Verification Statement

Xerxes HydroChain™ Main Header Row (MHR)
Registration number: (V-2026-03-01)
Date of issue: (2026-April-27)

Technology type	Stormwater Filtration Device
Application	Stormwater filtration technology to remove sediments, nutrients, heavy metals, and organic contaminants from stormwater runoff
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Verified Performance Claim
The HydroChain™ MHR demonstrated a total suspended solids (TSS) removal efficiency of at least 80% at the maximum treatment flow rate (MTFR), corresponding to a hydraulic loading rate of 4 gpm/ft², under defined test conditions. The minimum removal efficiency at the lower 95% confidence level is 81.6%, based on ten qualifying test runs. The verified performance applies to HydroChain™ MHR systems sized and operated at or below the corresponding hydraulic loading rate under the defined test conditions. Performance outside these conditions has not been verified.

Basis of Verification
Performance verification is based on full-scale laboratory testing conducted at Verdantas Flow Labs (Massachusetts, USA) using the HydroChain™ M-6 configuration as a representative test unit. Testing was performed in accordance with *the New Jersey Department of Environmental Protection (NJDEP), Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device, 2022 (updated 2023)* and an approved Quality Assurance Project Plan (QAPP)[1]. Data evaluation and independent verification were conducted by the Fleming Centre for Advancement of Water and Wastewater Technologies (Ontario, Canada) technical verification expert (TVE) in accordance with *ISO 14034:2016 Environmental management — Environmental technology verification (ETV)* and the VerifiGlobal Performance Verification Protocol.[2]

[1] Alden Research Laboratory, LLC, *Verification Testing of the Xerxes HydroChain M-6 Treatment Unit*, Quality Assurance Project Plan, April 2023
[2] VerifiGlobal, *Performance Verification Protocol (Applying ISO 14034:2016)*, VG-2016-002 (rev. 2017-05-04)

Technology Application

Xerxes Corporation, part of the Mattr Corporation group of companies, designs and manufactures engineered products for infrastructure and water management applications. The company develops systems for subsurface stormwater storage, conveyance, and treatment used in site and municipal drainage applications. Xerxes has developed proprietary stormwater technologies, including the HydroChain™ Main Header Row (MHR) system, which is intended for integration within subsurface chamber systems to provide flow distribution and filtration treatment.

The HydroChain™ MHR system is used within subsurface stormwater management systems to support treatment and flow distribution at development sites subject to stormwater regulations. The system is applicable in configurations where space constraints limit the use of surface-based treatment practices, including sites with a high proportion of impervious cover. By providing filtration of stormwater runoff and integration with subsurface storage systems, the HydroChain™ MHR contributes to pollutant load reduction and supports compliance with applicable regulatory requirements.

A photo of a typical HydroChain™ chamber storage system is shown in Figure 1.

Figure 1 - Typical HydroChain™ Chamber Storage System

Technology Description

The HydroChain™ system consists of open-bottom, arch-shaped chambers installed within a stone foundation layer to provide subsurface stormwater storage and conveyance. Depending on site design, stored stormwater is either infiltrated into underlying soils or discharged at a controlled rate through an outlet structure. Within this system, the HydroChain™ Main Header Row (MHR) serves as the inflow distribution and pretreatment zone.

As shown in Figure 2, the MHR incorporates a woven geotextile layer positioned between the chamber and the stone foundation. This layer functions as a filtration interface, capturing pollutants as stormwater enters the system and passes into the underlying stone layer. The stone foundation layer provides structural support and distributes flow to downstream chambers. Following pretreatment within the MHR, stormwater is conveyed through the chamber system for storage and subsequent infiltration or controlled discharge, depending on project-specific design conditions.

