January 10, 2025

Kris Bradner, PLA
Principal
Traverse Landscape Architects, Inc.
150 Chestnut Street, 4th Floor
Providence, RI, 02903

**RE: Summary of Well Water Development and Economic Analysis**
**Mount Hope High School, Bristol, RI**

Dear Kris:

Please allow this memorandum to serve as a narrative on the well water source investigation undertaken by Aqueous Consultants LLC (Aqueous) and its hydrogeologist subconsultant in response to the Bristol Planning Board's request to provide a well for irrigation for the athletic fields at the proposed Mount Hope High School (MHHS) in Bristol, Rhode Island. On October 10, 2024, members of the Bristol Planning Board commented during Master Plan Review Hearing #2 that a well for irrigation water supply should be explored to avoid the potential future economic impacts of purchasing water from Bristol County Water Authority (BCWA).

## Athletic Field Irrigation Demand

The current MHHS site and facility uses domestic water for irrigation. Using existing satellite imagery, approximately 322,000 square feet (approximately 7.4 acres) is estimated to cover the extent of existing athletic fields presumed to be irrigated. Based on the proposed plans, an area that is already irrigated and will continue to be irrigated is shown in blue on the plans to serve as a football practice field in the northwest corner of the site. This area totals approximately 90,000 square feet. New athletic fields proposed include a softball field, soccer field, and baseball field. The total new athletic field area is approximately 228,000 square feet.

The total irrigated area in the proposed MHHS athletic field condition is 318,000 square feet (approximately 7.3 acres). Thus, there is a net reduction in estimated irrigated area in the proposed condition versus the existing condition. The proposed synthetic turf infield (converting from the existing turfgrass infield) is not proposed to be irrigated and is not included in this calculation.

Athletic fields are high performance turfgrass surfaces with free draining soils, underdrainage to convey rainwater away from surfaces, and in constant need of maintenance in the form of mowing, topdressing, overseeding, and/or aeration due to the wear of athletics on these surfaces. Turfgrass in these systems require watering to maintain optimal soil moisture for continued growth and resilience to athletic field irrigation. The peak one-day summer demand for athletic field turfgrass irrigation is 0.25 inches per day, meaning that the depth of water applied across all athletic fields on the hottest day of the summer is 0.25 inches, or 0.02083 feet. Across 318,000 square feet applying 0.02083 feet of water depth yields a maximum daily irrigation volume of 6,625 cubic feet per day, equal to 49,555 gallons per day. To irrigate in an 8-hour overnight watering period (to not interfere with daily maintenance, practices, and games), an average flow rate of 103 gallons per minute is required. If the watering window were allowed to extend to 10 hours, the average flow rate would reduce to 83 gallons per minute.

Note that 49,555 gallons per day is not the irrigation demand every day. Irrigation must be designed to meet the peak turfgrass demand; however, climate and soil moisture-based irrigation controls allow for irrigation to be adjusted daily based on real-time weather conditions. For example, if the irrigation demand on any given day in late spring/early summer is half that of the peak summer condition, then the irrigation system only runs for half as much, dispensing half the peak volume. Moreover, if climate and soil moisture controls sense sufficient rain has fallen, then irrigation is not run at all—reducing irrigation demand to zero for that day. Climate and soil moisture sensing are critical to water conservation. The existing irrigation system at MHHS does not employ this type of advanced equipment, thus will irrigate the same amount every day, apart from a possible rain sensor suspending irrigation if it is installed and managed properly. Climate and soil moisture sensors on turfgrass irrigation systems can save 30% - 50% of typical constantly running irrigation systems—reducing the water consumption and costs incurred to BCWA.

## Well Water Supply as an Alternative to Municipal Water

Developing a water production well for irrigation at a flow rate of 83 – 103 gpm is unlikely. The underlying sedimentary bedrock requires extensive study and drilling to be able to develop this flow rate. Most wells that are drilled for residential domestic water wells range between 5 – 10 gpm. Commercial irrigation wells can be developed up to 20 – 30 gpm under favorable conditions. Given the difficulty of achieving at least 83 gpm, Aqueous procured the services of a hydrogeologist to assist in finding a suitable well location. While nothing in well drilling is guaranteed, a hydrogeologist can locate a drilling location based on local topography and vegetation variation in aerial photogrammetry.

The alternative to developing a well of at least 83 gpm to feed the irrigation system directly is to develop a lower yielding well and pump water into an underground holding tank for 24 hours to have enough water for the 8 – 10-hour overnight watering window. Given that there are only 1,440 minutes in a day (24 hours x 60 minutes per day) the minimum safe well flow would have to be 35 gpm for running non-stop to fill an underground tank and then install a second pump in the cistern to deliver a minimum of 83 gpm to avoid operating the irrigation system during the day. A 40,000-gallon cistern is required to pre-store water during the day for overnight watering. The cistern and second pump add to the project costs and capital investment substantially to the point where the payback analysis versus purchasing BCWA water (see below) is not favorable and does not make economic sense. In the best-case condition, one well that produces 83 gpm directly feeding the irrigation system can be developed. In the worst-case condition, one or multiple wells can be developed that feed a minimum of 35 gpm into a 40,000-gallon cistern with a separate pump feeding out to the irrigation system at a minimum of 83 gpm.

## Preliminary Well Pumping for Irrigation with Geothermal Pilot Well

A geothermal pilot well was drilled and tested to provide some estimate on the underlying aquifer's potential for providing geothermal heating and cooling. While the drill rigs were on site, the design team took the opportunity to perform some preliminary water quantity and water quality testing. With Aqueous' hydrogeologist subconsultant on site and providing support, the well driller pumped the pilot well to receive some cursory data on expected water quantity and quality. Initial indications are that the 6-inch geothermal pilot well could produce about 15 gpm. This falls short of 83 gpm for direct irrigation and 35 gpm for pre-storing water in a cistern. Thus, a larger well (8-inch or 10-inch) must be drilled, or multiple wells need to be drilled. More wells and wells of larger diameter greatly increase the initial outlay cost of an irrigation well system that change the balance of deciding to purchase BCWA water or not.

Initial water quality sampling performed indicated that the aquifer on site is not impacted by ocean tides. This was an important parameter to investigate as the potential intrusion of seawater into the irrigation well from overpumping the aquifer would lead to destroyed turfgrass and the loss of the well as a freshwater supply. A water quality sample was taken and analyzed in a laboratory. The water quality was adequate from a turfgrass agronomic perspective; however, the levels of iron and manganese were very high. While not necessarily deleterious to turfgrass, irrigation using high iron leads to unsightly and potentially damaging effects to hardscapes surfaces like sidewalks, buildings, and fences via staining: iron stains red and manganese stains black.

Initial indications are that the aquifer is difficult to extract large amounts of water and currently does not supply adequate water quality for athletic field irrigation (at least from an aesthetics perspective).

## RIDEM Groundwater Withdrawal Permitting

While drilling a well may seem like an attractive alternative to purchased municipal water, there are permitting requirements that must be satisfied prior to long-term use for irrigation. As the irrigation demand is greater than 10,000 gallons per day on any given single day, a Groundwater Withdrawal Permit is required through RIDEM. A pre-application checklist is offered by RIDEM (see attachments), and the requirements are exhaustive, including pumping tests, water quality tests, potential adverse impacts to rivers and wetlands as caused by pumping, and groundwater computer modeling. Additionally, pumping tests can only occur during the second half of the summer into early fall for accurate modeling of aquifers and to confirm potential flow rates during the driest times of year. Per RIDEM, the length of time to complete a Groundwater Withdrawal Permit testing program can last up to or greater than one (1) year.

Moreover, the RIDEM Wetlands application cannot be reviewed until all required Groundwater Withdrawal Permit application information has been received. Given that the project uses a Rhode Island Department of Education (RIDE) grant to be used under a time constraint, the testing work required by RIDEM could jeopardize BWRSD's ability to complete the project on time within the grant period.

## Cost-to-Benefit Analysis of Wells, Cisterns, and Permitting

The Planning Board asserted their lack of desire to pay for water to BCWA for the lifecycle of the project at the October 10, 2024 hearing. However, if the payback is poor based on current construction costs for a single well, multiple wells, an underground cistern, multiple pumps, and additional permitting against the current and projected BCWA water rates, then economically it is neither feasible, nor is it fiduciarily responsible, to move forward with well water exploration and development.

Doing a cursory payback period analysis, Aqueous projected average annual irrigation demand versus and the cost of purchasing required water from BCWA versus the estimated capital design, permitting, and construction costs of developing a well water supply. We used BCWA price rate data over the last 5 years and used a future increase in water rates of 4.5% per year when projecting costs over a 20-year period.

