaligned with the estimated sweeping flow direction by approximately 30°. The orientation was corrected and verified. Normal operation of the pilot wedgewire screens and scheduled samplings were reinstated following the correction.

Approximately three months after the installation of the pilot wedgewire screens, [redacted] Normal operation of the pilot wedgewire screens and scheduled sampling were restarted after the completion of the repairs.

2.2 SAMPLING PUMP AND FLOW METERS

Two [redacted] Pumps were used for continuous withdrawal of water through the pilot wedgewire screens. The pumps were mounted on separate pump pads and placed in Screen House #1. The suction hoses coming in from the river were secured along the route from the intake tunnel to the pumps. The hoses were connected to six inch PVC pipe as shown in GSPL-00001-M-002, Sh. 1 Attachment 4. A [redacted] were installed on the pipe, with one [redacted] downstream of the [redacted] and another upstream of the sampling tank. PVC piping was field-routed to final placement of the pump, using PVC elbows as needed.

[redacted] The components [redacted] are highlighted in the exploded view from selected pages of the pump manual in Attachment 3. [redacted]

[redacted]

[redacted]

Each pump was mounted to a pre-cast concrete pad as shown on GSPL-00001-M-002, Sh. 2 Attachment 4 using anchor bolts. Two 13 in. long pieces of 3-1/2" x 3-1/2" x ¼" square tube steel were mounted to the concrete pad as indicated on the drawing using anchor bolts. The motor was bolted to the tube steel as indicated on GSPL-00001-M-002, Sh. 2. All bolt holes required for mounting the pump and motor were drilled field-to-fit.

[redacted]

During the events when either screen became clogged (as detailed in Addendum C), a procedure to clear the screen for further testing was completed by site operating personnel (see Section 2.5). For this purpose, [redacted]

[redacted]

To prevent freezing in the piping in an abnormal event that the pump was not operational (i.e. [redacted]

The operation and maintenance of the pumps was conducted by site personnel in accordance with past operation experience of similar pumps.

2.3 COLLECTION TANK PIPING

The sampling tanks were six feet (ft.), eleven inches tall, and the piping was routed to the base of the tank and up the side of the tanks until the proper height was achieved, and flow was then discharged into the tanks from above. The piping was installed as shown in Section B-B on GSPL-00001-M-002, Sh. 2 (Attachment 4). The piping was restrained in the horizontal direction with a four-inch plastic routing clamp that attached the piping to the edge of the collection tanks. [redacted] All piping was field-routed, and pipe supports were added as necessary.

A procedure to fill and drain the tank was prepared. [redacted]

[redacted]

2.4 [redacted] SWITCH

Excessive pressure loss across the pilot wedgewire screens had the potential to cause damage to the pumps and/or screens. The Net Positive Suction Head (NPSH) limits of the pumps would have been exceeded if there was not sufficient suction pressure. Excessive pressure loss across the screens would have caused the screens to collapse if the differential pressure across the screens was too great. [redacted] The frequency of the data collection was set according to the desired resolution. On a regular basis, the data [redacted] was downloaded for processing.

According to the pump curve for the [redacted] pump with an [redacted], the Net Positive Suction Head required (NPSHr) at flow rates of [redacted] for 3.0 mm screens and [redacted] for 0.8 mm screens at the highest motor speed is approximately [redacted] respectively, as seen in Figure 1. This corresponds to the pump suction pressure readings of approximately [redacted] respectively. These pressures correspond to readings of approximately [redacted], respectively.

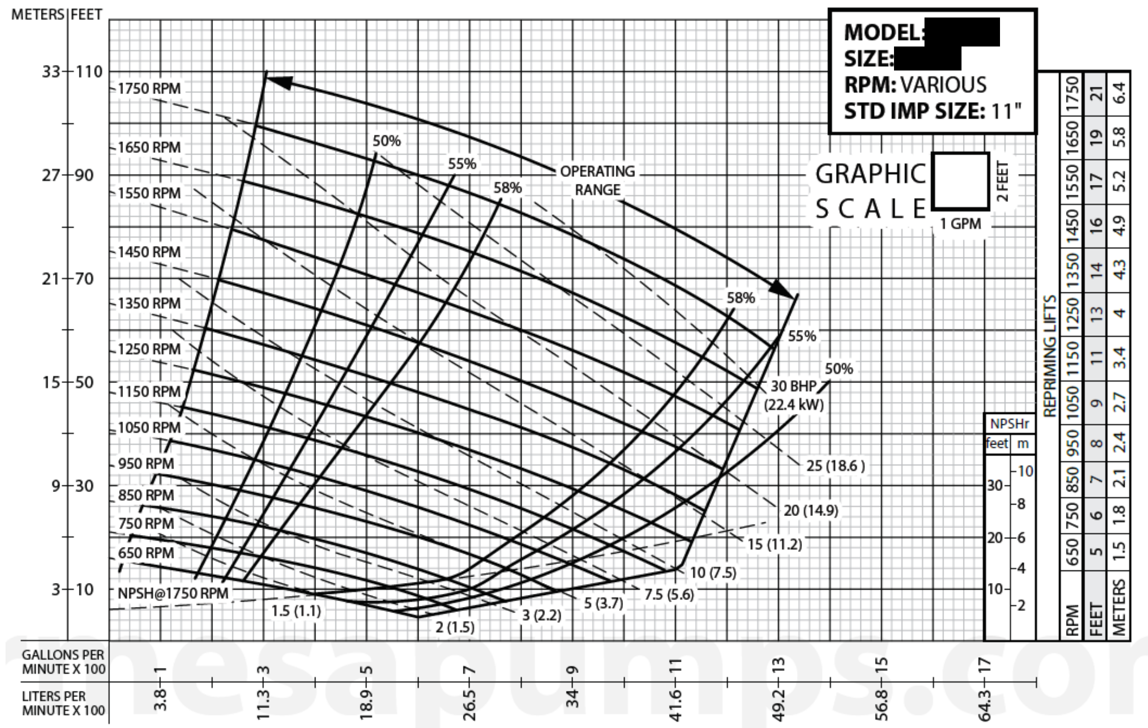

Figure 1: [redacted] pump curve for an [redacted]

The hydrostatic collapse pressure for 3.0 mm and 0.8 mm screens are both [redacted], per vendor specification sheet (Ref. 6.12 and Ref. 6.13). Calculating the Net Positive Suction Head available (NPSHa) at the point of screen collapse (i.e. atmospheric pressure minus elevation difference minus vapor pressure minus head loss from piping minus hydrostatic collapse pressure) reveals the pressure directly upstream of the pump when the screen would collapse.

[redacted]

[redacted]

[redacted]

[redacted]		[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]

The values in Table 1 were used as a guide for detecting problematic conditions related to the wedgewire screen.

2.5 [redacted] PROCEDURE

Upon blockage of either screen, a [redacted] procedure was initiated to clear the screen so that testing could continue (as described in Addendum C). This section documents the [redacted] procedure. [redacted]

[1] Note that the values in this table are in [redacted].

[2] [redacted]

[redacted] An event report capturing one [redacted] event is provided in Addendum C.

2.6 CONTROL SAMPLING TANK

To supply a control sample to compare to samples collected through the screens, a portion of the intake water from the existing Unit 5 Screen 5A pump was diverted to a collection tank of similar construction to the test sampling tanks. The site's configuration had a flanged valve tapped off the Screen 5A circulation water pump connected to a capped section of PVC piping. With the valve fully closed, the PVC end cap was cut off, and new PVC piping was installed to the controlled sampling tank. The pipe was field routed out of Screen House #2 and into the sample collection tank. When required, the normally closed tap off isolation valve was opened to collect control samples. After sufficient sampling of the control was acquired, the isolation valve was fully closed and the water in the collection tank emptied. Once the collection tank was emptied, the drain plug on the piping leading to the tank was opened momentarily to avoid standing water in the piping. The system was installed as shown in GSPL-00001-M-004, Sh. 2 Attachment 4.

3.0 SUPPORTING ANALYSIS

This section provides the details of the engineering analysis efforts that were conducted to support the design and implementation of the in-river testing setup. The analyses were conducted to evaluate the impact of the Hydraulic Zone of Influence (HZOI) of [redacted] are detailed below. The analysis performed to support the [redacted] is also detailed below.

3.1 HYDRAULIC ZONE OF INFLUENCE ANALYSIS

To ensure that the screens were installed sufficiently far from the intake structure to avoid interference effects, an evaluation was performed to assess the impact of the HZOI of the [redacted]

[redacted] This was used to determine the appropriate distance from the [redacted] and ensure that interference effects were negligible.