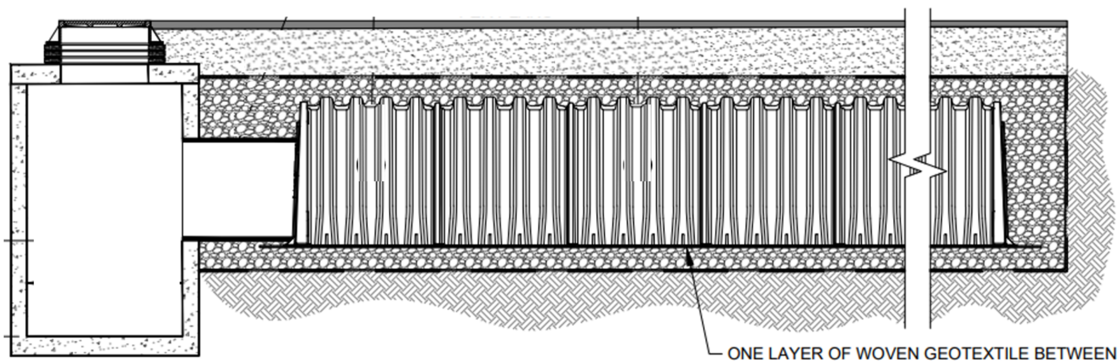


Figure 2 – HydroChain™ Main Header Row Detail

Test Methods and Conditions

Test Configuration
Performance testing was conducted at Verdantas[3] using a full-scale HydroChain™ MHR test unit constructed with HydroChain™ M-6 chambers. The test configuration consisted of two chamber sections with end caps, providing an effective treatment area of approximately 14.1 ft². The system was installed over a 6-inch stone foundation layer consisting of 3/4”–1-1/2” double-washed angular crushed granite, with a woven geotextile layer positioned between the chamber and the stone foundation. A cover layer of the same aggregate extended above the chamber crown to replicate field installation conditions.

Influent flow was introduced through a 12-inch PVC pipe installed at a 1% slope. Treated flow was collected through a 4-inch perforated underdrain located within the stone foundation layer to facilitate controlled discharge during testing. Flow rates were measured using a calibrated flow meter with measurement accuracy within ±1%, and water levels within the system were monitored using pressure-based instrumentation. Measurements were recorded throughout each test run to confirm hydraulic conditions and operational stability.

Test Sediment and Particle Size Distribution
Testing was conducted using a standardized silica-based sediment (1–1000 µm, specific gravity 2.65) prepared to meet the required particle size distribution (PSD). The PSD was verified in accordance with NJDEP Filtration MTD Protocol requirements, with all measured values within allowable tolerances and a median particle size (D50) of 66 µm. The target PSD is presented in Table 1, and a comparison of the measured PSD to the specified distribution is shown in Figure 3.

Test Conditions and Operation
Testing was performed at the maximum treatment flow rate (MTFR) of 56.4 gpm. The target influent sediment concentration was 200 mg/L (±20 mg/L). Flow and sediment feed rates were maintained within acceptable variability limits, with flow variation within ±10% of the target rate and a coefficient of variance (COV) ≤0.03.

Effluent sampling was conducted throughout each test run using time-based and volume-based collection methods. Five time-weighted effluent samples and three background samples were collected during each run, with additional samples obtained during the drawdown period.

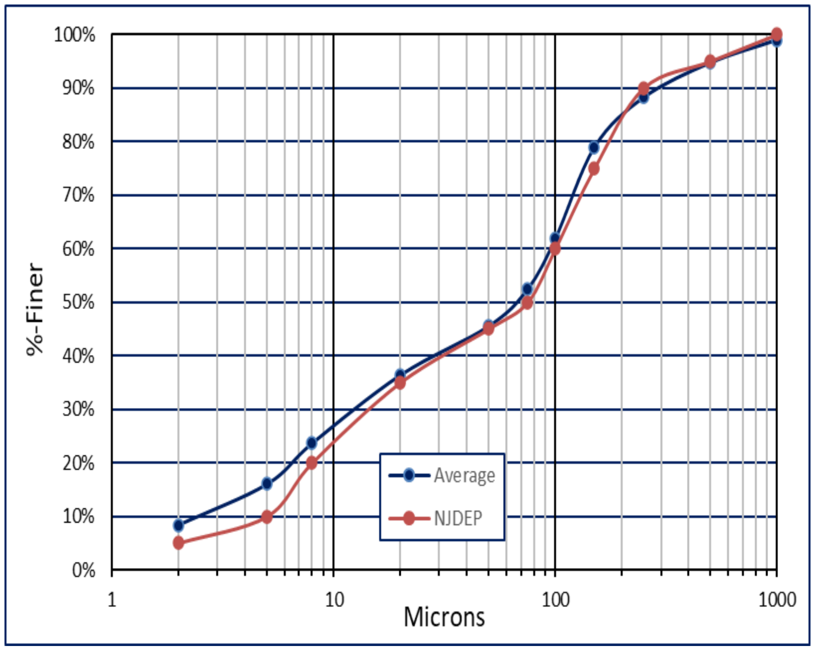
[3] *Verdantas Flow Labs Technical Evaluation Report # Xerxes1222-R0*, 2023

Flow rates were controlled and monitored using calibrated instrumentation, and water elevations within the system were measured throughout testing to confirm hydraulic conditions. All sampling and measurement systems met applicable calibration and accuracy requirements.