Generally, Aqueous suggests that a payback period, where the cumulative annual savings in water purchased from a water authority exceeds the initial infrastructure capital outlay (in "Year 0"), is 7 years or less is considered a "good" investment. The Internal Rate of Return (IRR) is favorable and worthwhile to make the initial outlay for infrastructure that will last 20 – 30 years. Between 8 - 12 years for payback, we consider this a "fair" or "borderline" investment. A payback beyond 12 years is generally not considered a great investment because of the volatility of projecting not only future costs for the infrastructure in question, but also the "opportunity cost" lost by allocating money to better investments (such as geothermal).

Preliminarily, the "best-case" scenario of drilling a single well that can produce 83 – 103 gpm would cost $384,000. This would result in more than the "fair" 8 to 12-year payback period. In other words, if everything worked out exactly as expected (not realistically plausible), the payback period would be fair or borderline. In the "worst-case" scenario, multiple wells, and/or additional cistern and pump systems would be between $800,000 and $1,000,000. On the low end, an $800,000 capital cost would have a total borrowed cost of more than $1.2M after interest charges and a payback period approaching 30 years. This would be a poor use of money today to save money in the future.

PMA Consultants provided a more robust study of payback analysis that included the interest paid on the bond required to raise the capital to install this infrastructure. Their analysis is congruous with Aqueous', but on a more detailed level.

The cost-to-benefit analysis does not include the following for a true comparison of options:

- The irrigation sprinkler system (we need this whether well or domestic water).
- A pump station (we either need a domestic booster pump station as in the current design or a well pump station).

- Electricity costs (this is almost a net wash because we need a domestic booster pump in the base condition)
- Maintenance costs (there would be more maintenance with a well and/or cistern system).
- Municipal BCWA water is not used to back up a well system
  - The goal of a well is to completely sever connections to municipal water.
  - Any connection (backup or primary) to BCWA for water requires a monthly meter fee that would add to the cost of the well system.

## Recommendation: Proceed with BCWA Municipal Water

Given the economic projections of slow payback periods, the variable and uncertain nature of well drilling and well water development, along with the existing project inertia to complete the project with RIDE funding within a set window, we are of the professional opinion that permitting, drilling, testing, and construction of a new well, or wells, additional pumps, and a large cistern is not economically feasible, which was the initial concern of the Planning Board: fiscal responsibility for now and the future.

If you have any questions, please do not hesitate to contact us, thank you.

Sincerely,

Michael Igo, PE, LEED AP, CID
President

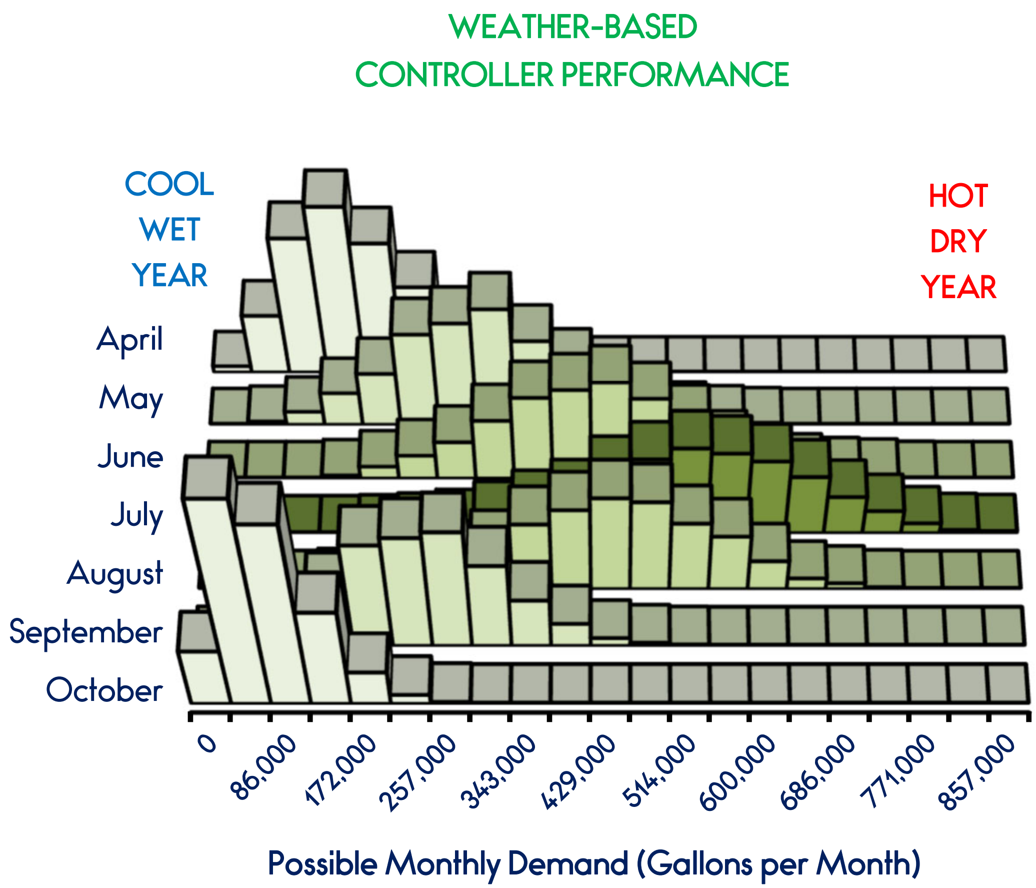
Attachments: Aqueous Cost-to-Benefit Analysis
Preliminary Irrigation Test Results for Geothermal Pilot Well

## Aqueous Cost-to-Benefit Analysis

# Monthly Irrigation Demand

Number of Computer Simulations = 2,000

Mount Hope HS
Bristol, RI
318,000 s.f. landscape




| Monthly Irrigation Demand with Smart Controller (gallons per month) | | |
|---|---|---|
| Month | Average | +/- |
| April | 122,000 | 65,000 |
| May | 264,000 | 94,000 |
| June | 385,000 | 108,000 |
| July | 506,000 | 116,000 |
| August | 408,000 | 106,000 |
| September | 211,000 | 81,000 |
| October | 57,000 | 45,000 |
| Annual | 1,951,000 | 247,000 |

Aqueous

**Effective March 1, 2024**

## Per 100 Cubic Foot Charge:

| Tier | | Monthly | Quarterly | Rate |
|---|---|---|---|---|
| 1 | For the first | 5 | 15 | 4.86 |
| 2 | For the next | 10 | 30 | 13.72 |
| 3 | For the next | 85 | 255 | 10.45 |
| 4 | For the next | 200 | 600 | 4.86 |
| 5 | Over | 300 | 900 | 6.30 |

Used for Cost-to-Benefit Analysis

## Service Charge:

| Size Code | Meter Size | Monthly | Quarterly |
|---|---|---|---|
| a | 5/8” x 3/4" | 37.25 | 111.71 |
| b | 3/4” x 3/4" | 55.90 | 167.73 |
| c | 1” | 93.19 | 279.58 |
| d | 1 1/2" | 186.31 | 559.03 |
| e | 2” | 298.11 | 894.30 |
| f | 3” | 559.03 | 1,677.11 |
| g | 4” | 931.61 | 2,794.90 |
| h | 6” | 1,863.36 | 5,589.98 |
| I | 8” | 2,981.33 | 8,943.88 |
| j | 10” | 4,285.67 | 12,856.86 |

$300 per month = $3,600 per year

| | | |
|---|---|---|
| Standard 5/8” x 3/4” Rate | 37.25 | 111.71 |
| Less senior discount frozen at the 3/1/2006 rate | (5.35) | (16.06) |
| 65 Years/Older Rate | 31.90 | 95.65 |

For any meter that measures water which passes through the meter and is delivered to more than one premise, and where the BCWA maintains the distribution pipes downstream of that meter, the BCWA will charge the customer service charge equal to the number of premises that receives water multiplied by the customer service charge for a 5/8” x 3/4"meter.