The ADCP data gathered prior to installation of the pilot wedgewire screens concluded that the average river velocity is approximately [redacted] With this data, it was determined that a [redacted]. The location at which the pilot wedgewire screens were placed [redacted] This concluded that the hydraulic influence of the [redacted] did not negatively impact test sampling results.

3.2 SUCTION HOSE DRAG FORCE

[redacted]

[redacted]

$$F_D \text{ [redacted] } \frac{C_D \text{ [redacted] } v^{\text{[redacted]}} \text{ [redacted] } A}{\text{[redacted] } g}$$

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

$$A \text{[redacted]} in \text{[redacted]} \text{[redacted]}\frac{ft}{in}\Big) \text{[redacted]} ft \text{[redacted]} ft^{\text{[redacted]}}$$

[redacted]

[redacted]

$$F_D \text{[redacted]} \frac{C_D \text{[redacted]} v^{\text{[redacted]}} \text{[redacted]} A}{\text{[redacted]} g} \text{[redacted]} \frac{\text{[redacted]} \frac{lb}{ft^3} \text{[redacted]} \frac{ft}{sec}^{\text{[redacted]}} \text{[redacted]} ft^{\text{[redacted]}}}{\text{[redacted]}} \text{[redacted]} \frac{\text{[redacted]} lbf}{\text{[redacted]} \frac{ft \text{[redacted]} lb}{sec^{\text{[redacted]}}}} \text{[redacted]} lbf$$

[redacted]

[redacted]

[redacted]

[redacted]

$$Water\ Displaced\ [redacted]\ \frac{\pi\ [redacted]\ Do\ [redacted]\ [redacted]\ Di\ [redacted]}{4}\ [redacted]\ [redacted]$$

$$[redacted]\ ft[redacted]$$

[redacted]

Please refer to Addendum A for the intake hose anchoring equipment detail.

3.3 PUMP SIZING

The sampling pumps for the pilot wedgewire screens were sized to be able to draw sufficient flow through the screens [redacted] present in the system. To size the pumps for the study, the pump sizing evaluation performed in the Site-Specific Study Scope (Ref. 6.5) was revised to incorporate the setup from the detailed design.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

	[redacted]		[redacted]	
	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

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[redacted]

[redacted]	[redacted]		[redacted]		[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]			[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted].

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]		[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]			

[redacted]

[redacted]

[redacted]

[redacted]

	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Wedgewire Screen [redacted]

From the wedgewire screen vendor specification sheets the listed [redacted]

These values were based on the screens being completely clean and were only an "estimated" [redacted]

[redacted]

Based on Reference 4.8, the Mean Lower-Low Water (MLLW) elevation was 0 ft. The floor elevation in Screen House #1 platform was assumed to be [redacted]

[redacted]

[redacted] requirement for the pumps was the sum of all the [redacted] determined in the pump sizing calculations. As shown below.

[redacted]

	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

The values for the [redacted] were based on a pre-installation evaluation. [redacted]

[redacted]

[redacted] Available

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]		[redacted]	[redacted]	[redacted]
[redacted]		[redacted]	[redacted]	[redacted]
[redacted]		[redacted]	[redacted]	
[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]		[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

3.4 WEDGEWIRE SCREEN SUPPORTS

An analysis of the wedgewire screen supports for structural stability is included in Attachment 5. Note that the analysis was done for a conservative six-inch thick concrete pad. The 12-in. pad used and depicted in GSPL-00001-SK-001, and GSPL-00001-SK-02, Attachment 4 had a higher factor of safety than the one analyzed. The screen support design accounted for the 12-in. pad used when assessing screen centerline height. [redacted]

4.0 POST-TESTING CONDITIONS

Following the conclusion of the testing period, the pilot wedgewire screens were found to be in an ineffective condition due to a significant amount of damage and fouling. Detailed condition findings from during and following the testing period are provided in Addendums C through E. The variable tidal patterns, ambient water quality, submerged debris and high velocity sweeping river flow resulted in both pilot wedgewire screens developing relatively large openings. Additionally, the conditions in the Piscataqua River led to the clogging of a large surface area by siltation and biogrowth. A summary of the conditions is provided in Table 8. An image of each pilot wedgewire screen after retrieval is provided in Figure 2. Note that a significant amount of fouling material was incidentally removed during retrieval of the screens. Regions of dark discoloration on the screens indicate locations of accumulated fouling deposits present during the pilot study. Underwater imagery showing the amount of fouling present on the screens during the pilot tests are provided in Addendums C through E.

Table 8: Wedgewire Screen Conditions Summary

Screen	Final Proportion of Screening Area Damaged	Estimated Flow Through Final Damaged Area	Width of Largest Damage Opening	Peak Proportion of Screening Area Clogged
3.0 mm	15.5%	23%	2.5 inch	21%
0.8 mm	19.25%	44.5%	3.5 inch	36%

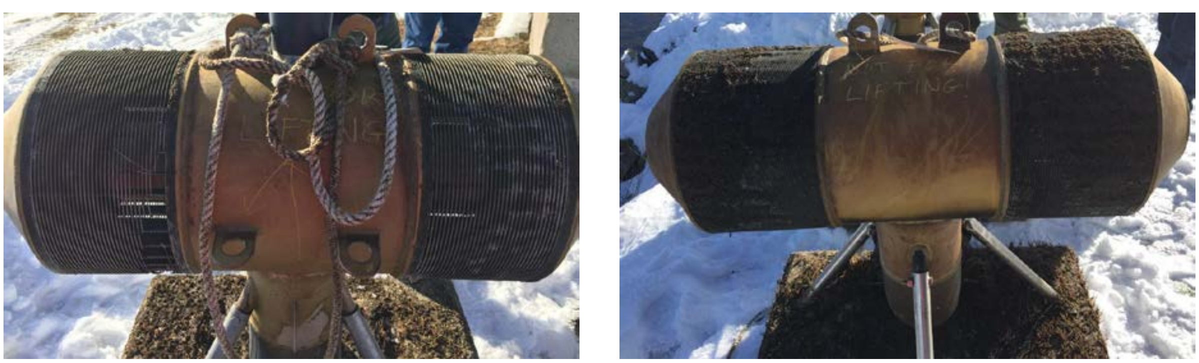

Figure 2: Post-Testing Wedgewire Screen Conditions (Left: 3.0 mm Pilot Wedgewire Screen, Right: 0.8 mm Pilot Wedgewire Screen, Note: Images Do Not Reflect In-Water Fouling Conditions Due to Material Removed During Retrieval)

5.0 CONCLUSIONS

The Wedgewire Screen Site-Specific Study demonstrated the difficulty of installing and operating wedgewire screens at Schiller Station. The excessive amount of damage and fouling observed on both pilot wedgewire screens indicates that a full-scale installation of wedgewire screens in the vicinity of Schiller Station would likely have a brief lifespan, unreliable availability and reduced effectiveness that further degrades over time. Additionally, the variable and location-dependent ambient currents create susbstantial uncertainty regarding entrainment reduction performance. The characteristics observed during the in-situ testing period are considered representative of what should be expected from a full-scale installation of this wedgewire screen technology.

The collection of damage and fouling on the pilot wedgewire screens was first identified after seven months of continuous operation (see Addendum C), prior to which the pilot wedgewire screens were in acceptable conditions based on diver visual inspections. The remainder of the test period was characterized by a rapid increase of the proportion of damage and persistent fouling on both pilot wedgewire screens. A full-scale wedgewire screen assembly with a corresponding amount of damage and fouling would require extensive repairs or replacement for continued operation. A technology lifespan as low as one year would result in frequent downtime and costly maintenance. The removal from service of full-scale wedgewire screens due to excessive damage and fouling would require the use of an emergency bypass in conjunction with other screening technologies until the wedgewire screen could be restored to acceptable conditions. Based on the results of the site-specific study, this could occur on an annual, or likely more frequent, basis. Further, the removal of ineffective screens from service would be dependent on observation of damage and fouling. Monitoring of damage and fouling would be difficult to observe through intake bay drawdown due to the [redacted] wedgewire screens. Due to the high turbidity of the ambient water and location where full-scale wedgewire screens would be installed, visual observation would require periodic dive inspection. Therefore, screens in service at reduced effectiveness could continue operating in unacceptable conditions for extended periods until observed by planned or emergent dive inspection.

