Date: 09/04/2024

Rules Coordinator

Railroad Commission of Texas

Office of General Counsel

P.O. Drawer 12967

Austin, TX 78711-2967

Subject: Public Comment on Proposed Amendments to 16 TAC 3.8 and various other rules in Chapter 3 and proposed new rules and amendments in 16 TAC Chapter 4

Dear RRC,

This comment pertains specifically to Sec. 4.219 relating to Commercial Solid Oil & Gas Waste Recycling and more specifically to pages 141, 150, 164, and 181, where the siting limitation of such facilities is presented. The problematic issue in this guidance is that an exception is afforded for siting such facilities in areas where there has been observable groundwater within 100 feet of the ground surface provided the pit design includes a geosynthetic clay liner (GCL). This suggests that the RRC believes that the existence of a GCL below the facilities will somehow act as a barrier to fluid migration and potential contamination of groundwater.

We believe that a GCL does not provide any significant impediment to fluid migration in environments where the fluid is similar to fluids encountered in most Oil & Gas operations, mainly that being "produced water" with elevated salt concentrations, often exceeding 150,000 mg/l. A GCL's listed specifications are usually based on performance in distilled water environments. Most GCL manufacturers caution that performance criteria should be tested using fluids comparable to that which the GCL is likely to encounter.

Our conclusion is based on the documented results of a controlled laboratory experiment that tested the effectiveness of a standard GCL. We performed simple laboratory tests to demonstrate the difference between GCL performance when saturated with distilled water versus produced water (a copy of which is attached). This test demonstrated that the GCL tested had no observable leakage over the test period when the fluid consisted of distilled water, however, within the first 3 hours of the test, almost all of the produced water had passed through the GCL. Basically, the GCL under produced water conditions, leaked like a sieve. Basic calculations of the test results suggested a "leakage rate" of more than 213 gallons per minute per acre, which is over 5 barrels per minute or 7,300 barrels per day per acre. Figure 1 illustrates how a common GCL used in landfills performs when saturated with distilled water versus produced water.

As such, it is difficult to understand why the RRC would view the existence of a GCL in the design of a facility to somehow eliminate the concern/threat that such facilities would have on the shallow aquifers beneath a site. Point being, if it serves no real purpose, then why force an Operator to incur the expense of installing a GCL, but more importantly why site a facility in a location where useable shallow groundwater exists beneath a site. This is particularly true in West Texas, where the shallow aquifers have undergone extensive over-pumpage by the Oil & Gas industry and in many places have been entirely exhausted or in other cases, irreparably impacted by saltwater intrusion.