## Terms of Payment

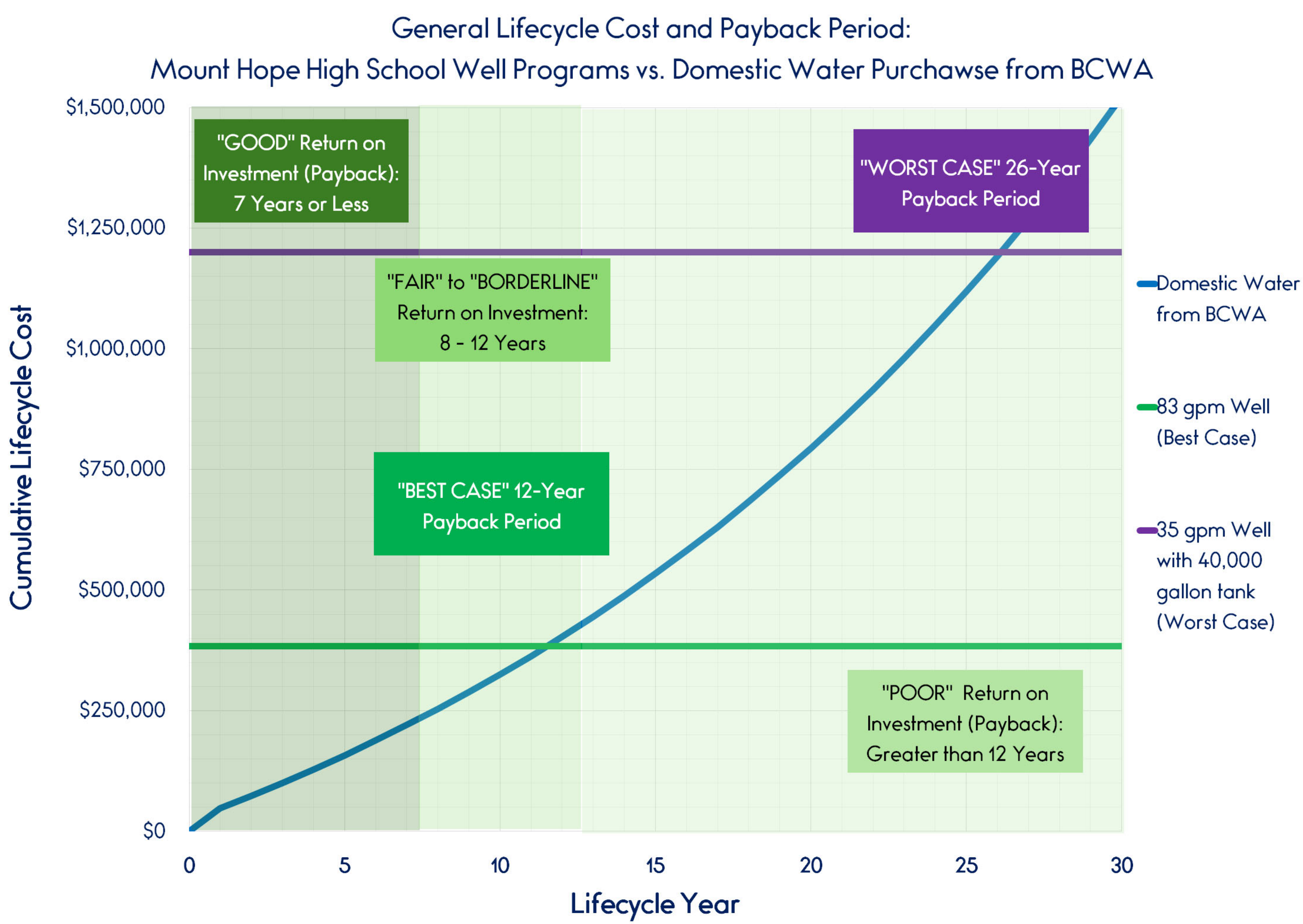
All customer service charges billed under this schedule are rendered in arrears on either a monthly or quarterly basis as applicable and are due and payable in full when rendered.

| Mount Hope High School Project Annual BCWA Water Costs* | | | |
|---|---|---|---|
| Water Use (Average) | (from A1 ETHOS) | 1,951,000 | gallons per year |
| BCWA Meter Fees | (from A2 Rate Sheet) | $ 2,100 | per year (7 Months) |
| Average Water Cost | (see Monthly Tiered Rates) | $ 21,406 | per year (7 Months) |
| Total Average Water Cost | (paid to BCWA) | $ 23,506 | per 100 cubic feet |
| Annual Increase | (Escalator) | 4.5% | BCWA Trend Data |

| Year | Annual Cost with Escalator | Cumulative Cost | Payback |
|---|---|---|---|
| 0 | $ 23,506 | | Well and Pump Design, Hydrology, Permitting, Driling, Hydrofracking, Testing, and Pump Station Installation Costs in the Range of Good ROI/Payback |
| 1 | $ 24,563 | $ 48,069 | |
| 2 | $ 25,669 | $ 73,738 | |
| 3 | $ 26,824 | $ 100,562 | |
| 4 | $ 28,031 | $ 128,593 | |
| 5 | $ 29,292 | $ 157,885 | |
| 6 | $ 30,611 | $ 188,496 | |
| 7 | $ 31,988 | $ 220,484 | |
| 8 | $ 33,428 | $ 253,912 | Borderline ROI/Payback |
| 9 | $ 34,932 | $ 288,843 | |
| 10 | $ 36,504 | $ 325,347 | |
| 11 | $ 38,146 | $ 363,493 | |
| 12 | $ 39,863 | $ 403,356 | |
| 13 | $ 41,657 | $ 445,013 | Ulterior Motives for Implementation: Regulation (No Access to Municipal Water), Desire for Greater Degree of Water Autonomy |
| 14 | $ 43,531 | $ 488,544 | |
| 15 | $ 45,490 | $ 534,034 | |
| 16 | $ 47,537 | $ 581,572 | |
| 17 | $ 49,676 | $ 631,248 | |
| 18 | $ 51,912 | $ 683,160 | |
| 19 | $ 54,248 | $ 737,408 | |
| 20 | $ 56,689 | $ 794,097 | |
| 21 | $ 59,240 | $ 853,337 | |
| 22 | $ 61,906 | $ 915,243 | |
| 23 | $ 64,692 | $ 979,935 | |
| 24 | $ 67,603 | $ 1,047,538 | |
| 25 | $ 70,645 | $ 1,118,182 | |
| 26 | $ 73,824 | $ 1,192,006 | |
| 27 | $ 77,146 | $ 1,269,152 | |
| 28 | $ 80,618 | $ 1,349,770 | |
| 29 | $ 84,245 | $ 1,434,015 | |
| 30 | $ 88,036 | $ 1,522,052 | |

| Mount Hope High School Monthly Irrigation Demand | | | BCWA Tiered Rates (up to Quantities of 100 cf below) | | | | | |
|---|---|---|---|---|---|---|---|---|
| Irrigation Month | Irrigation Gallons (from ETHOS) | Irrigation 100 cf (748 gal / 100 cf) | $ 4.86 | $ 13.72 | $ 10.45 | $ 4.86 | $ 6.30 | ANNUAL TOTAL |
| | | | 5 | 15 | 100 | 300 | 300 | |
| April | 122,000 | 163 | 5 | 15 | 100 | 137 | 0 | $ 1,940 |
| May | 264,000 | 353 | 5 | 15 | 100 | 300 | 53 | $ 3,067 |
| June | 385,000 | 515 | 5 | 15 | 100 | 300 | 215 | $ 4,086 |
| July | 506,000 | 676 | 5 | 15 | 100 | 300 | 376 | $ 5,105 |
| August | 408,000 | 545 | 5 | 15 | 100 | 300 | 245 | $ 4,279 |
| September | 211,000 | 282 | 5 | 15 | 100 | 18 | 0 | $ 1,362 |
| October | 57,000 | 76 | 5 | 15 | 24 | 224 | 0 | $ 1,566 |
| Annual | | | 2024 Dollars | | | | | $ 21,406 |

*Subject to Drought Restrictions, Not a Fully Autonomous Water Source


General Lifecycle Cost and Payback Period:
Mount Hope High School Well Programs vs. Domestic Water Purchawse from BCWA
$1,500,000
$1,250,000
$1,000,000
$750,000
$500,000
$250,000
$0
Cumulative Lifecycle Cost
0
5
10
15
20
25
30
Lifecycle Year
"GOOD" Return on Investment (Payback): 7 Years or Less
"FAIR" to "BORDERLINE" Return on Investment: 8 - 12 Years
"BEST CASE" 12-Year Payback Period
"WORST CASE" 26-Year Payback Period
"POOR" Return on Investment (Payback): Greater than 12 Years
Domestic Water from BCWA
83 gpm Well (Best Case)
35 gpm Well with 40,000 gallon tank (Worst Case)

## Preliminary Irrigation Test Results for Geothermal Pilot Well

## Michael Igo

**From:** Ray Talkington <rtalkington@geospherenh.com>
**Sent:** Wednesday, November 6, 2024 1:27 PM
**To:** Michael Igo
**Subject:** Mt Hope HS Geothermal Well Hydro Update.

Hi Mike,

The drilling was finally completed the other day and we were able to get access to the well to collect some data and calculate a preliminary depth to and thickness of the freshwater lens beneath Bristol. I have this to you first for review and comment before it goes to the group.

The following information was obtained about the local hydrogeologic conditions and the potential for saltwater intrusion from the drilling of the geothermal test well at Mt. Hope High School in Bristol, RI between 10/31/2024 and 11/5/2024.