The exclusionary performance of wedgewire screens is dependent on several factors, including current velocity, current direction, and tidal stage. Wedgewire screens are designed to operate in constant sweeping flows in order to develop a hydraulic bypass effect and provide sufficient screening effectiveness. As demonstrated during the site-specific study, excessively high ambient current velocities may cause entrainment of fish eggs or larvae of larger size than the screen opening due to extrusion effects. The current velocity and current direction during the testing period were observed to be inconsistent and variable based on location, time, tidal stage, and season. These factors will likely produce poor performance during at least some high entrainment periods. Performance of a full-scale wedgewire screen system would likewise be uncertain due to these varying ambient conditions caused by unpredictable tidal effects.

Due to the relatively large footprint of a full-scale wedgewire screen installation, the impact of the tidal conditions would be compounded. The likelihood that a screen or a portion of a screen would be misaligned to the current would increase with the expanded footprint. Misalignment could result in collision or impingement of submerged debris or aquatic organisms, detrimental extrusion effects, and reduced hydraulic bypass, among other unfavorable impacts.

The results of the Wedgewire Screen Site-Specific Study indicate that the availability and effectiveness of a full-scale installation of wedgewire screens would be uncertain and unreliable. The installation and operation of full-scale wedgewire screens would encounter the issues observed during the site-specific study and may result in further issues unique to full-scale installations. For these reasons, the installation of wedgewire screens at Schiller Station would be a difficult and imprudent measure which would not provide reliable, year-round operation.

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6.9 Mooring and Berthing Operational Procedures, Public Service of New Hampshire Schiller Station, Portsmouth, New Hampshire, January 2015

6.10 Survey Report on Water Velocity and Bathymetry near Schiller Station, Normandeau Associates, Inc., July 2018.

6.11 PE26 Specifications, American Earth Anchors.

6.12 Aqseptance Group, Inc. Quotation Number 20035296 Revision A. Johnson T-12HC 3.0 mm Intake Screen. February 2017.

6.13 Aqseptance Group, Inc. Quotation 20056124 Revision A. Johnson T-12HC 0.8 mm Intake Screen. August 2018.

6.14 Enercon Services, Inc. Response to Environmental Protection Agency's Statement of Substantial New Questions For Public Comment. Prepared for Public Service Company of New Hampshire D/B/A Eversource Energy. December 2017.

COMPONENT SPECIFICATION #001

Cylindrical Wedgewire Screen

Two Johnson Screens T-12 cylindrical wedgewire screens were used for the confirmatory testing. As discussed in the confirmatory testing scoping document, a [redacted] full cylindrical screen provides a reasonable representation of the expected flow field over a 96-in. half screen. Each screen was supported by a tripod stand mounted on a concrete foundation such that the screen centerline was approximately [redacted]

Design and Construction:	[redacted] cylindrical wedgewire screen with slot sizes of 3.0 mm and 0.8 mm [redacted] Tripod legs to elevate screen centerline [redacted]
Material:	[redacted]
Performance:	Shall be designed to pass flow at an average through-slot velocity of at least [redacted]
Packaging, Shipping, and Storage:	Wedgewire screen shall be inspected for damage upon receipt. The dimensions shall be verified against the fabrication drawings.
Electrical Requirements:	N/A
Documentation:	Shop fabrication drawings of tripod support, as well as vendor operation and maintenance manual.
Codes, Standards, and/or Regulations:	N/A
Installation:	Shall be installed in [redacted], with the centerline of the screen approximately [redacted]
Testing and Inspections:	[redacted]

COMPONENT SPECIFICATION #002

Piping and Hose

The following pipes and hoses were used in the testing design.

- [redacted] suction hose
- [redacted] discharge hose
- [redacted] PVC piping

Design and Construction:	[redacted]
Material:	[redacted]
Performance:	[redacted]
Packaging, Shipping, and Storage:	Materials shall be inspected upon receipt for damage.
Electrical Requirements:	N/A
Documentation:	N/A
Codes, Standards, and/or Regulations:	[redacted]
Installation:	Piping and hose shall be installed in accordance with design and layout drawings.
Testing and Inspections:	[redacted]

COMPONENT SPECIFICATION #003

[redacted]

A [redacted] was procured to [redacted]

[redacted]

Design and Construction:	[redacted]
Material:	[redacted]
Performance:	[redacted]
Packaging, Shipping, and Storage:	Materials shall be inspected upon receipt for damage.
Electrical Requirements:	An AC to DC power supply shall be provided which outputs 12 to 36 VDC and has a current capacity of at least 1 amp. Power supply shall ultimately originate from a 120 VAC source.
Documentation:	Vendor operation and maintenance manuals.
Codes, Standards, and/or Regulations:	[redacted]
Installation:	[redacted]
Testing and Inspections:	[redacted]

COMPONENT SPECIFICATION #004

Test Pump

An electric motor-driven pump was used to draw water through the screen and pump it to the sampling tank. [redacted] The pump was placed on a platform on the north side of the Unit 1 intake. [redacted] The pump was bolted to the pump skid and rest atop the angle irons.

[redacted]

Design and Construction:	[redacted]
Material:	[redacted]
Performance:	[redacted]
Packaging, Shipping, and Storage:	Delivered on skid to site. Upon receipt inspect pump for visible flaws and perform validation testing.
Electrical Requirements:	[redacted]
Documentation:	Vendor operation and maintenance manual.
Codes, Standards, and/or Regulations:	[redacted]
Installation:	[redacted]
Testing and Inspections:	[redacted].

COMPONENT SPECIFICATION #005

[redacted]

[redacted] were procured to [redacted]

[redacted]

Design and Construction:	[redacted]
Material:	[redacted]
Performance:	[redacted]
Packaging, Shipping, and Storage:	Materials shall be inspected upon receipt for damage.
Electrical Requirements:	An AC to DC power supply shall be provided which outputs 5 to 24 VDC and has a current capacity of at least 0.2 amps. Power supply shall ultimately originate from a 120 VAC source.
Documentation:	Vendor operation and maintenance manuals.
Codes, Standards, and/or Regulations:	N/A
Installation:	[redacted].
Testing and Inspections:	[redacted]

COMPONENT SPECIFICATION #006

[redacted]

[redacted]

[redacted]

Design and Construction:	[redacted]
Material:	[redacted] be made of rubber to keep cooling water out of lubricated retainer.
Performance:	[redacted]
Packaging, Shipping, and Storage:	Materials shall be inspected upon receipt for damage.
Electrical Requirements:	N/A
Documentation:	N/A
Codes, Standards, and/or Regulations:	N/A
Installation:	[redacted]
Testing and Inspections:	[redacted]

COMPONENT SPECIFICATION #007

Requirements for Pilot Wedgewire Screens Concrete Pad

A pre-cast concrete pad was procured to be installed and placed below the pilot wedgewire screens. This is to allow the pilot wedgewire screens to sit on the surface of the riverbed and not intrude into soil below.

Design and Construction:	(Two) 3’-0” x 3’-0” x 1’-0” Concrete Pads. 3000 psi compressive strength at 28 days.
Material:	[redacted]
Performance:	N/A
Packaging, Shipping, and Storage:	Materials shall be inspected upon receipt for damage.
Electrical Requirements:	N/A
Documentation:	N/A
Codes, Standards, and/or Regulations:	ACI 318-14
Installation:	Pilot wedgewire screens tripods shall be fastened to concrete pad on site prior to placement at its location in the river.
Testing and Inspections:	N/A

COMPONENT SPECIFICATION #008

Requirements for Pump & Motor Concrete Pad

A pre-cast concrete pad was procured to support the pump and motor for the pilot wedgewire screens. This is to allow the pump and motor to sit leveled on a platform for it to function.

Design and Construction:	(Two) 2’-6” x 5’-0” x 6” Concrete Pad. 3000 psi compressive strength at 28 days.
Material:	[redacted]
Performance:	N/A
Packaging, Shipping, and Storage:	Materials shall be inspected upon receipt for damage.
Electrical Requirements:	N/A
Documentation:	N/A
Codes, Standards, and/or Regulations:	ACI 318-14
Installation:	All steel and anchors shall be field installed on the concrete pad for a proper fit to mount the pump and motor.
Testing and Inspections:	N/A

COMPONENT SPECIFICATION #009

Requirements for Data Logger

A [redacted] was procured to record [redacted] The data logger was accessible for regular data transfers.