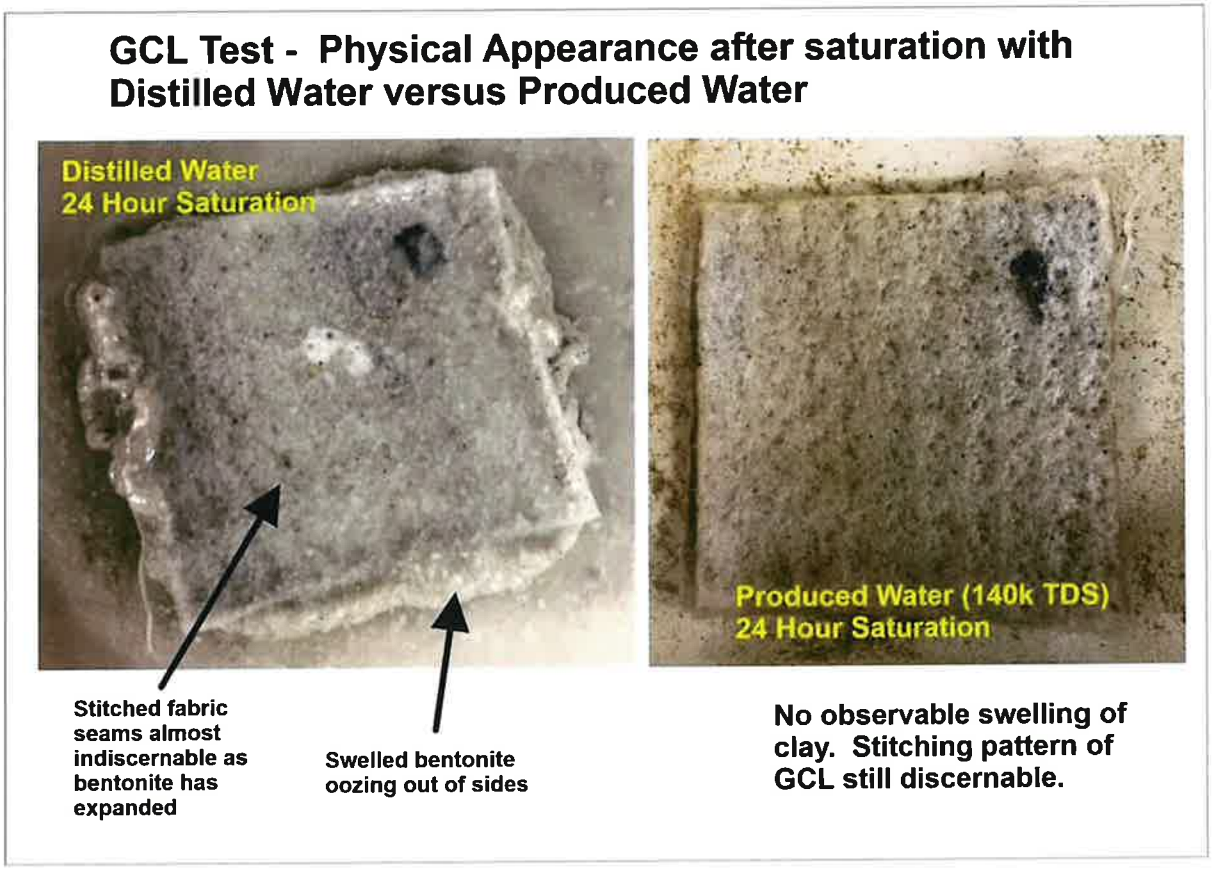

Figure 1. GCL Saturation in Distilled Versus Produced Water

Interestingly, with respect to Produced Water Recycling pits, the RRC does not have a similar limitation (groundwater less than 100 feet below surface) on siting such facilities, however, neither do those rules reference a GCL. Instead, the proposed rules for a short-lived produced water recycling pit requires a natural liner of two feet of fat clay, placed in continuous six-inch lifts, compacted to 95% proctor as defined in ASTM D698 and having a hydraulic conductivity of 1.0 x 10 -7 cm/sec or less. And for longer duration pits, a synthetic liner should be used.

Going back to the issue of the potential for exempting facilities provided a GCL is used in the facility design, we would propose the RRC modify the rule language in one of two ways:

1) Keep the rule as is but add language that requires:
   a. the GCL used in the design must be tested using fluids likely to be encountered in the operations of the facility, including typical produced water from the area, and
   b. the test results should demonstrate the ability of the GCL to sustain a hydraulic conductivity of 1.0 x 10-7 cm/sec or less; or,

2) Remove the reference to the GCL and replace with a requirement that a natural liner of two feet of fat clay, placed in continuous six-inch lifts, compacted to 95% proctor as defined in ASTM D698 and having a hydraulic conductivity of 1.0 x 10 -7 cm/sec or less.

It is important to also recognize that while the primary role of the natural "fat" clay and even the bentonite within the GCL is to reduce the migration of fluids, the clay itself has unique properties that allow the clay to potentially trap certain elements and compounds. This process, referred to as "Cation Exchange Capacity" or CEC is an important factor in assessing the performance of clay minerals. It is clear from the test performed on the GCL in a produced water environment that the clay's swelling capacity has been dramatically reduced and consequently, it's CEC has also likely been substantially lessened.