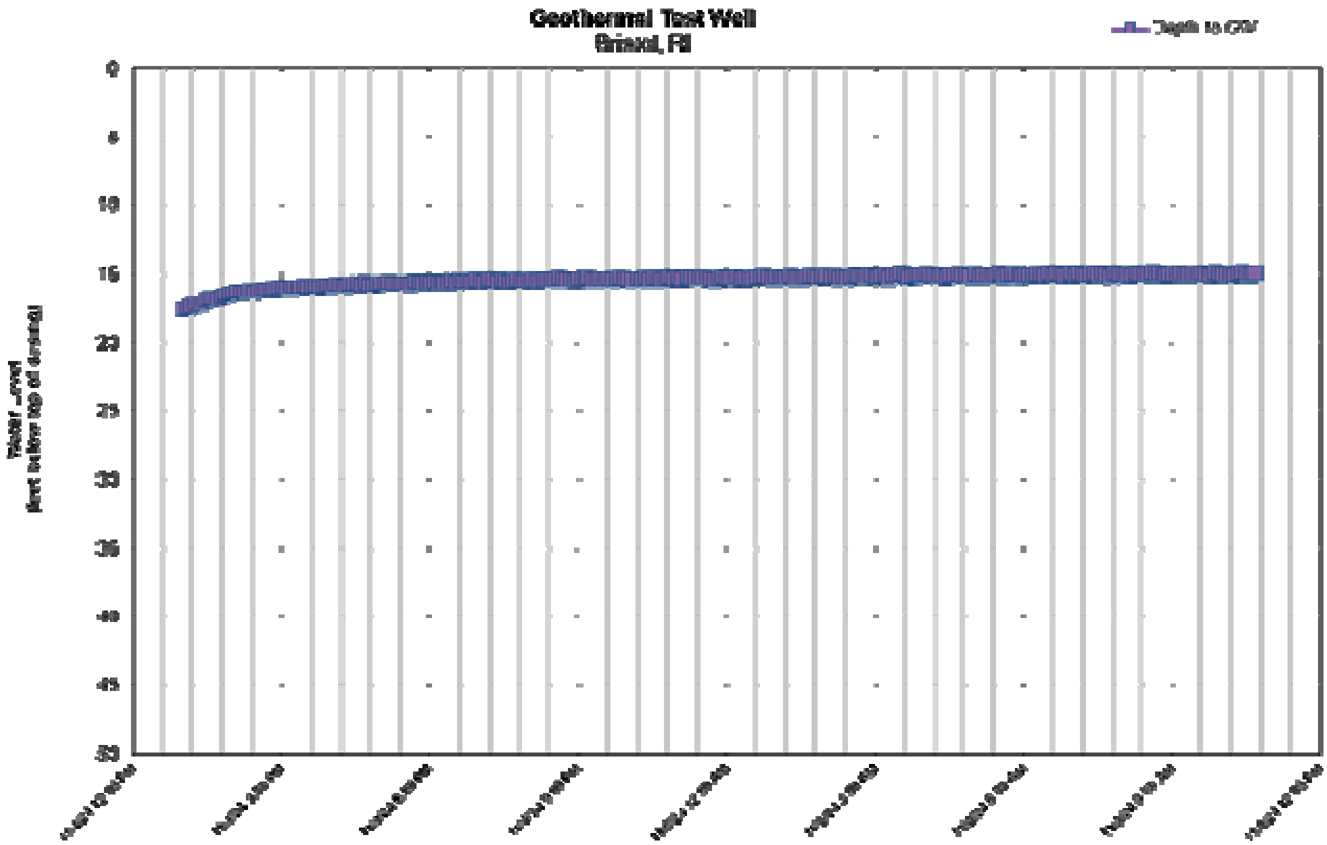
**Well Construction:**
Well diameter: 6-inches
Depth to bedrock: 55’
Top of casing: 2’ above ground surface
Bottom of casing: 60’ below ground surface

**Bedrock Geology:**
55’-550’: Grey siltstone
550’-600’: Grey and white granite

**Fracture Zones and Airlift yields:**
295’: 8 gallons per minute (gpm)
300’ airlift yield->8 gpm
560’: 7 gpm
600’ airlift yield->15 gpm

**Thickness of freshwater lens**
Ground surface elevation at test well (from Google Earth): 68’ above sea level
Static water level: 14.91’ below top of casing (11/5/2024)
Static water level elevation: ~55’ above sea level (68’-14.91’-2’ = 55.09’)
Thickness of freshwater lens calculated using Ghyben-Herzberg: ~2200’ (55.09’ x 40 = 2203’)

GEOSPHERE installed a transducer in the well which collected water level data between 11/4/204 and 11/5/2024. As shown in the plot below, none of the collected data indicates that water levels in the well are influenced by tidal fluctuations:




Overall, the thickness of the freshwater lens at Mt Hope High School in Bristol, RI appears to be sufficient to support an irrigation well without drawing in brackish/saline water. However, a multiday bedrock aquifer pumping test along with water quality testing will have to be performed before a more definitive assessment can be made on the long term use of an irrigation well. In addition, the challenge will be in encountering bedrock fractures that will support a well with adequate yield for the school's irrigation demands (i.e. 60 – 100 gpm).

Let me know if you have any questions. We are checking hours to see where we are budget wise with the $5K.

Best,

Ray

Raymond Talkington, Ph.D., P.G.
President/Principal Hydrogeologist
Geosphere Environmental Management, Inc.
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Exeter, New Hampshire 03833
603-773-0075 x 11
603-773-0077 fax
508-944-8765 cell
https://link.edgepilot.com/s/3601157d/kbpORnQRr0WHlbl_h6_HTw?u=http://www.linkedin.com/in/raytalkington/

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https://link.edgepilot.com/s/fc54ffb7/gBv2b3vVHU_Cl_snxY1_KQ?u=http://www.geospherenh.com/

NASHOBA ANALYTICAL
A DIVISION OF GRANITE STATE ANALYTICAL SERVICES, LLC

31A Willow Road Ayer, Massachusetts 01432
Phone: 978-391-4428 | website: www.nashobaanalytical.com

# Laboratory Report

**T.J. Ogden**
**17 Catherwood Road**
**Tewksbury, MA 01876**

| | |
|---|---|
| **Date Printed:** | **11/11/2024** |
| **Work Order #:** | **2411-00620** |
| **Client Job #:** | |
| **Date Received:** | **11/05/2024** |
| **Sample collected in:** | **Rhode Island** |

**Attached please find results for the analysis of the samples received on the date referenced above.**

Unless otherwise noted in the attached report, the analyses performed met the requirements of the analyzing laboratory's Quality Assurance Plan, Standard Operating Procedures and State Accreditation. This certificate shall not be reproduced, except in full, without the written approval of the analyzing laboratory. The results presented in this report relate to the samples listed on the following pages in the condition in which they were received. Accreditation for each analyte is identified by the * symbol following the analyte name. Location of our analyzing laboratory is identified by the code in the Analyst Column.

**A & L Laboratory:**
*Identified by ME in Analyst Column*
155 Center Street, Auburn, Maine 04210
www.allaboratory.com

**Granite State Analytical Services LLC:**
*Identified by NH in Analyst Column*
22 Manchester Road, Derry, NH 03038
www.granitestateanalytical.com

**Nashoba Analytical:**
*Identified by MA in the Analyst Column*
31A Willow Road, Ayer, MA 01432
www.nashobaanalytical.com

**ANALYSIS RELATED NOTES:**

- RL: "Reporting limit" means the lowest level of an analyte that can be accurately recovered from the matrix of interest.
- DF: "Dilution factor" means the ratio of the volume of the sample to the volume of the final (dilute) solution.
- MDL: "Minimum Detection Limit" means the minimum result which can be reliably discriminated from a blank with a predetermined confidence level.
- A & L Laboratory / Granite State Analytical Services LLC / Nashoba Analytical. accreditation lists can be found on our websites listed above.
- Data Qualifiers (DQ) Flags provide additional information in regards to the receipt, analysis or quality control of a sample. These are indicated under the DQ Flags Column on your report and listed here if necessary: Data Qualifier (DQ) Flags: H = Hold time non-compliant.

**SAMPLE STATE SPECIFIC NOTES:**

Additional Narrative or Comments: Nashoba Analytical does not hold certifications in the State of Rhode Island. Samples analyzed with client approval.

We appreciate the opportunity to provide you with laboratory services. If you have any questions regarding the enclosed report, please contact the laboratory and we will be happy to assist you.