[redacted]

Design and Construction:	[redacted].
Material:	Primarily plastic case containing logic board and LCD screen.
Performance:	[redacted]
Packaging, Shipping, and Storage:	Materials shall be inspected upon receipt for damage. Included should be 6 AAA batteries, SD memory card, universal AC adaptor, 3 input connect sockets and mounting bracket.
Electrical Requirements:	Requires 120 VAC source.
Documentation:	Vendor user guide.
Codes, Standards, and/or Regulations:	ISO-9001, NIST traceable calibration
Installation:	[redacted]
Testing and Inspections:	[redacted]

COMPONENT SPECIFICATION #010

Requirements for [redacted]

[redacted] were procured to [redacted]

[redacted]

Design and Construction:	[redacted]
Material:	[redacted]
Performance:	[redacted]
Packaging, Shipping, and Storage:	Materials shall be inspected upon receipt for damage.
Electrical Requirements:	Requires 480 VAC three phase power source.
Documentation:	Vendor user guide.
Codes, Standards, and/or Regulations:	UL 508A, UL 508C, IEEE 519
Installation:	[redacted]
Testing and Inspections:	[redacted]

Bill of Materials for Schiller Station Confirmatory Study							
Item #	Dwg. BOM #	Quantity	Component Description	Specification No.	Potential Vendor	Vendor Part Number	Notes
Test Sample Collection System **(GSPL-00001-M-002-A)**							
[redacted]							

Bill of Materials for Schiller Station Confirmatory Study

Item #	Dwg. BOM #	Quantity	Component Description	Specification No.	Potential Vendor	Vendor Part Number	Notes
[redacted]							

Bill of Materials for Schiller Station Confirmatory Study

Item #	Dwg. BOM #	Quantity	Component Description	Specification No.	Potential Vendor	Vendor Part Number	Notes
[redacted]							

Bill of Materials for Schiller Station Confirmatory Study							
Item #	**Dwg. BOM #**	**Quantity**	**Component Description**	**Specification No.**	**Potential Vendor**	**Vendor Part Number**	**Notes**
Control Sample Collection System (GSPL-00001-M-003-A)							

[redacted]

Bill of Materials for Schiller Station Confirmatory Study

Item #	Dwg. BOM #	Quantity	Component Description	Specification No.	Potential Vendor	Vendor Part Number	Notes
0.8mm Wedgewire Screen and Tripod Support							
(GSPL-00001-SK-001-A)							
[redacted]							

Bill of Materials for Schiller Station Confirmatory Study

[redacted]

3.0mm Wedgewire Screen and Tripod Support

(GSPL-00001-SK-002-A)

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

For: GSP Schiller Plant	**Project:** GSP Schiller Plant- Wedge Wire Pipe Support Design	Prepared by : Mehul Patel
		Date:08/01/18
		Checker: Date:_______
	Revision 0- IFR	

Load Inputs for GSP Schiller Plant Wedge Wire Support

[redacted]

For: GSP Schiller Plant	**Project:** *GSP Schiller Plant- Wedge Wire Pipe Support Design* Revision 0- IFR	Prepared by : Mehul Patel Date:08/01/18 Checker: Date:_______

[redacted]

For: GSP Schiller Plant	**Project:** *GSP Schiller Plant- Wedge Wire Pipe Support Design* Revision 0- IFR	Prepared by : Mehul Patel Date:08/01/18 Checker: Date:_______

[redacted]

For: GSP Schiller Plant	**Project:** *GSP Schiller Plant- Wedge Wire Pipe Support Design* Revision 0- IFR	Prepared by : Mehul Patel Date:08/01/18 Checker: Date:_______

[redacted]

For: GSP Schiller Plant	**Project:** GSP Schiller Plant- Wedge Wire Pipe Support Design Revision 0- IFR	Prepared by : Mehul Patel Date:08/01/18 Checker: Date:_______

[redacted]

For: GSP Schiller Plant	**Project:** *GSP Schiller Plant- Wedge Wire Pipe Support Design* Revision 0- IFR	Prepared by : Mehul Patel Date:08/01/18 Checker: Date:_______

[redacted]

A.0 ADDENDUM A: CHANGE OF EQUIPMENT

A.1 DESCRIPTION OF ADDENDUM

This addendum was generated following a change of equipment for securing and anchoring the intake hoses. The change resulted in an update to Section 3.2. This addendum details the new equipment that was used for securing and anchoring the intake hoses. [redacted]

A.2 [redacted]

In Section 3.2 of the main body, an analysis was done to account for the [redacted] experienced by the intake hoses. [redacted]

[redacted]

A.3 CHANGE OF EQUIPMENT

Originally, [redacted] were specified for securing the intake hoses. [redacted]

[redacted]

[redacted]

[redacted]

B.0 ADDENDUM B: [redacted]

B.1 DESCRIPTION OF ADDENDUM

This addendum was generated following an abnormal operating event that occurred on August 31, 2019 and September 1, 2019. During the event, [redacted] This addendum details the findings of the inspection and the actions taken as a result of [redacted]

B.2 DESCRIPTION OF INSPECTION

[redacted]

[redacted]

B.3 RESULTS AND CONCLUSION

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

C.0 ADDENDUM C: FOULING AND DAMAGE

C.1 DESCRIPTION OF ADDENDUM

This addendum was generated following a series of underwater inspections that documented the conditions of the pilot wedgewire screens after seven months of continuous operation. This addendum details the amount of screen fouling and damage observed during the underwater inspections from October 1, 2019. The impacts of the observed conditions were estimated based on the imagery captured during the underwater inspection. Further, [redacted]

For clarity, subsections of the pilot wedgewire screens are identified by hemicylinders in reference to the installation configuration. The naming convention of the wedgewire screen subsections used in this Addendum follow the configuration provided in Figure C-1.

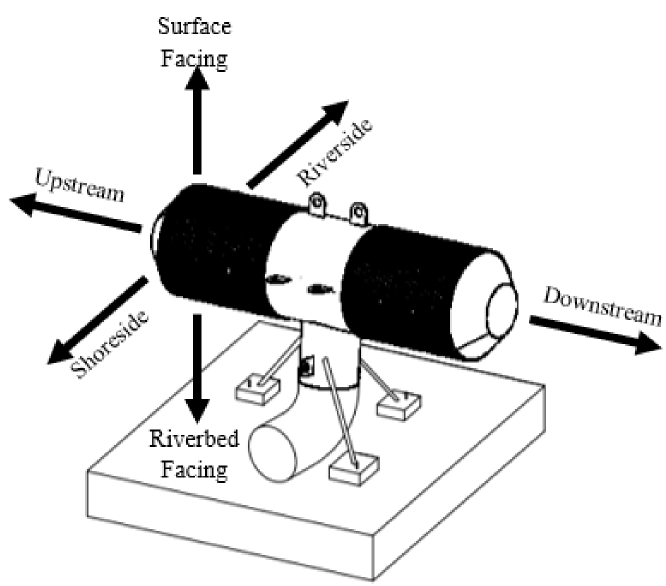


Figure C-1: Pilot Wedgewire Screen Subsection Naming Convention

C.2 DESCRIPTION OF INSPECTIONS

[redacted] an underwater inspection of the pilot wedgewire screens occurred on September 2, 2019. A notable amount of high hardness (i.e. resistive to mechanical cleaning) fouling was observed along with a moderate amount of biogrowth on the fouling deposits that was clogging the screens. An additional inspection occurred on September 18, 2019 [redacted]. An increased amount of fouling was observed during the dive, with an appreciable amount of surface area completely clogged. [redacted] accompanying inspection occurred on October 1, 2019 in reaction to the amount of observed fouling. Damage to the 0.8 mm wedgewire screen was also identified during this inspection. The information presented in this Addendum was based on the imagery captured during the October 1, 2019 inspection.

C.3 FOULING CALCULATIONS

The fouling observed during the inspections was primarily accumulated along the axial support bars. The pilot wedgewire screens demonstrated different fouling density patterns, suggesting that the fouling deposits were not evenly dispersed on the pilot wedgewire screens. The fouling observed on the pilot wedgewire screens was assumed to be due to mechanical compaction of the fouling deposits against the axial support bars and between the circumferential wire rings. The constant flow compressed the fouling deposits into the wedgewire slot openings. [redacted] the compacted fouling deposits were believed to have provided a host surface on which biogrowth occurred. It was noted that, while biogrowth occurred where fouling deposits collected, there was a negligible amount of fouling on the risers, flow diverters, and conical end closures.