In addition, the use of "100 feet" below ground surface as a condition by which "monitoring of groundwater is required" or for which a GCL should be employed is entirely arbitrary. The existence of and consequent concern for protection of the groundwater should not be restricted to an arbitrary depth, but rather the characteristics of the subsurface between the base of a facility and the top of the water table. Consider a case where the water table at one site was 95 feet below surface but the overlying sediments were predominantly clay. The ability of water to migrate from the facility to the water table may be very limited. Alternatively, consider a case where the water table is 105 feet below the facility surface and the intermediary materials are porous sand and gravel. The threat to the groundwater quality is much greater in the second case than in the first, yet based upon an arbitrary 100 foot "limit", the second case is not even considered yet is far more dangerous.

A more reasonable guidance related to siting as it pertains to depth of groundwater is to require a site analysis that actually considers the lithology and aquifer characteristics beneath the site so as to more fully assess the threat of groundwater contamination. This type of information is far more critical than placing an arbitrary depth of groundwater factor on a site.

Consider **Oil & Gas Docket No. 72-0299935**, in which a contested case hearing was held involving West Texas Mud Disposal, LLC's application to construct a Commercial Oil & Gas Waste Stationary Treatment & Disposal Facility. The Proposal for Decision in that case which was affirmed by the RRC, concluded that the facility as designed (which included dual synthetic liners and a GCL) was a threat to the Edwards-Trinity aquifer beneath the site. The static groundwater table at this site was over 240 feet below surface. However, the protestant (at great financial cost) successfully demonstrated that the natural materials between the base of the proposed facility and the aquifer would not act as a barrier to potential fluid migration and contamination of the aquifer could happen.

Consider **Oil & Gas Docket No. 08-0318617**, in which a contested case hearing was held involving HR Martin County Landfill, LLC's application to construct a Commercial Oil & Gas Waste Stationary Treatment & Disposal Facility. The Proposal for Decision in that case concluded that the facility as designed (which included dual synthetic liners and a GCL) was a threat to the Ogallala Aquifer beneath the site. The static groundwater table at this site was only 60 feet below surface. However, the protestant successfully demonstrated (at considerable cost) that the natural materials between the base of the proposed facility and the aquifer were not of sufficient character to prevent potential fluid migration and likely contamination of the aquifer could result.

Both of these cases demonstrated that the concern for groundwater contamination from such facilities is real, and that despite various liners and even GCL's and leachate collection systems, the threat is always present. The fact is, the best desk-top engineering design in the world cannot overcome poor execution in the field construction, improper care and maintenance, and negligence by the operator. Even if the groundwater monitoring systems that are typically employed at the facility boundaries confirm contamination, if the contamination has reached the groundwater on the boundary of the facility, the damage is likely irreparable. Unfortunately, the financial burden on a nearby landowner to develop a thorough permit protest can cost hundreds of thousands of dollars. These costs are often more than the cost of designing a facility with adequate protections and certainly more than the cost of an adequate site characterization. This difficulty in protesting applications is exacerbated when inadequate rules and guidelines are in place that allow applicants to easily meet the RRC requirement, regardless of site-specific conditions and scientific facts. In short, the driving decision for a site's location cannot simply be that which is most convenient and profitable for the operator of the facility.

Now consider **Oil & Gas Docket No. OG-23-00012910**, in which a contested case hearing was held involving Martin Water Operating, LLC's application to construct and operate a Stationary Produced Water Treatment & Recycling Facility. Remarkably the applicant was so confident that the permit would be granted that roughly 80% of the facility was constructed before the actual contested case hearing. Despite being located a mere 300 feet away from a TCEQ-approved public water supply system and wells for an active Christian Church camp, which provides the sole source of drinking water for thousands of young children and adults attending year-round, the RRC basically determined the site was suitable because the design included a GCL and therefore any risk was abated. We believe this was a very bad decision. Our scientific assessment indicates that the GCL cannot function as intended to protect local groundwater.