Table 1 – Test Sediment Particle Size Distribution

Particle Size (Microns)	Target Minimum % Less Than*
1,000	100
500	95
250	90
150	75
100	60
75	50
50	45
20	35
8	20
5	10
2	5

Figure 3 – Average PSD of the 1-1000 micron Test Sediment Used for Sediment Removal Test



Analytical Methods
Influent sediment concentration for each test run was calculated based on the sediment mass feed rate and measured flow rate. Measured effluent concentrations, together with calculated influent concentrations, were used to determine concentration-based removal efficiency.

Suspended solids concentrations were determined using ASTM D3977 by an ISO/IEC 17025[4] accredited laboratory. All samples were analyzed for suspended solids concentration (SSC) in accordance with ASTM D3977, which was used as the basis for total suspended solids (TSS) removal. Particle size distribution (PSD) of the test sediment was determined using sieve and hydrometer analyses in accordance with ASTM D6913/D6913M and ASTM D7928. Moisture content was measured in accordance with ASTM D2216 to support sediment preparation and concentration calculations.

Effluent Sampling
During each test run, five time-stamped effluent samples were collected at the outlet, and three background samples of the supply water were collected prior to sediment dosing to establish background concentrations. At the conclusion of each run, two additional volume-based effluent samples were collected during drawdown.

[4] *ISO/IEC 17025:2017 - General requirements for the competence of testing and calibration laboratories*

Test Results

The results of sediment removal efficiency testing for the HydroChain™ MHR M-6 configuration are summarized in Table 2. The table presents measured flow volumes, concentrations, and calculated mass-based performance for each test run. Removal efficiency was calculated using a mass-balance approach based on influent, effluent and drawdown measurements.

Table 2 – Summary of HydroChain MHR M-6 Removal Efficiency Test Results

Run #	Mass/Volume Influent Concentration mg/L	Average Adjusted Effluent Concentration mg/L	Average Adjusted Drawdown Concentration mg/L	Influent Volume L	Influent Mass g	Effluent Volume L	Effluent Mass g	Drawdown Volume L	Drawdown Mass g	Single Run Removal Efficiency %	Mass Captured g	Cumulative Average %
1	187	39.2	24.3	7,142	1,338	6,467	253	675	16	79.8	1,066	79.8
2	208	36.4	21.0	7,141	1,483	6,245	227	896	19	83.4	1,238	81.6
3	204	30.9	16.1	7,573	1,542	6,616	204	957	15	85.7	1,320	83.0
4	204	34.2	14.1	8,217	1,674	7,040	241	1,177	17	84.6	1,415	83.4
5	208	36.2	23.1	9,682	2,014	8,325	301	1,357	31	83.5	1,683	83.4
6	203	35.2	20.8	10,559	2,141	9,042	318	1,518	32	83.7	1,792	83.5
7	199	19.1	12.8	9,280	1,842	7,683	147	1,598	20	90.9	1,678	84.5
8	197	33.0	11.9	9,274	1,828	7,623	252	1,651	20	85.2	1,556	84.6
9	214	33.7	24.3	9,708	2,077	7,961	268	1,747	42	85.0	1,764	84.7
10	207	35.6	23.3	10,131	2,096	8,329	297	1,802	42	83.8	1,760	84.6
11	196	29.4	13.7	10,985	2,150	9,157	269	1,828	25	86.3	1,855	84.7
12	198	34.1	14.0	11,203	2,214	9,422	321	1,780	25	84.4	1,869	84.7
13	211	32.2	17.6	10,973	2,313	8,808	284	2,165	38	86.1	1,991	84.8
14	198	27.3	17.0	9,905	1,960	8,070	220	1,836	31	87.2	1,710	85.0
15	201	29.4	13.2	10,669	2,141	8,731	257	1,938	26	86.8	1,860	85.1
				Totals (g) =	28,812		3,860		400		24,557	
				Totals (lbs) =	63.52		8.51		0.88		54.14	

**Runs 14 and 15 were conducted at 90% of the maximum treatment flow rate (MTFR) following attainment of the target driving head condition in Run 13, in accordance with the protocol.*

Ten qualifying runs were used for statistical evaluation per protocol, with observed removal efficiencies ranging from 79.8% to 90.9% and cumulative removal exceeding 80%. The cumulative injected and captured sediment mass across all test runs was 63.53 lbs and 54.13 lbs, respectively, which forms the basis for the calculated sediment mass load capacity of 3.84 lbs/ft^2. Note: This is reported for completeness and not intended as a design or sizing parameter for the technology.