Based on the imagery captured [redacted] during the October 1, 2019 inspection, a proportion of clogged surface area was calculated. Each wedgewire screen was constructed with 36 axial support bars, making up 36 distinct divisions around each wedgewire screen or 18 divisions per hemicylindrical subsection. An estimate of clogged surface area was assigned to each division following a graphical evaluation of the inspection imagery. The average percentage of clogged surface area was then determined using an unweighted arithmetic mean. The estimated averages are provided in Tables C-1 and C-2.

Table C-1: 3.0 mm Slot Width Wedgewire Screen Fouling Estimation

Subsection	Percentage Clogged	Percentage Clogged per Side	Total Percentage Clogged
Upstream Shoreside	2%	34%	21%
Upstream Riverside	66%		
Downstream Shoreside	10%	8%	
Downstream Riverside	6%		

Table C-2: 0.8 mm Slot Width Wedgewire Screen Fouling Estimation

Subsection	Percentage Clogged	Percentage Clogged per Side	Total Percentage Clogged
Upstream Shoreside	14%	19%	21%
Upstream Riverside	24%		
Downstream Shoreside	14%	22%	
Downstream Riverside	30%		

Fouling on pilot wedgewire screens creates a lower local percent of open area in the region where the fouling deposits are accumulated resulting in a higher local head loss relative to a unit through slot velocity. [redacted] The head losses associated with the pilot wedgewire screens remained relatively low [redacted].

The imagery from the October 1, 2019 indicated [redacted] The fouling was highly resistant [redacted]. Additionally, a large amount of biogrowth was observed on the surfaces of submerged [redacted]

[redacted]. It is evident that [redacted]. High fouling events leading to loss of effectiveness or operability may occur [redacted]

C.4 DAMAGE CALCULATIONS

Minor damage to the 0.8 mm wedgewire screen was identified during the October 1, 2019 inspection. Review of the imagery captured during the prior inspections confirmed that the damage occurred between September 18, 2019 and October 1, 2019. The damage is comprised of two distinct compromised sections: widened through slot width on the upstream riverbed facing subsection and missing circumferential wire rings on the downstream riverbed facing subsection. A large amount of plant matter and biogrowth was entangled in the widened slots on the upstream riverbed facing side. The widest portion of the widened slots was clogged by the plant matter and biogrowth. The widest portion of the unclogged widened slots was estimated to be 3.2 mm wide. The missing circumferential wire rings on the downstream riverbed facing subsection were located near the wedgewire screen riser and extended across the bottom 90° of the screen. The widest portion of the missing circumferential wire rings was estimated to be 2.4 mm wide.

A percentage of damaged surface area was calculated using a similar methodology as used for the calculation of clogged surface area. The estimated averages are provided in Table C-3.

Table C-3: 0.8 mm Slot Width Wedgewire Screen Damage Estimation

Subsection	Percentage Damage	Percentage Damage per Side	Total Percentage Damage
Upstream Surface Facing	0%	2%	4%
Upstream Riverbed Facing	4%		
Downstream Surface Facing	0%	6%	
Downstream Riverbed Facing	12%		

The resultant decrease in exclusion efficiency was [redacted] The withdrawal of water through the damaged surface area [redacted]

Based on the approximate width of the damage, it was assumed that the exclusion efficiency and [redacted] There was no damage detected on the 3.0 mm screen.

C.5 CONCLUSION

A significant amount of fouling was observed during the inspection on October 1, 2019. This inspection was scheduled to [redacted] From the imagery captured during the inspection, [redacted] A significant amount of fouling remained between the wedgewire screen through slot openings [redacted] Furthermore, damage to the 0.8 mm screen occurred on the river facing side. It is uncertain what might have caused the damage.

C.6 INSPECTION IMAGERY

A series of images of each hemispherical subsection of the 3.0 mm wedgewire screen and 0.8 mm wedgewire screen were captured prior to, during and following the backflushing procedure, and is provided in Tables C-4 and C-5, respectively.

Table C-4: 3.0 mm Slot Width Wedgewire Screen Imagery (October 1, 2019 Inspection)

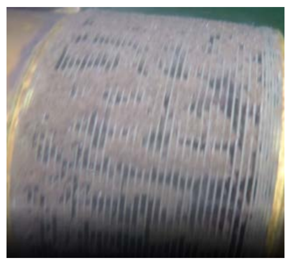
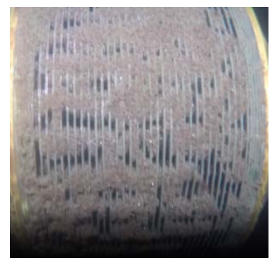
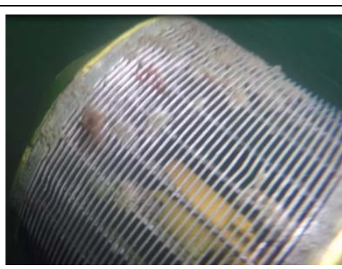
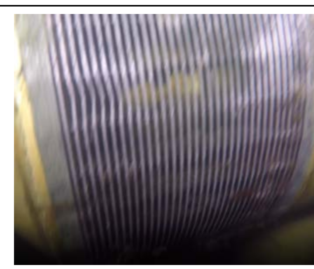
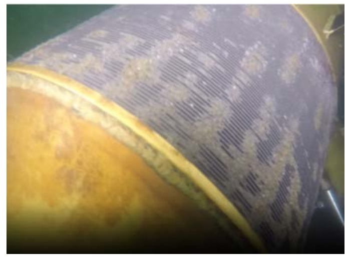
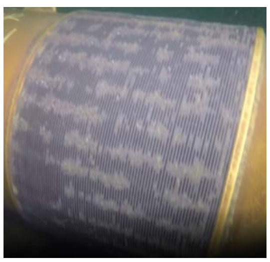
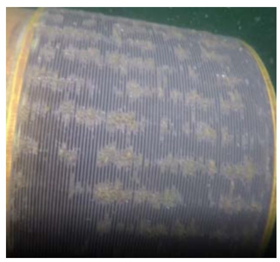
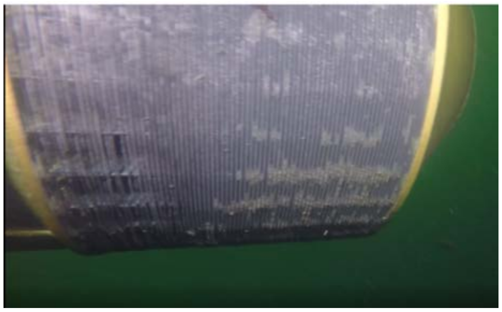
[redacted]	[redacted]	[redacted]
Upstream Shoreside		
		
Upstream Riverside		
		
Downstream Shoreside		
		
Downstream Riverside		
		

Table C-5: 0.8 mm Slot Width Wedgewire Screen Imagery (October 1, 2019 Inspection)

[redacted]	[redacted]	[redacted]
Upstream Shoreside		
		
Upstream Riverside		
		
Downstream Shoreside		
		
Downstream Riverside		
		

Images of the damaged subsections of the 0.8 mm wedgewire screen are provided in Table C-6. No equivalent or comparative images of the 3.0 mm wedgewire screen are provided due to the absence of identified damage.

Table C-6: 0.8 mm Slot Width Wedgewire Screen Damage Imagery (October 1, 2019 Inspection)

Shoreside	Riverside
Upstream Riverbed Facing	
	
Downstream Riverbed Facing	
	

D.0 ADDENDUM D: INCREASED DAMAGE AND FOULING EVENT REPORT

D.1 DESCRIPTION OF ADDENDUM

This addendum was generated following [redacted] that occurred on November 20, 2019. An underwater dive inspection was scheduled for December 7, 2019 to observe and identify the current conditions of the pilot wedgewire screens and equipment. This addendum details the [redacted] the physical conditions of the pilot wedgewire screens and makes a comparison of the conditions between the October 1, 2019 inspection and the December 7, 2019 inspections. The observed conditions were estimated based on the imagery captured during the underwater inspection.

For clarity, subsections of the pilot wedgewire screens are identified by hemicylinders in reference to the installation configuration as described in Addendum C, Section C.1.

D.2 DESCRIPTION OF INSPECTIONS

On November 20, 2019 [redacted] A dive was scheduled for December 7, 2019 to inspect and film equipment conditions. During the inspection, a lobster trap was observed [redacted] and is believed to [redacted] The inspection also observed that the conditions of pilot wedgewire screens had physically deteriorated since the prior inspection on October 1, 2019. [redacted] Post inspection reporting and footage of the underwater inspection demonstrate that [redacted] The imagery shows major damage to the riverbed facing sides and increased fouling on the 0.8 mm screen.