Furthermore, detailed geological analysis of the protestant's own geotechnical boring along its own fenceline bordering the applicant's site proved that the native materials between the base of the recycle pits and the Ogallala aquifer is highly porous sand and gravel. Here, the Ogallala Aquifer is less than 40 feet below the base of the recycling pits which store millions of barrels of produced water containing dissolved solids in the range of 120 to 150 thousand mg/l. This equates to as much as or more than 50 pounds of dissolved solids per barrel of produced water. The dissolved solids are primarily salt (NaCl), however, because the sources of the produced water are the very same formations the oil comes from, a host of other elements including arsenic, lead, strontium, and others, as well as residual hydrocarbons accompany the salt. And while the RRC has its own action levels for contamination of soil, contamination of a drinking water supply falls under the oversight of the TCEQ and the EPA. Therefore, to protect the quality of groundwater beneath a facility, it is critical that RRC rules be adequate to insure that potential leakage from a facility is minimized if not prevented. Our research demonstrates that GCL cannot insure against this potential.

In summary, unless the RRC has evidence that a GCL has been fully tested in the environments and under the site-specific conditions which they are to be employed, a GCL likely will not serve its intended purposes to protect groundwater from contamination. In addition, the RRC may be accepting a risk mitigation approach that provides a false assurance of protection that ultimately increases risk for nearby landowners and consumers of the groundwater.

We strongly encourage the RRC to amend these proposed rules by including either or both of the changes identified above. Incorporating either proposal makes the 100 foot limit of groundwater existence unnecessary. The RRC has great responsibility in developing the State's Oil & Gas resources, however, every care should be given to protect the State's other natural resources, especially groundwater. All Texans expect that their natural resources and private property (groundwater) is being protected by the rules and guidelines adopted by the RRC. We thank you for your consideration and diligence in these matters.

Sincerely,

Darrell T. Brownlow, PhD

William J Rogers, PhD

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(Dr. Brownlow has been approved as a qualified Expert in Hydrology, Geology, Mining Geology, Clay Mineralogy, and Geochemistry in multiple RRC contested case hearings)

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(Dr. Rogers has been approved as a qualified Expert in Landfill Design, Toxicology, and Geomorphology of Playa Lakes on the Southern Plains in multiple RRC contested case hearings)

Bench scale comparison of permeability for commonly used GCL when exposed to distilled water versus exposure to "produced water"

Provided to Texas Railroad Commission Staff

January 24th, 2024

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Background

In proposed commercial oil field waste and produced water system locations where shallow potable groundwater occurs, the Texas RRC has recently considered the use of a Geosynthetic Clay Liner system (GCL) as a suitable alternative to naturally occurring clay barriers separating the contaminant fluid from the aquifer.

A GCL is a relatively thin (3/8") woven fabric with granulated sodium bentonite incorporated into the fabric. When properly hydrated using Distilled Water*, the GCL acts as a barrier to fluid migration. This is due to the unique properties of the bentonite and its ability to absorb water and create a "sealing layer".*