Erin Shaw

Erin Shaw
Laboratory Director

A & L Laboratory: Accreditations: Maine ME00021, New Hampshire 2501, Maine Radon Registration ID # SPC20
Granite State Analytical Services, LLC: Accreditations: New Hampshire 1015; Maine NH00003; Massachusetts M-NH0003; Rhode Island 101513; Vermont VT-101507
Nashoba Analytical: Accreditations: Massachusetts M-MA1118

# NASHOBA ANALYTICAL

A DIVISION OF GRANITE STATE ANALYTICAL SERVICES, LLC

31A Willow Road Ayer, Massachusetts 01432

Phone: 978-391-4428 | website: www.nashobaanalytical.com


## CERTIFICATE OF ANALYSIS FOR DRINKING WATER

| Legend | |
|---|---|
| Passes | ✓ |
| Fails EPA Primary | ⊗ |
| Fails EPA Secondary | ▽ |
| Fails State Guideline | ✕ |
| Attention | ⚠ |

**DATE PRINTED:** 11/11/2024

**CLIENT NAME:** T.J. Ogden

**CLIENT ADDRESS:** 17 Catherwood Road
Tewksbury, MA 01876

**SAMPLE ID #:** 2411-00620-001

**SAMPLED BY:** Pump Crew

**SAMPLE ADDRESS:** Mount Hope High Sch
Chestnut Street
Bristol RI

**MORE LOC INFO:** Well Head

**DATE AND TIME COLLECTED:** 11/04/2024 05:00PM

**DATE AND TIME RECEIVED:** 11/05/2024 10:50AM

**ANALYSIS PACKAGE:** M-General Less TC

**RECEIPT TEMPERATURE:** 19.1° CELSIUS

**CLIENT JOB #:**

| Test Description | Result | Test Units | Pass /Fail | DQ Flag | RL | Limit | Method | Analyst | Date - Time Analyzed |
|---|---|---|---|---|---|---|---|---|---|
| Turbidity* | 160 | NTU | | | 0.5 | No Limit | EPA 180.1 | AH-MA | 11/05/2024 12:00PM |
| Calcium* | 12 | mg/L | | | 1 | No Limit | EPA 200.7 | KW-MA | 11/07/2024 06:02PM |
| Copper* | 0.026 | mg/L | ✓ | | 0.010 | 1.3 mg/L | EPA 200.7 | KW-MA | 11/07/2024 06:02PM |
| Iron* | 13.1 | mg/L | ▽ | | 0.010 | 0.3 mg/L | EPA 200.7 | PF-MA | 11/08/2024 06:17PM |
| Magnesium | 4.9 | mg/L | | | 1.0 | No Limit | EPA 200.7 | KW-MA | 11/07/2024 06:02PM |
| Manganese* | 0.509 | mg/L | ▽ | | 0.010 | 0.05 mg/L | EPA 200.7 | PF-MA | 11/08/2024 06:25PM |
| Sodium* | 22.9 | mg/L | ✕ | | 1 | 20 mg/L | EPA 200.7 | KW-MA | 11/07/2024 06:02PM |
| Chloride* | 35.4 | mg/L | ✓ | | 2 | 250 mg/L | EPA 300.0 | AH-MA | 11/05/2024 02:26PM |
| Nitrate as N* | 0.32 | mg/L | ✓ | | 0.05 | 10 mg/L | EPA 300.0 | AH-MA | 11/05/2024 02:26PM |
| Nitrite as N* | <0.05 | mg/L | ✓ | | 0.05 | 1 mg/L | EPA 300.0 | AH-MA | 11/05/2024 02:26PM |
| Sulfate* | 13.5 | mg/L | ✓ | | 2 | 250 mg/L | EPA 300.0 | AH-MA | 11/05/2024 02:26PM |
| Sediment | Present | | | | | | N/A N/A | AH-MA | 11/05/2024 11:45AM |
| Color, Apparent | 510 | CU | ▽ | | 0 | 15 | SM 2120B | AH-MA | 11/05/2024 11:57AM |
| Odor | 2 | TON | ✓ | H | 0 | 3 T.O.N. | SM 2150B | AH-MA | 11/05/2024 11:45AM |
| Total Alkalinity* | 42 | mg CaCO3/L | | | 5 | No Limit | SM 2320B | AH-MA | 11/05/2024 04:39PM |
| Hardness (calc.) | 50 | mg CaCO3/L | | | 1 | No Limit | SM 2340 B | KW-MA | 11/07/2024 06:02PM |
| Specific Conductance @ 25°C | 224 | umhos/cm | | | 10 | No Limit | SM 2510B | AH-MA | 11/05/2024 01:07PM |
| Residual Free Chlorine* | <0.2 | mg/L | ✓ | H | 0.2 | 4 | SM 4500Cl-G | KW-MA | 11/05/2024 01:43PM |
| pH at 25°C* | 6.86 | SU | ✓ | H | N/A | 6.5 - 8.5 SU | SM 4500-H-B | AH-MA | 11/05/2024 01:07PM |
| Ammonia as N | <0.1 | mg/L | | | 0.1 | No Limit | SM 4500NH3 D | MR-MA | 11/08/2024 03:05PM |

Erin Shaw

Erin Shaw
Laboratory Director

New England Testing Laboratory, Inc.
(401) 353-3420

# REPORT OF ANALYTICAL RESULTS

## NETLAB Work Order Number: 4K21039
## Client Project: 23099 - MHHS, Bristol

Report Date: 03-December-2024

Prepared for:

Sean Markey
Pare Corporation
8 Blackstone Valley Place
Lincoln, RI 02865

Mike Mccallum, Laboratory Director
New England Testing Laboratory, Inc.
59 Greenhill Street
West Warwick, RI 02893
mike.mccallum@newenglandtesting.com

## Samples Submitted :

The samples listed below were submitted to New England Testing Laboratory on 11/21/24. The group of samples appearing in this report was assigned an internal identification number (case number) for laboratory information management purposes. The client's designations for the individual samples, along with our case numbers, are used to identify the samples in this report. This report of analytical results pertains only to the sample(s) provided to us by the client which are indicated on the custody record. The case number for this sample submission is 4K21039. Custody records are included in this report.

| Lab ID | Sample | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| 4K21039-01 | MHHS Pilot Well | Water | 11/04/2024 | 11/21/2024 |

# *Request for Analysis*

At the client's request, the analyses presented in the following table were performed on the samples submitted.

**MHHS Pilot Well (Lab Number: 4K21039-01)**

| | **Method** |
|---|---|
| Arsenic | EPA 200.8 |
| Total & E. coli bacteria | SM9223B(04) (Colilert 18) |
| Total Dissolved Solids | SM2540-C (11) |

## *Method References*

*Methods for the Determination of Metals in Environmental Samples EPA-600/R-94/111*, USEPA, 1994

*Standard Methods for the Examination of Water and Wastewater, 20th Edition*, APHA/ AWWA-WPCF, 1998

## Case Narrative

The samples were all appropriately cooled and preserved upon receipt. The samples were received in the appropriate containers. The chain of custody was adequately completed and corresponded to the samples submitted.

All samples were analyzed in accordance with 40 CFR 136 approved methodologies when applicable.

Total Coliform: the sample was received in a non-sterile container outside of the method recommended holding time.

Arsenic: the sample was received in a non-preserved container.

Total Dissolved Solids: the sample was received outside of the method recommended holding time.

# Results: Microbiology

## Sample: MHHS Pilot Well

**Lab Number: 4K21039-01 (Water)**

| Analyte | Result | Qual | Reporting Limit | Units | Date Prepared | Date Analyzed |
|---|---|---|---|---|---|---|
| Total coliform | ND | | 10 | MPN/100ml | 11/21/24 16:30 | 11/21/24 16:30 |

# Results: General Chemistry

**Sample: MHHS Pilot Well**

**Lab Number: 4K21039-01 (Water)**

| Analyte | Result | Qual | Reporting Limit | Units | Date Prepared | Date Analyzed |
|---|---|---|---|---|---|---|
| Total Dissolved Solids | ND | | 10 | mg/L | 11/27/24 | 11/27/24 |

# Results: Total Metals

**Sample: MHHS Pilot Well**
**Lab Number: 4K21039-01 (Water)**

| Analyte | Result | Qual | Reporting Limit | Units | Date Prepared | Date Analyzed |
|---|---|---|---|---|---|---|
| **Arsenic** | **0.0117** | | 0.0002 | mg/L | 11/22/24 | 11/25/24 |

# Quality Control

## Microbiology

| Analyte | Result | Qual | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Batch: B4K0862 - Microbiology*** | | | | | | | | | | |
| **Blank (B4K0862-BLK1)** | | | | | Prepared & Analyzed: 11/21/24 | | | | | |
| Total coliform | < | | 1 | MPN/100ml | | | | | | |

# Quality Control
**(Continued)**

## General Chemistry

| Analyte | Result | Qual | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Batch: B4K1113 - TDS*** | | | | | | | | | | |
| **Blank (B4K1113-BLK1)** | | | | | Prepared & Analyzed: 11/27/24 | | | | | |
| Total Dissolved Solids | ND | | 10 | mg/L | | | | | | |
| **LCS (B4K1113-BS1)** | | | | | Prepared & Analyzed: 11/27/24 | | | | | |
| Total Dissolved Solids | 944 | | 10 | mg/L | 1000 | | 94.4 | 0-200 | | |
| **Duplicate (B4K1113-DUP1)** | | Source: 4K21039-01 | | | Prepared & Analyzed: 11/27/24 | | | | | |
| Total Dissolved Solids | ND | | 10 | mg/L | | ND | | | | 200 |