D.3 DAMAGE CALCULATIONS

Previously, the October 1, 2019 dive inspection observed screen damage to be minor and only located on the riverbed facing side of the 0.8 mm screens with a total of 4% of surface area damaged, as shown in Table D-1. The December 7, 2019 dive inspection observed damage on both the 3.0 mm and 0.8 mm pilot wedgewire screens, with a significant increased percentage in the total surface area damaged.

Based on the imagery captured from the inspection, the proportion of damaged surface area was calculated. The calculation for the damaged surface area is similar to the calculation for clogged surface area in Addendum C, Section C.3. Tables D-1 and D-2 detail the damaged surface area for October and December respectively.

The inspection on December 7, 2019 observed major damage to both the 3.0 mm and 0.8 mm screens on the riverbed facing sides. During the previous inspection in October inspection, the 3.0 mm screen did not have any damaged areas. The December inspection observed the development of damaged area on the 3.0 mm screen. The 3.0 mm screen damaged area had widened through slots approximately ¾ in. wide, which increased the percentage of total surface area damaged from 0% to 5.5%. During the October inspection, the damage on the 0.8 mm screens was minor with a few of the through slots being widened to approximately 3.0 mm in width. The damage observed during the December dive inspection revealed a severe increase, including entire sections of the radial rings missing. The smallest damaged opening observed during this December inspection was approximately ¾ in. wide and the largest damaged opening was approximately two inches wide on the 0.8 mm screen. For the 0.8 mm screen, the total surface area damage increased from 4% to 10.25% of total surface area damaged.

Table D-1: Wedgewire Screen Damage Estimation (October 1, 2019 Inspection)

Subsection	Percentage Damage	Percentage Damage per Side	Total Percentage Damage
3.0 mm Wedgewire screen	0%	0%	0%
0.8 mm Upstream Surface Facing	0%	2%	4%
0.8 mm Upstream Riverbed Facing	4%		
0.8 mm Downstream Surface Facing	0%	6%	
0.8 mm Downstream Riverbed Facing	12%		

Table D-2: Wedgewire Screen Damage Estimation (December 7, 2019 Inspection)

Subsection	Percentage Damage	Percentage Damage per Side	Total Percentage Damage
3.0 mm Upstream Surface Facing	0%	3%	5.5%
3.0 mm Upstream Riverbed Facing	6%		
3.0 mm Downstream Surface Facing	0%	8%	
3.0 mm Downstream Riverbed Facing	16%		
0.8 mm Upstream Surface Facing	0%	3%	10.25%
0.8 mm Upstream Riverbed Facing	6%		
0.8 mm Downstream Surface Facing	0%	17.5%	
0.8 mm Downstream Riverbed Facing	35%		

The resultant decrease in exclusion efficiency [redacted]

Based on the approximate width of the damage, it is assumed that the exclusion efficiency [redacted]

D.4 FOULING CALCULATIONS

Fouling conditions changed since the previous dive inspection on October 1, 2019. From the October inspection, the total clogged surface area was 21% for both screens. During the December inspection, the clogged surface area decreased on the 3.0 mm screen from 21% to 17% but had increased on the 0.8 mm screen from 21% to 37%.

A percentage of clogged surface area was calculated using the methodology used for the calculation in Addendum C, Section C.3. Tables D-3 and D-4 below detail the clogged surface area from the October inspection and the December inspection, respectively.

Table D-3: Wedgewire Screen Fouling Estimation (October 1, 2019)

Subsection	Percentage Clogged	Percentage Clogged per Side	Total Percentage Clogged
3.0 mm Upstream Shoreside	2%	34%	21%
3.0 mm Upstream Riverside	66%		
3.0 mm Downstream Shoreside	10%	8%	
3.0 mm Downstream Riverside	6%		
0.8 mm Upstream Shoreside	14%	19%	21%
0.8 mm Upstream Riverside	24%		
0.8 mm Downstream Shoreside	14%	22%	
0.8 mm Downstream Riverside	30%		

Table D-4: Wedgewire Screen Fouling Estimation (December 7, 2019)

Subsection	Percentage Clogged	Percentage Clogged per Side	Total Percentage Clogged
3.0 mm Upstream Shoreside	2%	24%	17%
3.0 mm Upstream Riverside	46%		
3.0 mm Downstream Shoreside	12%	11%	
3.0 mm Downstream Riverside	10%		
0.8 mm Upstream Shoreside	20%	37%	36%
0.8 mm Upstream Riverside	55%		
0.8 mm Downstream Shoreside	35%	35%	
0.8 mm Downstream Riverside	35%		

D.5 CONCLUSIONS

A significant amount of damage was observed during the inspection on December 7, 2019. This inspection was scheduled [redacted] which then observed that the screens had physically deteriorated since the previous inspection from October 2019. The screens had major damage and continued to have clogged surface areas. Damage to the 3.0 mm screen was similar to the damage that was first observed on the 0.8 mm screens, indicating the deterioration of the screens occurred through a similar mechanism and was not circumstantial to a singular occurrence. The damage on the 0.8 mm screen had radial [redacted] rings sections missing in the damaged areas and had accumulated fouling on the screen. From the damage observed during the inspections, it is anticipated that the physical conditions of the screens would have continued to deteriorate and eventually would have led to decreased effectiveness of the screens. Similar deterioration would be expected with a full-scale screen installation.

D.6 INSPECTION IMAGERY

Below is an imagery comparison of past to current conditions for the pilot wedgewire screens. Imagery of the ADCP inspection is also included below.

Table D-5: Slot Width Wedgewire Screen Damage Imagery Comparison

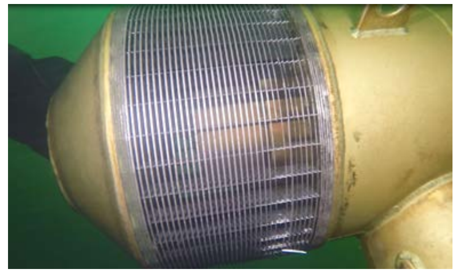
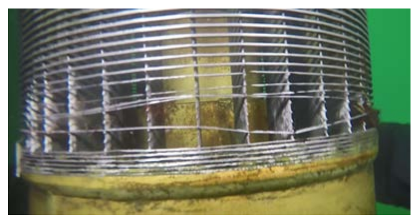
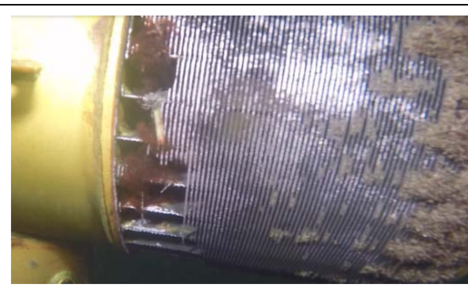
October 1, 2019	December 7, 2019
Upstream 3.0 mm Wedgewire Screen Riverbed Facing Damage	
No damage was observed on the 3.0 mm screens during the October inspection.	
Downstream 3.0 mm Wedgewire Screen Riverbed Facing Damage	
No damage was observed on the 3.0 mm screens during the October inspection.	
Upstream 0.8 mm Wedgewire Screen Riverbed Facing Damage	
	