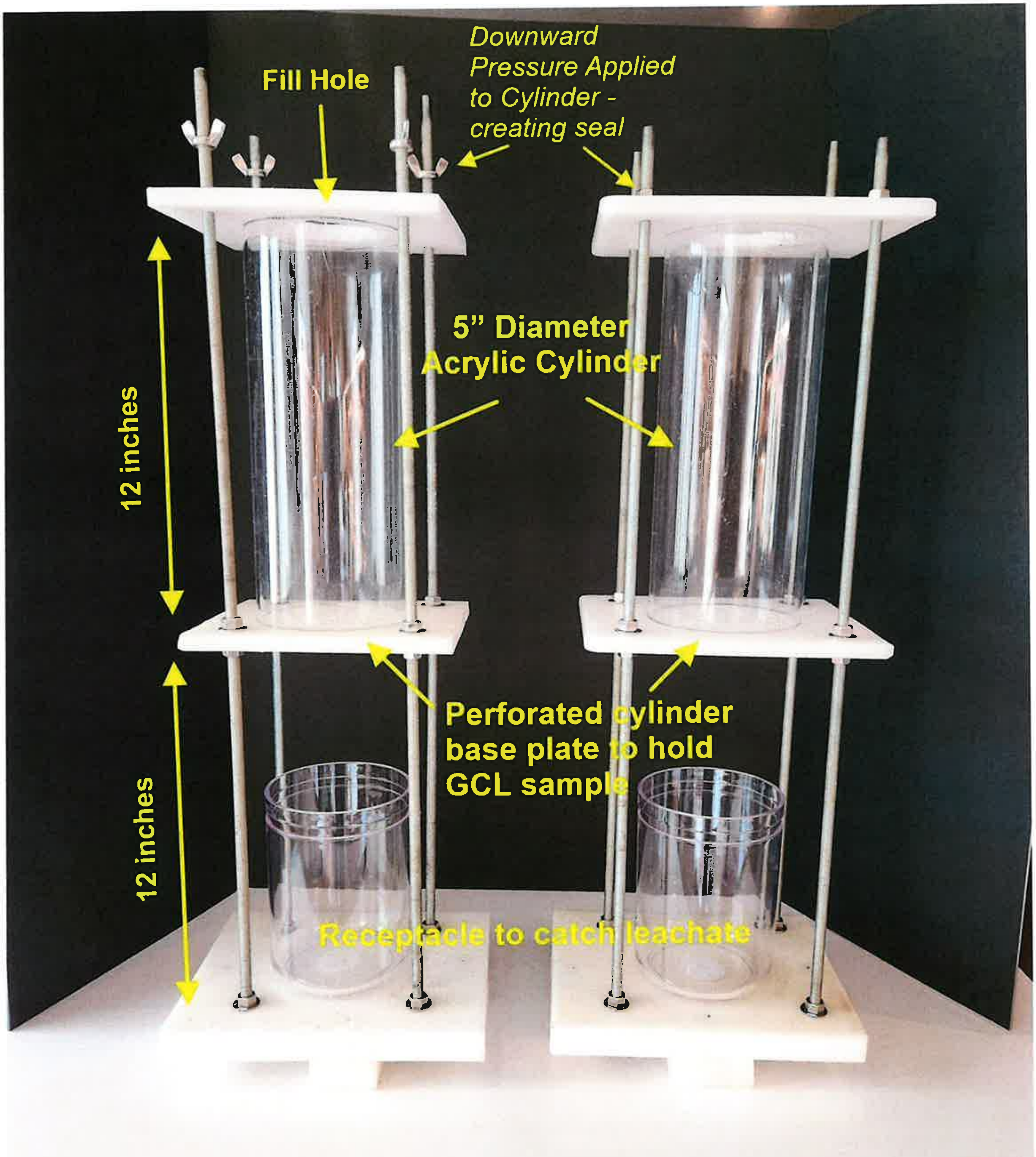
The GCL manufacturers caution the installers of the product that the performance of the product can be impacted by the nature of the fluid environment the GCL is placed in. Reliance on the GCL as a barrier to fluid migration is "cautioned" and testing of the GCL with the specific fluids to be encountered is recommended, otherwise the material may not perform in its intended purpose.