## Quality Control
**(Continued)**

### Total Metals

| Analyte | Result | Qual | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Batch: B4K0883 - Metals Digestion Waters*** | | | | | | | | | | |
| **Blank (B4K0883-BLK1)** | | | | | Prepared: 11/22/24 Analyzed: 11/25/24 | | | | | |
| Arsenic | ND | | 0.0001 | mg/L | | | | | | |
| **LCS (B4K0883-BS2)** | | | | | Prepared: 11/22/24 Analyzed: 11/25/24 | | | | | |
| Arsenic | 0.0189 | | 0.0001 | mg/L | 0.0200 | | 94.5 | 85-115 | | |

## Notes and Definitions

| Item | Definition |
| --- | --- |
| Wet | Sample results reported on a wet weight basis. |
| ND | Analyte NOT DETECTED at or above the reporting limit. |

## New England Testing Laboratory

59 Greenhill Street
West Warwick, RI 02893
1-888-863-8522

4K2 10391

# Chain of Custody Record

| Project No. | Project Name/Location: |
|---|---|
| 23099.07 | MHHS Bristol, RI |
| Client: | Pare Corporation |
| Report To: | smarkey@parecorp.com |
| Invoice To: | smarkey@parecorp.com<br>bnehring@parecorp.com |

| Date | Time | Comp | Grab | Sample I.D. | Matrix: Aqueous | Matrix: Soil | Matrix: Other | No. of Containers | Preservative | Tests**: Arsenic | Tests**: Total Dissolved Solids | Tests**: Total coliform bacteria | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/4/24 | 11:00 | | | MHHS Pilot Well | X | | | 1 | | X | X | X | | | | | | |

| Sampled By: | Date/Time | Received By: | Date/Time | Laboratory Remarks: | Special Instructions: |
|---|---|---|---|---|---|
| Ogden Wells | 11/4/24 11:00 | | | On ice | |
| **Relinquished By:** | **Date/Time** | **Received By:** | **Date/Time** | | |
| Sean Markey Pare Corporation | 11/21/24 13:00 | HK | 11/21/24 13:01 | Temp. Received: 11.2 | |

**Netlab Subcontracts the following tests: Radiologicals, Radon, TOC, Asbestos, UCMRs, Perchlorate, Bromate, Bromide, Sieve, Salmonella, Carbamates

Turnaround Time [Business Days]: **5 Days**

Aqueous

# Mt. Hope Test Geothermal Well
# Irrigation Water Quality Results (120624)

| WATER QUALITY ANALYSIS | | | Test Geothermal for Irrigation Adequacy | |
|---|---|---|---|---|
| Constituent | Symbol | Units | Test Level | Agronomic Rating |
| GENERAL WATER CHARACTERISTICS (Duncan, Carrow, Huck 2009: Table 3.12) | | | | |
| pH | | 1 - 14 | 6.86 | OK |
| Hardness | | ppm (<150 OK) | 50 | OK |
| Alkalinity | $HCO^3+CO^3$ | ppm CaCO3 | 42 | OK |
| TOTAL SALINITY | | | | |
| Total Dissolved Solids | TDS | ppm (< 832 OK) | 0 | LOW, OK |
| Electrical Conductivity | $EC_w$ | mmhos/cm (<1200 OK) | 224 | LOW, OK |
| ION IMPACT TO ROOTS OR FOLIAGE | | | | |
| Boron | B | ppm | N/A | N/A |
| Sodium | Na | ppm (<70 OK) | 22.9 | OK |
| Chloride | $Cl^-$ | ppm (<70 OK) | 35.4 | OK |
| NUTRIENTS | | | | |
| Calcium | Ca | ppm | 12 | OK |
| Magnesium | Mg | ppm (<40 OK) | 4.9 | OK |
| Potassium | K | ppm (<20 OK) | N/A | N/A |
| Sulfate | $SO^4$ | ppm (< 90 OK) | 13.5 | OK |
| Iron | Fe | ppm | 13.10 | TREAT |
| Manganese | Mn | ppm | 0.51 | TREAT |
| Copper | Cu | ppm | 0.03 | OK |
| Zinc | Zn | ppm | N/A | N/A |
| TRACE ELEMENTS | | | | |
| Arsenic | As | ppm | 0.0117 | OK |
| Beryllium | Be | ppm | N/A | N/A |
| Cadmium | Cd | ppm | N/A | N/A |
| Chromium | Cr | ppm | N/A | N/A |
| Selenium | Se | ppm | N/A | N/A |
| Lead | Pb | ppm | N/A | N/A |
| Mercury | Hg | ppb | N/A | N/A |
| MISCELLANOUS EFFECTS | | | | |
| Nitrate | $NO^3$ | ppm | 0.32 | OK |
| Nitrite | $NO^2$ | ppm | 0.05 | OK |
| Residual Chlorine | $Cl_2$ | ppm | 0.2 | OK |
| Turbidity | | NTU | 160 | TREAT |
| Total Coliform Bacteria | | MPN/100 mL (=0 OK) | 0 | OK |
| Calculations | | | | |
| | Element | ppm/meq | meq/L | SARw |
| Sodium | Ca | 20.04 | 0.60 | |
| Absorption | Mg | 12.16 | 0.40 | 1.41 |
| Ratio | Na | 22.99 | 1.00 | |
| Sodium Permeability Hazard | | | LOW | |
| Adjusted | Element | ppm/meq | meq/L | SARw |
| RNa | $Ca_x$ (Use Table & Input) | 20.04 | 0.80 | |
| (Table 11 - Ayers and | Mg | 12.16 | 0.40 | 1.28 |
| Wescott 1984) | Na | 22.99 | 1.00 | |
| Sodium Permeability Hazard | | | LOW | |

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANGEMENT
OFFICE OF WATER RESOURCES
GROUNDWATER AND WETLANDS PROTECTION PROGRAM

# FINAL DRAFT

# PRE-APPLICATION GUIDANCE FOR THOSE SEEKING A GROUNDWATER WITHDRAWAL PERMIT FOR > 10,000 GPD

**STEP 1.** **Complete the Pre-application form and a report containing the required information identified in Attachment A and submit 3 copies of the information to the RIDEM Office of Customer and Technical Assistance with a request for a pre-application meeting. Farmers can coordinate with the Department of Agriculture rather than Office of Customer and Technical Assistance.**

**STEP 2.** **Meet with DEM to discuss the project and the pumping test requirements.**

Please submit Attachment A at least one week in advance of the meeting. At the meeting, the Department will discuss any requirements for the pumping test, any wetlands concerns that have been identified in Attachment A, the location of pumping test discharge point, any fill, access concerns, aquifer characteristics, pumping rates, changes in protocol, stabilization etc…

**Note: A separate wetlands permit may be necessary if** there is a potential impact to the wetland from the discharge point or from construction of roads or facilities for the pumping test. DEM will advise whether or not wetlands permit will be required.

**STEP 3.** **Submit your pumping test proposal to the Office of Freshwater Wetlands. The proposal must address the concerns from any prior meeting(s) and it must address the requirements in Attachment B. An approval of the pumping test is required from this Department prior to commencement of the pumping test.**

**Note:** Please notify this Department at least 3 days prior to commencement of the pumping test.

**STEP 4.** **Submit a final pumping test report to the Office of Freshwater Wetlands –** applicants are urged to request a second meeting to discuss pumping test results and requirements for the wetland permit application.