Downstream 0.8 mm Wedgewire Screen Riverbed Facing Damage	
	

Table D-6: 3.0 mm Slot Width Fouling Imagery Comparison

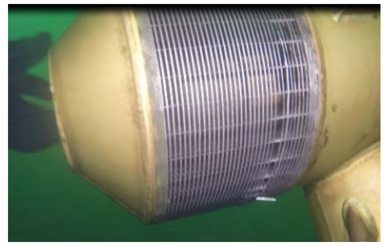
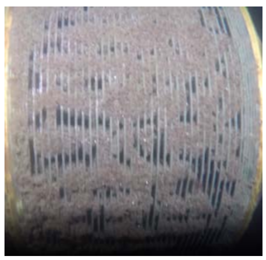
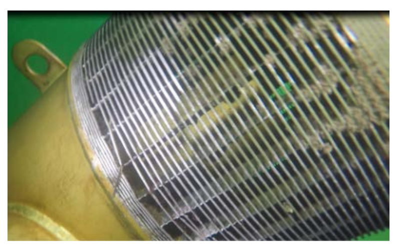
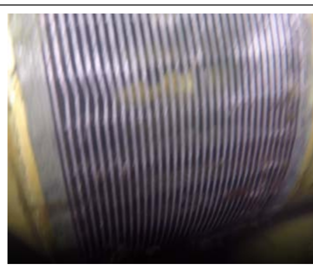
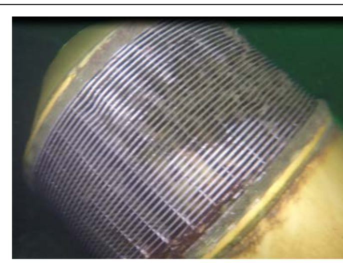
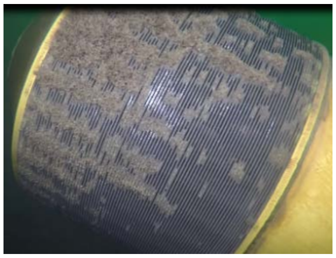
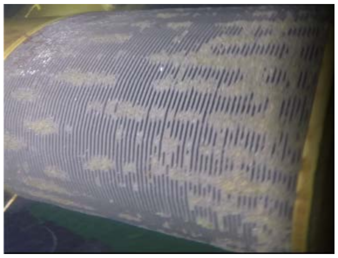
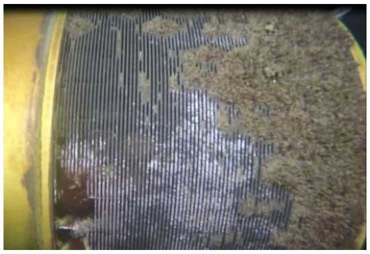
October 1, 2019 Inspection	December 7, 2019 Inspection
Upstream Shoreside	
	
Upstream Riverside	
	
Downstream Shoreside	
	
Downstream Riverside	
	

Table D-7: 0.8 mm Slot Width Fouling Imagery Comparison

October 1, 2019	December 7, 2019
Upstream Shoreside	
	
Upstream Riverside	
	
Downstream Shoreside	
	
Downstream Riverside	
	

[redacted]

E.0 ADDENDUM E: FINAL DAMAGE AND FOULING

E.1 DESCRIPTION OF ADDENDUM

This addendum was generated following the series of underwater inspections for the Wedgewire Screen Site-Specific Study at GSP's Schiller Station. Following a series of events that impacted the effectiveness of the pilot wedgewire screens, video and photo images were used to keep a record of the physical conditions of the screens. The inspections generated an imagery comparison of the damaged surface area and clogged surface area between October 1, 2019 and January 23, 2020. The physical conditions of the screens rapidly degraded between the inspection periods, and as a result, reduced the entrainment reduction effectiveness of the pilot wedgewire screens. Percentages of the total damaged area and percentage of the clogged surface area are detailed in Table E-1. This addendum also details the conditions of the pilot wedgewire screens at each inspection, as shown in Table E-2.

For clarity, subsections of the pilot wedgewire screens are identified by hemicylinders in reference to the installation configuration. The naming convention of the wedgewire screen subsections used in this Addendum follow the configuration provided in Figure C.1 of Addendum C.

E.2 DESCRIPTION OF INSPECTIONS

The inspections of the screens occurred on an as-needed basis and were prompted according to the observations of the site operators. The inspection on October 1, 2019 occurred in order to record the physical condition of the pilot wedgewire screens [redacted], as detailed in Addendum C. The inspection on December 7, 2019 occurred in response to [redacted] as detailed in Addendum D. The onshore inspection on January 23, 2020 occurred at the conclusion of the study period and recorded the final physical condition of the pilot wedgewire screens.

E.3 DESCRIPTION OF IMAGERY

The final inspection images were captured onshore shortly after the removal of the pilot wedgewire screens on January 23, 2020. The images captured were used to document and compare the physical deterioration of the pilot wedgewire screens over the study period. Since the prior inspection from December 7, 2019, the physical condition of the screens rapidly deteriorated. The amount of clogged surface area visible in the imagery demonstrates the fouling that has compounded during the study period.

E.4 DAMAGE COMPARISON

The methodology used for calculating the damaged surface area is similar to the methodology used for calculating the clogged surface area as described in Section C.3 of Addendum C. The proportion of damaged surface area of the 3.0 mm screen increased to 15.5%. The proportion of damaged surface area of the 0.8 mm screen at the conclusion of the testing period increased to 19.25%. The damage is localized on the riverbed facing sides but increased in severity with large portions of the screens missing. The damaged areas measure as wide as 2.5 in. on the 3.0 mm screens and as wide as 3.5 in. on the 0.8 mm screens. Table E-8 shows imagery of the screens compared alongside a measuring tape. With the amount of damage, the screens have a decreased entrainment reduction effectiveness. Table E-1 details the damaged surface area of the screens at the conclusion of the study period. Due to the size of the damaged portion of the screens, [redacted]. This had an effect on the withdrawal profile of the screens. There was a larger proportionate withdrawal flow rate through the damaged areas due to the larger openings. The withdrawal flow rate through the damaged portions on the 3.0 mm screen increased to 23% by the conclusion of the testing period. The withdrawal flow rate through the damaged portions increased on the 0.8 mm screen to 44.5% by the conclusion of the testing period. [redacted]

Table E-1: Wedgewire Screen Damage Estimation (January 2020 Inspection)

Subsection	Percentage Damage	Percentage Damage per Side	Total Percentage Damage
3.0 mm Upstream Surface Facing	0%	17.5%	15.5%
3.0 mm Upstream Riverbed Facing	35%		
3.0 mm Downstream Surface Facing	0%	13.5%	
3.0 mm Downstream Riverbed Facing	27%		
0.8 mm Upstream Surface Facing	0%	18.5%	19.25%
0.8 mm Upstream Riverbed Facing	37%		
0.8 mm Downstream Surface Facing	0%	20%	
0.8 mm Downstream Riverbed Facing	40%		

Table E-2: Wedgewire Screen Damage Estimation Comparison

Screen	October 1, 2019		December 7, 2019		January 23, 2020	
	Damaged Area	[redacted]	Damaged Area	[redacted]	Damaged Area	[redacted]
3.0 mm	0%	[redacted]	5.5%	[redacted]	15.5%	[redacted]
0.8 mm	4%	[redacted]	10.25%	[redacted]	19.25%	[redacted]

E.5 FOULING COMPARISON

The inspection imagery provides a record of the clogged surface area. The calculation for the clogged surface area is detailed in Addendum C, Section C.3. During the final onshore inspection, it was noted that significant fouling continued to occur. The amount and distribution of clogged surface area remained persistent throughout the inspections. The final amount of surface area is approximate due to some amount of fouling being removed during the screen retrieval process. Table E-3 shows the percentage of the covered surface area during the final inspection and Table E-4 compares the percentage of clogged surface area throughout the testing period.

Table E-3: Wedgewire Screen Fouling Estimation (January 23, 2020)

Subsection	Percentage Clogged	Percentage Clogged per Side	Total Percentage Clogged
3.0 mm Upstream Shoreside	2%	17%	14.5%
3.0 mm Upstream Riverside	15%		
3.0 mm Downstream Shoreside	7%	12%	
3.0 mm Downstream Riverside	5%		
0.8 mm Upstream Shoreside	16%	33%	31.5%
0.8 mm Upstream Riverside	50%		
0.8 mm Downstream Shoreside	30%	30%	
0.8 mm Downstream Riverside	30%		

Table E-4: Wedgewire Screen Fouling Estimation Comparison

Screen	Fouling Percentage October 1, 2019	Fouling Percentage December 7, 2019	Fouling Percentage January 23, 2020
3.0 mm	21%	17%	14.5%*
0.8 mm	21%	36%	31.5%*

* an amount of fouling was removed during the screen retrieval process

E.6 CONCLUSION

The final onshore inspection concluded the testing period for the Wedgewire Screen Site-Specific Study at GSP's Schiller Station. The inspection was used to outline a final comparison of the physical conditions of the pilot wedgewire screens. Throughout the testing period, images of the pilot wedgewire screens captured and recorded the percentage of damaged surface area and the percentage of clogged surface area between the months of October 2019 and January 2020. The pilot wedgewire screens had a rapid deterioration rate in the waters of the Piscataqua River adjacent to Schiller Station over the duration of the study period. Additionally, the biogrowth was observed to thicken throughout the duration of the testing period. For both of the pilot wedgewire screens the percentage of damaged surface area also quickly increased during the inspection period. The cause of the damage is not verified. Given the observed damage and fouling on both pilot wedgewire screens, it is believed that the issues were not circumstantial to the site-specific study. The amount of consistent damage and fouling on both screens indicates that similar damage on a full-scale screen would occur, furthermore it has been seen that once damage occurs the physical conditions of the screens rapidly deteriorate. At the conclusion of the testing period, the pilot wedgewire screens were considered to be in an ineffective and unusable condition. Due to the rapid deterioration of the screens, the implementation of this technology is not recommended.