Verification Results

The verification was conducted in accordance with ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The process included review of the test procedure, supporting documentation, and validation of test data against the requirements of an established lab testing protocol.

The verified performance claim for the HydroChain™ MHR technology is based on full-scale laboratory testing conducted using the HydroChain™ M-6 configuration as a representative test unit. The verified performance applies to HydroChain™ MHR systems sized and operated at or below the corresponding hydraulic loading rate under the defined test conditions.

Testing was performed at a target maximum treatment flow rate (MTFR) of 56.4 gpm (4 gpm/ft²). Measured flows were consistent with target conditions, with an average flow of approximately 56.3 gpm and minimal variability (COV ≤ 0.004). Water elevations were monitored throughout testing to confirm hydraulic conditions, with a maximum measured driving head of approximately 3.14 ft observed during peak conditions.

The test results were used to establish the performance claim summarized in Table 3. The claim is based on the "Cumulative Average Removal Efficiency" data that were statistically evaluated using a non-parametric Wilcoxon Signed-Ranks test, as applied by the TVE, to support the reported performance for the sample size (n = 10).

Table 3 - Summary of Verified HydroChain™ MHR Performance Claim

Parameter	Verified Claim	Accuracy
Sediment Removal Efficiency	During sediment removal efficiency testing conducted under controlled laboratory conditions, the HydroChain™ MHR demonstrated a minimum total suspended solids (TSS) removal efficiency of 81.6% at the lower 95% confidence level, based on ten qualifying test runs. Testing was performed using an inlet sediment concentration of approximately 200 mg/L, a particle size distribution of 1–1000 µm (D50 = 66 µm), and an average flow rate of 56.3 gpm, corresponding to a hydraulic loading rate of 4 gpm/ft².	Sediment removal characteristics were quantified at the maximum treatment flow rate (MTFR) of 56.4 gallons per minute (gpm), with a particle size distribution (PSD) gradation of 1-1000 microns fractions (D_{50} = 66 microns). The target influent total sediment concentration was 200 mg/L (+/-20 mg/L) for all tests. The allowed Coefficient of Variance (COV) for the measured samples was 0.10. The temperature of the supply water was below 26.7 °C (80 °F).

Quality Assurance

Quality assurance (QA) and quality control (QC) procedures were implemented to ensure consistency, accuracy, and reproducibility of test results. These procedures included the use of ISO 17025 accredited laboratories, standardized analytical methods, calibrated instrumentation, and defined acceptance criteria for key test parameters.

The TVE reviewed and validated that QA/QC requirements were met, including confirmation of particle size distribution, influent concentration control, flow and head measurement accuracy, and analytical methods used for suspended solids concentration. Table 4 summarizes the QA/QC parameters and acceptance criteria applied during testing.

Table 4 – Validation of Performance Testing QA/QC Procedures

QC Parameter	Acceptance Criteria
Particle Size Distribution	Analyzed by ISO 17025 accredited laboratory in accordance with ASTM D6913 and D7928. Test sediment met the required PSD specification with ≤2% variation at each size fraction and D50 < 75 µm.
Background Suspended Solids	Background suspended solids concentration < 20 mg/L. Samples analyzed in accordance with ASTM D3977.
Water temperature	Maintained below 26.7 °C (80 °F) during testing.
Flow measurement equipment	Flow meters calibrated to ±1% accuracy. Flow recorded at regular intervals and maintained within ±10% of target with COV ≤ 0.03.
Head measurement equipment	Water levels measured using calibrated instrumentation with minimum accuracy of ±0.125 inches (0.32 cm). Measurements recorded at regular intervals throughout testing.
Sediment feed	Target influent concentration of 200 mg/L ± 20 mg/L. Variability controlled with COV ≤ 0.10
Sediment moisture content	Determined in accordance with ASTM D2216 to support accurate sediment dosing.
Sample analysis	Conducted by ISO 17025 accredited laboratories using established analytical methods.