**STEP 5.** **Apply to the Office of Freshwater Wetlands for a permit and include the final pumping test report along with the requirements in Attachment C.**

**Note:** All surface water withdrawals require a freshwater wetlands permit.

**PRE-APPLICATION GUIDANCE FOR THOSE SEEKING A GROUNDWATER WITHDRAWAL PERMIT FOR > 10,000 GPD**

**FINAL DRAFT**

## PRE-APPLICATION FORM FOR GROUNDWATER WITHDRAWAL PROJECTS

**Complete the Pre-application form and a report containing the required information identified in Attachment A and submit 3 copies of the information to the RIDEM Office of Customer and Technical Assistance with a request for a pre-application meeting. Farmers can coordinate with the Department of Agriculture rather than Office of Customer and Technical Assistance.**

Rhode Island Department of
Environmental Management
Office of Technical & Customer Assistance
235 Promenade Street
Providence, RI 02908

Rhode Island Department of
Environmental Management
Department of Agriculture
235 Promenade Street
Providence, RI 02908

**Submit one form for each proposed water withdrawal source (project).**

### A. APPLICANT INFORMATION *(Please Type or Print)*

Applicant Name: ______________________________________________

Applicant Mailing Address: ______________________________ Telephone No. ____________

City /Town: ______________________________ State:____________ Zip: ________

### B. PROJECT INFORMATION

Project Location (A*ddress)*: ______________________________________________

City/Town: ______________________________ State: ____________ Zip: ________

Tax Assessor's Plat (s) and Lot Numbers(s): ______________________________

Project Consultant Name :______________________________________________

Project Consultant Mailing Address: ______________________________ Telephone No. ____________

City/Town: ______________________________State: ____________ Zip: ________

# PRE-APPLICATION GUIDANCE FOR THOSE SEEKING A GROUNDWATER WITHDRAWAL PERMIT FOR > 10,000 GPD

**FINAL DRAFT**

## ATTACHMENT A

### I. PROJECT DESCRIPTION

**A.** Describe the project including an explanation of the project purpose and why the withdrawal is necessary.
**B.** Identify the location of the proposed withdrawal.
**C.** Identify the watershed in which the proposed well is located and source water (river and aquifer) for the withdrawal.
**D.** Is this project within CRMC jurisdiction?
**E.** Describe how much of the water is actually consumed and the quantity and location of return flow relative to the withdrawal point (whether upstream or downstream). If the water is returned downstream of the point of withdrawal, discuss how this will effect water quantity in the basin. If an out-of-basin transfer of water is proposed, discuss impacts on water quantity in the basin of origin – as well as the receiving basin.
**F.** Describe the proposed new or replacement withdrawals - rate, quantity, duration and frequency including:
   **1.** Maximum 24 hr. withdrawal volume (MGD or GPD)
   **2.** Maximum withdrawal rate (GPM)
   **3.** Average day withdrawal volume (MGD or GPD)
   **4.** Proposed duration and frequency of pumping (i.e. proposed operating protocol)
   **5.** Summer to winter ratio and max daily to average daily ratio (if different)
   **6.** Maximum daily flow to average daily flow

### II. SYSTEM DESCRIPTION

Describe existing sources of supply both purchased and produced for your water supply system (if applicable) – including rate, quantity, duration and frequency.

**A.** Maximum 24 hr. withdrawal volume (MGD or GPD)
**B.** Maximum withdrawal rate (GPM)
**C.** Average day withdrawal volume (MGD or GPD)
**D.** Current duration and frequency of pumping for all wells
**E.** Peaking factor MDD/ADD
**F.** Original design yield and current yield
**G.** List all State permit approvals and any conditions in those approvals that are relevant to water withdrawals
**H.** Describe legal obligations to supply water
**I.** Estimate-evaluate
   **a.** Fire fighting
   **b.** Non-account (including system use-unmetered public use)
   **c.** Meter inaccuracies-major leaks (annual basis % of water produced)
**J.** Describe any system deficiencies

### III. SITE CONDITIONS

Description of natural and manmade features, including wetlands, watercourses, fish and wildlife habitat, floodplains, and structures potentially affected by the proposed diversion due to physical alterations, or streamflow or water level depletion(s).

# PRE-APPLICATION GUIDANCE FOR THOSE SEEKING A GROUNDWATER WITHDRAWAL PERMIT FOR > 10,000 GPD

## FINAL DRAFT

Presence of sensitive or multiple receptors may limit site availability for water supply withdrawal. Some of the information required in this section can be found on the RIDEM website geographic data viewer at **http://www.dem.ri.gov/maps/index.htm#GV** and click on the Environmental Resource Map.

Other information such as low flow studies and water availability studies to locate existing withdrawals can be found on the USGS website at **http://www.wrb.ri.gov.**.

**A.** Provide a 1:6,000 scale or larger map depicting the proposed well site and the area within ½ mile radius of the proposed well including the following information:

1. Current land uses
2. Known water withdrawals within ½ mile
3. Zoning
4. Lakes, ponds, streams, and wetlands within 1000' radius of the well
5. The following sensitive receptors exist within 1000' of your site
6. Priority habitat for rare and endangered species
   a. Recreational areas (parks or management areas, public beaches, boat ramps)
   b. Amphibian breeding pools
   c. Stocked trout streams
   d. Cold water fisheries resource
   e. Any other critical resources
   f. Public and Private wells

**B.** Provide listings and locations of the following potential threats within one-half mile of your site?

1. Identified CIRCLAS sites
2. Combined Sewer Overflows or Sanitary Sewer Overflows
3. Landfills
4. Salt Storage Facilities
5. DPW Garages
6. Agricultural Uses
7. Automobile graveyards and junkyards
8. Industrial Parks/Plants
9. Petroleum, Gas station and oil bulk stations and terminals

**C.** Provide listings and locations of the following within the watershed of the proposed well:

1. RIPDES or NPDES permitted facilities (National Pollution Discharge Elimination System)
2. Public and known private water withdrawals
3. Regulated impoundment(s) within the watershed

## III. HYDROLOGIC CONDITIONS

This section is intended to preliminarily evaluate the potential impacts of proposed withdrawals on streamflow and availability of water in the river basin. The following stream screening criteria provides guidance concerning a withdrawal's potential for impact on flow.

Proposed groundwater withdrawals are assumed to have a 1:1 relationship with the amount of streamflow or water level depletion in hydrogeologically connected waterbodies (in other words, one gallon of water withdrawn from a well is expected to result in one gallon depleted from the affected waterbody) . The Department will accept calculations, which may show a lesser amount of depletion (such as Jenkins-Barlow calculations) in the pre-determination. It is generally considered that a cumulative consumptive use of 5% of the 7Q10 returned within ½ mile of the withdrawal is de minimus and would not result in measurable impacts to the river however, isolated wetlands and amphibian breeding pools may be impacted.

Studies have shown that at a cumulative, consumptive use of 50% of the 7Q10 creates measurable changes in the fish communities (Freeman, M.C. and Marcinek, P.A., Environmental Management Vol. 38, No. 3, pp. 435-450). The Department recommends that you carefully select your water source to avoid small streams and pools.

**A.** Provide the following flow statistics to the nearest stream reach from the withdrawal point. If the withdrawal location is near a confluence of two streams, please provide flows of both streams. These are the 7Q10 flow (MGD) and ABF of the nearest hydrologically connected stream(s) and the methods used to determine the 7Q10 and ABF.

**B.** Provide the peak cumulative consumptive use (MGD) within the basin in July, August and September (reference the USGS Water Availability Studies)

**C.** Identify locations within the basin that are stressed for quantity, quality or habitat (reference state's 303(d) list, USGS Water Availability Studies)

**D.** Provide a hydrologic budget of the watershed

**E.** Provide the aquifer characteristics

**F.** Provide results of any field test, secondary contaminants, and VOC analysis if available

**G.** For wells with planned yields of 10,000 gpd or greater in any 24 hour period, please provide a preliminary conceptual model of the aquifer, including:

1. Conceptual model of groundwater flow through the proposed well site including recharge and discharge areas
2. Stratigraphic cross-sections and boundary conditions
3. Initial estimates of the Well Head Protection Area

## IV. DEMAND MANAGEMENT AND CONSERVATION PLANNING

**A.** As part of it's assessment of water resource impact avoidance measures, the Department evaluates the applicants' efforts to optimize water efficiency and effectively manage demand (Rule 10.01). Describe what you do or plan to do to ensure the efficient use and conservation of water as detailed below. Provide data on historic, current, and projected future demand (projections from approved water system supply management plans may be used if still valid), if applicable.

**1.** Average daily demand for the last 5 years, current year, and projected 5 and 20 year periods (system-wide and per capita basis, if relevant).
**2.** Maximum daily demand (MGD) for the last 5 years, current year, and projected 5 and 20 year periods (MGD and per capita basis, if relevant).
**3.** Describe current water conservation programs and their impact, please provide assumptions and methodologies.

**B.** Provide data on historic current and projected future water production (supply): For 5 and 20 year periods, considering only current sources (supply) data, and with water supplied from proposed well.
**1.** What is your system's redundancy? Can you meet your average day demand with your largest existing source off-line? Can you meet you average daily demand from other available sources?
**2.** Do any of your existing sources have restricted or diminished capacity? If so, briefly indicate which sources and the reasons for the capacity restrictions. Are these restrictions temporary or permanent?

**C.** Water Conservation– what efforts have been made to avoid the need for a new or expanded withdrawal? Has every reasonable effort been made to avoid the need for new withdrawals? Has conservation been practiced and is it effective?