E.7 COMPARISON OF IMAGERY

Table E-5: Wedgewire Screen Damage Imagery Comparison

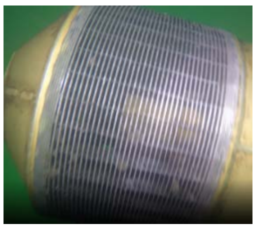
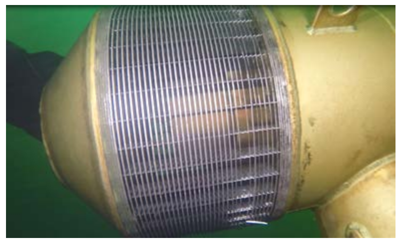
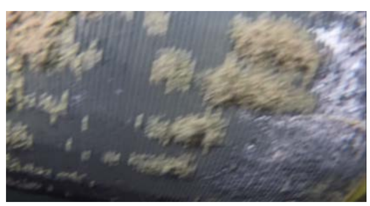
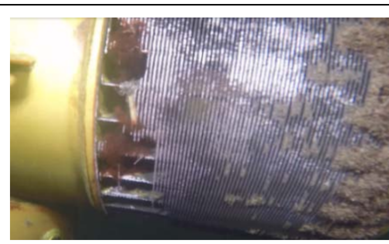
October 1, 2019	December 7, 2019	On Shore January 23, 2020
Upstream 3.0 mm Wedgewire Screen River Facing Damage		
		
Downstream 3.0 mm Wedgewire Screen River Facing Damage		
		
Upstream 0.8 mm Wedgewire Screen River Facing Damage		
		
Downstream 0.8 mm Wedgewire Screen River Facing Damage		
		

Table E-6: 3.0 mm Slot Width Wedgewire Screen Fouling Imagery Comparison

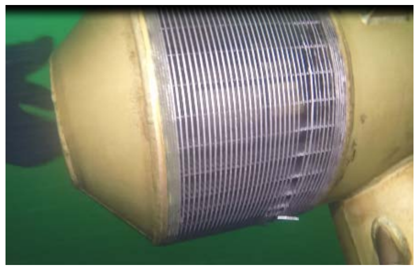
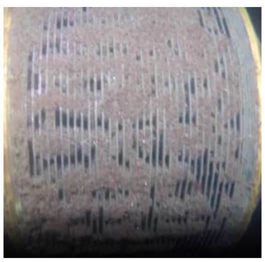
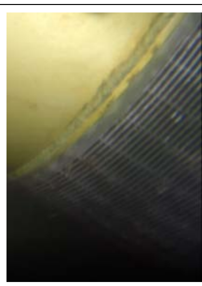
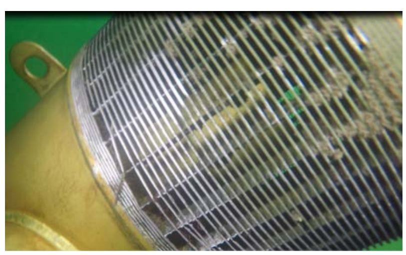
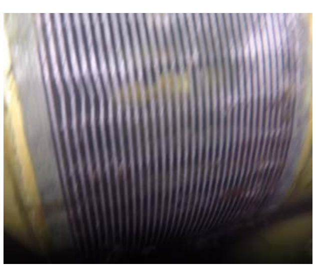
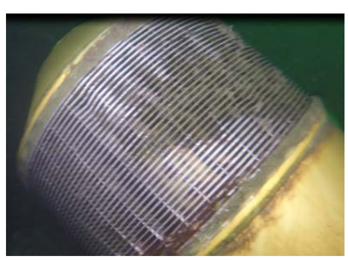
October 1, 2019	December 7, 2019	On Shore January 23, 2020
Upstream Shoreside		
		
Upstream Riverside		
		
Downstream Shoreside		
		
Downstream Riverside		
		

Table E-7: 0.8 mm Slot Width Wedgewire Screen Fouling Imagery Comparison

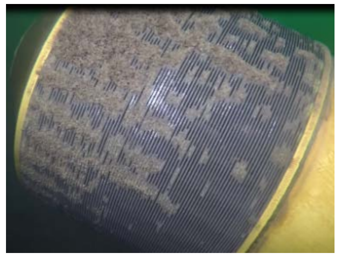
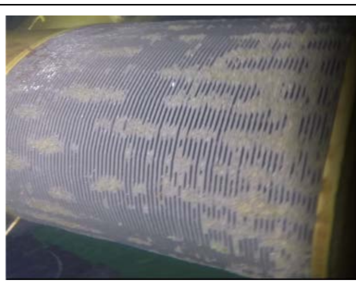
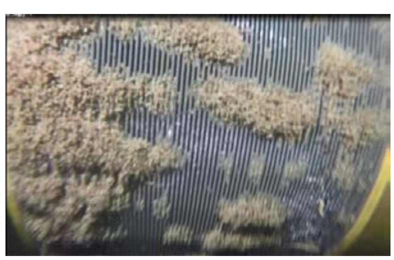
October 1, 2019	December 7, 2019	On Shore January 23, 2020
Upstream Shoreside		
		
Upstream Riverside		
		
Downstream Shoreside		
		
Downstream Riverside		
		

Table E-8: Imagery of Measured Damage on Pilot Wedgewire Screens

3.0 mm Screen Damage	0.8 mm Screen Damage
	

Schiller Station Wedgewire Screen Site-Specific Study Technical Availability Summary

This technical availability summary documents the condition and performance of the pilot wedgewire screens at Schiller Station and provides conclusions regarding the availability of a full-scale installation. The conditions of the pilot wedgewire screens were quantified over time using imagery from underwater dive inspections. A significant amount of fouling and damage to the pilot wedgewire screens was observed during the approximate yearlong test period of continuous operation. The characteristics observed during the in-situ testing period are considered representative of what should be expected from a full-scale installation of this wedgewire screen technology.

The amount and quality of observed fouling and damage to the pilot wedgewire screens suggests that maintenance of year-round operability of a full-scale installation of wedgewire screens at Schiller Station would impose significant technical challenges. [redacted]

Ambient (i.e. water quality induced) and/or flow-based (i.e. constant sweeping/through velocity induced) corrosion could cause further damage to the screens. No feasible, additional mitigation of corrosion has been identified beyond the measures taken during the pilot test. When significant damage is identified during inspections, repair of the screens (either in water or onshore) would be required to maintain the exclusion efficiency of the wedgewire screens. Reduced effectiveness of the wedgewire screens due to unidentified damage could be present for extended periods of time between inspections. Repair or replacement of the wedgewire screens would be an expensive and time intensive task which could occur frequently based on the conditions observed during the site-specific study.

A bypass system would be imperative to ensure continued reliability during wedgewire screen fouling events. Use of the bypass system would result in extended periods when the wedgewire screens would be removed from service and provide no protection. The duration and timing of these periods is currently unknown. Use of a bypass system would be required during the repair process for continued withdrawal of cooling water. If the wedgewire screens are damaged, they would operate at decreased exclusion efficiency.

The fouling and damage to the pilot wedgewire screens during the approximate 12 months of operation present critical concerns that would challenge the operability of a full-scale installation of wedgewire screens at Schiller Station. Implementation of a full-scale installation of wedgewire screens would be at risk of significant fouling, loss of effectiveness, and catastrophic failure. Given the results of the testing period, the incorporation of additional design features to reduce the potential for fouling and impact-based damage would need to be considered prior to full-scale installation of wedgewire screens at Schiller Station. Even then, the effectiveness of any such design features is currently unknown. Fouling and damage commensurate with the conditions observed during the testing period would result in operational challenges, increased maintenance requirements, and routine unavailability of the system. The availability and effectiveness of a full-scale installation of wedgewire screens would be uncertain and unreliable. For these reasons, it is concluded that wedgewire screens capable of operating continuously and reliably at Schiller Station are not available. Installation of wedgewire screens at Schiller Station would be a difficult, costly and imprudent measure which would not provide reliable, year-round operation.