Design and Operational Considerations

The verified performance of the HydroChain™ MHR applies to systems designed, sized, and operated within the hydraulic loading conditions established during testing. The Maximum Treatment Flow Rate (MTFR) is defined based on the effective filtration treatment area (open-bottom area) and a maximum hydraulic loading rate of 4.0 gpm/ft².

System performance is dependent on available driving head and hydraulic conditions. As sediment accumulates within the system, head loss will increase, which may reduce treatment flow capacity and increase the potential for bypass if not addressed through maintenance. The verified performance is applicable under conditions where the system is operated within the tested hydraulic range, including a maximum water elevation of approximately 36 inches above the base of the stone foundation.

Design of the HydroChain™ MHR system must consider site-specific factors including available footprint, storage requirements, pipe configuration, and allowable head conditions to ensure that treatment flow rates and hydraulic performance remain within the verified range.

The system is designed to meet applicable structural standards for thermoplastic stormwater chambers, including ASTM F2787 and ASTM F2418, and is suitable for installation under typical earth and traffic loading conditions when installed in accordance with manufacturer requirements.

The HydroChain™ MHR may be applied across a range of site conditions. In areas with high groundwater or sensitive receiving environments, additional design measures such as liners may be required in accordance with local regulations. While additional pretreatment is not required for verified performance, upstream sediment control measures may be considered for sites with elevated pollutant loading to support long-term operation.

Routine inspection and maintenance are required to sustain hydraulic and treatment performance over time. Performance outside these conditions has not been verified.

Verification Statement Summary

The verified performance of the HydroChain™ MHR is presented on the front page of this Verification Statement. In addition to total suspended solids (TSS) removal efficiency, other performance parameters were measured during testing to characterize system hydraulics, treatment capacity, and operational conditions under the defined test conditions. These parameters are not independent performance claims but provide supporting information for interpreting the verified performance and understanding system behavior under the tested conditions. Key parameters measured during testing are summarized in Table 5.

Table 5 – Supporting Test Parameters and Measured Values (Non-Verified Metrics)

Performance Parameter	Measured Value Under Test Conditions
Maximum Treatment Flow Rate - MTFR	56.4 gpm corresponding to a hydraulic loading rate of 4 gpm/ft² and an effective filtration treatment area of 14.1 ft².
Detention Time and Wetted Volume	11.8 ft³ at approximately 1.5 ft water depth, corresponding to an average detention time of approximately 1.6 minutes under test conditions. Wetted volume represents the active treatment volume and excludes temporary surcharge above the chamber crown.
Hydraulic Losses	Water elevation reached the target driving head of 3.0 ft during MTFR testing (Run 13) and did not exceed 3.25 ft. Following reduction to 90% MTFR per protocol, head decreased to a final elevation of 2.92 ft..
Effective Sedimentation Treatment Area -ESTA	For the MHR configuration, no distinct pre-filtration settling zone is present; therefore, the effective filtration treatment area (EFTA) and effective sedimentation treatment area (ESTA) are equivalent and defined by the chamber treatment area of 14.11 ft².
Sediment Mass Load Capacity	Sediment mass load capacity was 3.84 lbs/ft² while maintaining >80% removal under tested conditions, based on a cumulative injected and captured mass of 63.53 lbs and 54.13 lbs, respectively, with a final end-of-run water elevation of 2.92 ft. Note: This is reported for completeness and not intended as a design or sizing parameter for the technology.

What is ISO 14034?

The purpose of environmental technology verification is to provide a credible and impartial account of the performance of environmental technologies. Environmental technology verification is based on a number of principles to ensure that verifications are performed and reported accurately, clearly, unambiguously and objectively. The International Organization for Standardization (ISO) standard for environmental technology verification (ETV) is ISO 14034, which was published in November 2016.

Benefits of ETV

ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative features or performance cannot be fully assessed using existing standards. Through the provision of objective evidence, ETV provides an independent and impartial confirmation of the performance of an environmental technology based on reliable test data. ETV aims to strengthen the credibility of new, innovative technologies by supporting informed decision-making among interested parties.

For more information on the Xerxes HydroChain™ Main Header Row (MHR) technology, contact:	For more information on VerifiGlobal, contact:
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