**1.** Detailed description of a community's efforts to discover and minimize unaccounted-for (non-account) water including leak detection and repair program and meter reading, calibration and replacement program. Consistent with AWWA recommendations, the goal is to reduce this to less than 10%.
**2.** Outline the existing efforts and the strategy for adopting and implementing measures to optimize water efficiency, conserve water and reduce peak demands:
  - **a.** Consideration of construction or acquisition of additional storage facilities
  - **b.** Establishing caps on per-day residential water use
  - **c.** Technical assistance to major users to implement water efficiency and water conservation measures
  - **d.** Outdoor watering requirements (local ordinances re: limiting lawn size or incentives for native or xeriscape plantings or use of rain gardens)
  - **e.** Retrofit or replacement of residential plumbing fixtures
  - **f.** Implementing a water conservation pricing structure and billing program
  - **g.** Increased education
  - **h.** Recycling of gray water

## V. ALTERNATIVE PLANS

The wetlands regulations require a demonstration of avoidance and minimization. With regards to water supplies, this includes formulating, evaluating effects and comparing alternative plans: At a minimum, the plans that must be formulated are:

- **a.** Leak detection alternative
- **b.** Conservation and demand management alternatives including but not limited to:
  - **1.** Toilet replacement program
  - **2.** Outdoor water bans
  - **3.** Pricing Structure
- **c.** Alternate locations at the site to minimize wetland crossings
- **d.** Alternative sources of supply

# ATTACHMENT B

# PUMPING TEST PROPOSAL

**The pumping test proposal must provide the following information for each pumping test. If any deviations from the listed protocol(s) are necessary, please explain the reasons why.**

## I. SITE INFORMATION

**A.** Historic water level data

**B.** Site Plan showing location of piezometers, observation wells, pumping wells, staff gages, nearby wetlands, discharge point and other pertinent information.
**Note:** Please refer to the attached document "Technical Standards for Water-Table Monitoring of Potential Wetland Sites" ERDC TN-WRAP-05-2 US Army Corps of Engineers for piezometer locations and installation recommendations.

- If staff gages are required one must be outside of the influence of pumping and the other must be located in the stream reach closest to the pumping well. In certain cases a stilling well may be required around the gage.
- Selected observation wells should fully penetrate the aquifer and should also be screened in the same aquifer as the screen of the pumping well unless there needs to be an exception (i.e. to confirm a confined aquifer, to evaluate surface water infiltration, or to locate source water from a bedrock well).
- Selected observation wells and/or staff gages should be set so as to observe impacts to surrounding wetlands including identified vernal pools or amphibian breeding areas within the area of influence of the production well.

**C.** Plan showing any other wells, private or public, in the area that may affect the cone of depression and to whether or not they will be running during the pumping test.

**D.** Location and log (depth, yield, lithology) of all exploratory wells, water table of the pumping well and the screen depths (if not possible to screen through the entire aquifer, explain why).

**E.** Description of the aquifer extent and characteristics (e.g. confined, unconfined, transmissivity, storage coefficient).

**F.** Description of nearby wetlands and methods that will be used to define stratigraphy in the wetland and impacts of pumping. Peat probing and monitoring wells or a combination of both are acceptable unless another is deemed more appropriate.

**G.** Description of recharge available to the well site including the delineation of drainage area and estimated precipitation compared to desired withdrawal rate.

## II. OPERATIONAL INFORMATION

**A.** Description of the physical dimensions of the test well

**B.** Description of the planned test pumping rate

- There should be no more than a 10 percent variation in the pumping rate during the course of the test unless a step test is used to determine the rate of pumping.

- The proposed well must by pumped for some duration (minimum of 3-5 days depending on amount requested) at a rate for which the source approval is sought.
- All of the wells within the influence of the pumping well must be pumped at their approved yield for the duration of the pumping test unless modeling is conducted to determine the cumulative impacts.

**C.** Documentation of test drilling and preliminary pumping test results
**D.** Documentation of method (i.e. step test)
**E.** Description of planned duration of test
**F.** Description of the location of discharge (make sure water is not returned to the pumping well through infiltration). A freshwater wetlands permit for the pumping test is not necessary provided proper erosion and sediment controls are installed to avoid freshwater wetland impacts from any discharge is protective any receiving..
**G.** Description of the measurement frequency of the observation wells, pumping well, precipitation and staff gages and discussion of proposed measurement methods.

1. Precipitation – During the pumping test, precipitation should be measured daily on site to the nearest 0.01 in. Precipitation measurements should commence 5 days prior to the startup of the pumping test. If at all possible the pumping test should be scheduled so that there is no heavy rainfall for 2 days prior, during and 1 day after the pump test
2. Water-level readings in the well commence after one minute of pumping, the 1 ½ minute measurement should be made and then it should continue on the order of ten readings per log cycle of time in minutes.
3. Measurements of antecedent water levels (all wells and stream gages min. 3 days). If there are tidal influences or other reasons for the static levels to fluctuate, then more than 3 days at 2 times per day of antecedent measurements may be required in order to establish the proper pattern.

**H.** The flow measuring device must be capable of providing instantaneous flow measurements accurate to within ±5% of the pumping rate. The flow meter must be calibrated and maintained in accordance with manufacturers specifications. Measurements and adjustments of the pumping rate should occur frequently at the start of the test until a stable rate is achieved around every 2 hours. Flow can also be measured using an orifice and piezometer tube. The time and measurement of the pumping rate should be recorded in the field notes and included as an appendix in the report.
**I.** Description of the drawdown and recovery reading methodologies. Recovery must be recorded to until a minimum of 95% of the drawdown is restored.

1. All drawdown and recovery readings shall be recorded to the nearest ¼ inch. (0.02 feet).
2. The pumping well should be fully developed prior to the pump test.

**J.** Describe stabilization criteria.
**K.** Describe the step test methods that may be used to determine pumping rates.
**L.** Describe how the water contours would be drawn and resolved. Since the wetlands application already requires contours the water contours should be drawn over the land contours.
**M.** Describe the well's proposed pumping schedule.

**N.** Shutdowns for generator service should not exceed 2 hours.

**O.** Description of planned water quality measurements. It is recommended that specific conductance, pH, temperature and other indicator parameters in samples from the surface water body, production well discharge, and appropriate observation wells are collected before and during the pump test. Discuss methods anticipated to generate appropriate mass balance equations to estimate the extent of induced infiltration under pumping conditions. These water quality tests do not replace the Department of Health water quality testing requirements.

**P.** Description of vertical hydraulic conductivity estimations. Recommended techniques include, field or laboratory techniques like streambed piezometers to measure the hydraulic conductivity.

## III. REQUIREMENTS FOR LARGER OR MORE COMPLEX PROJECTS AS DETERMINED BY THE DEPARTMENT

**A.** Stream profiling or enhanced stream gaging. This may be required to supplement induced infiltration information when large volumes of water are taken out near a stream.

**B.** In certain complex hydrogeologic situations, it is difficult to predict the zone of contribution for a well without employing a numerical computer model. Based on the geologic and hydrogeologic complexity of the aquifer, DEM may require that a specific modeling approach be used to delineate the zone of contribution to the pumping well and well head protection areas and to delineate areas of potential impact with MODFLOW or other approved method.

**C.** Habitat survey and analysis which includes lists of those species considered to be endangered, threatened, or of special concern in the state within the 1’ drawdown contour calculated for August.

**D.** The installation of as many monitoring or observation wells which are necessary to validate the assumptions used in the computer model and to assess existing or suspected water quality problems.

**RE-APPLICATION GUIDANCE FOR THOSE SEEKING A GROUNDWATER WITHDRAWAL PERMIT FOR > 10,000 GPD**

**DRAFT**

## ATTACHMENT C

**The freshwater wetlands application must include all of the requirements outlined in the freshwater wetlands regulations and:**

- ❑ The pumping test report
- ❑ All data collected during the pumping test including accurate records of pumping rate, barometric pressure, drawdown and recovery readings and localized weather conditions.
  - Drawdown and recovery analysis.
  - Aquifer transmissivity and storativity including graphs and calculations, determined from the pumping test analysis.
- ❑ Safe Yield calculations using appropriate methods.
- ❑ Discussion of the wetland hydraulic connection to the underlying aquifer based on the aforementioned borings and/or peat probes.
- ❑ The pumping schedule that is anticipated for the new source based on population served, the engineering complexity of the system, and availability of alternate sources.
- ❑ Discussion of watershed impacts, identification of any RIPDES facilities, 7Q10 flows and impacts on any IPDES dischargers.
- ❑ Discussion of impact on upstream or downstream users.
- ❑ Estimations of consumptive use to the watershed.
- ❑ Design analysis necessary to determine no adverse impacts to the natural resources found in the impacted area.
- ❑ Proposed backup, storage and conservation measures for low flow and drought conditions.
- ❑ Discussion of environmental impacts to the surrounding wetlands, stream and watershed.
- ❑ A calculation of existing aquatic base flow values
- ❑ Hydrologic and hydrogeologic studies quantifying and qualifying the groundwater flows may be required for significant or environmentally sensitive projects.
- ❑ A species inventory addressing aquatic resources and community structure may be required for the project area; scope of work must be approved by the Office of Water Resources.
- ❑ A comprehensive description of proposed methodology of irrigation and pesticide/herbicide application, if applicable
- ❑ A narrative describing potential impacts to all state waters associated with the project and surrounding area.