*The fluid environments encountered in commercial water and waste handling operations of the Permian Basin are likely to be "*Produced Water*", which is a salty brine fluid containing between 120,000 an 180,000 mg/l of dissolved salts and minerals.*

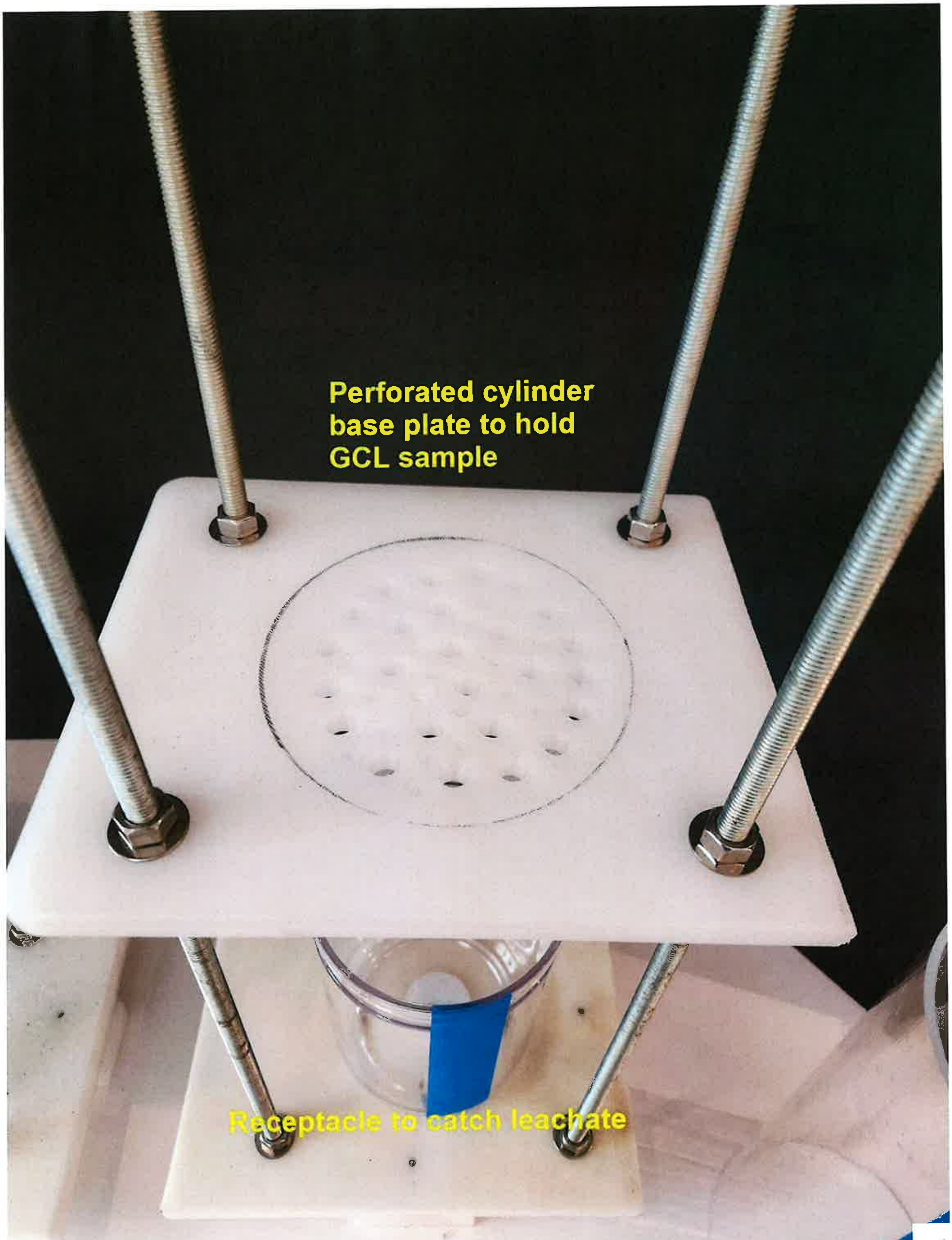
So is the GCL's performance and intended use as an alternative to natural clay barriers impacted by "Produced Water" ?

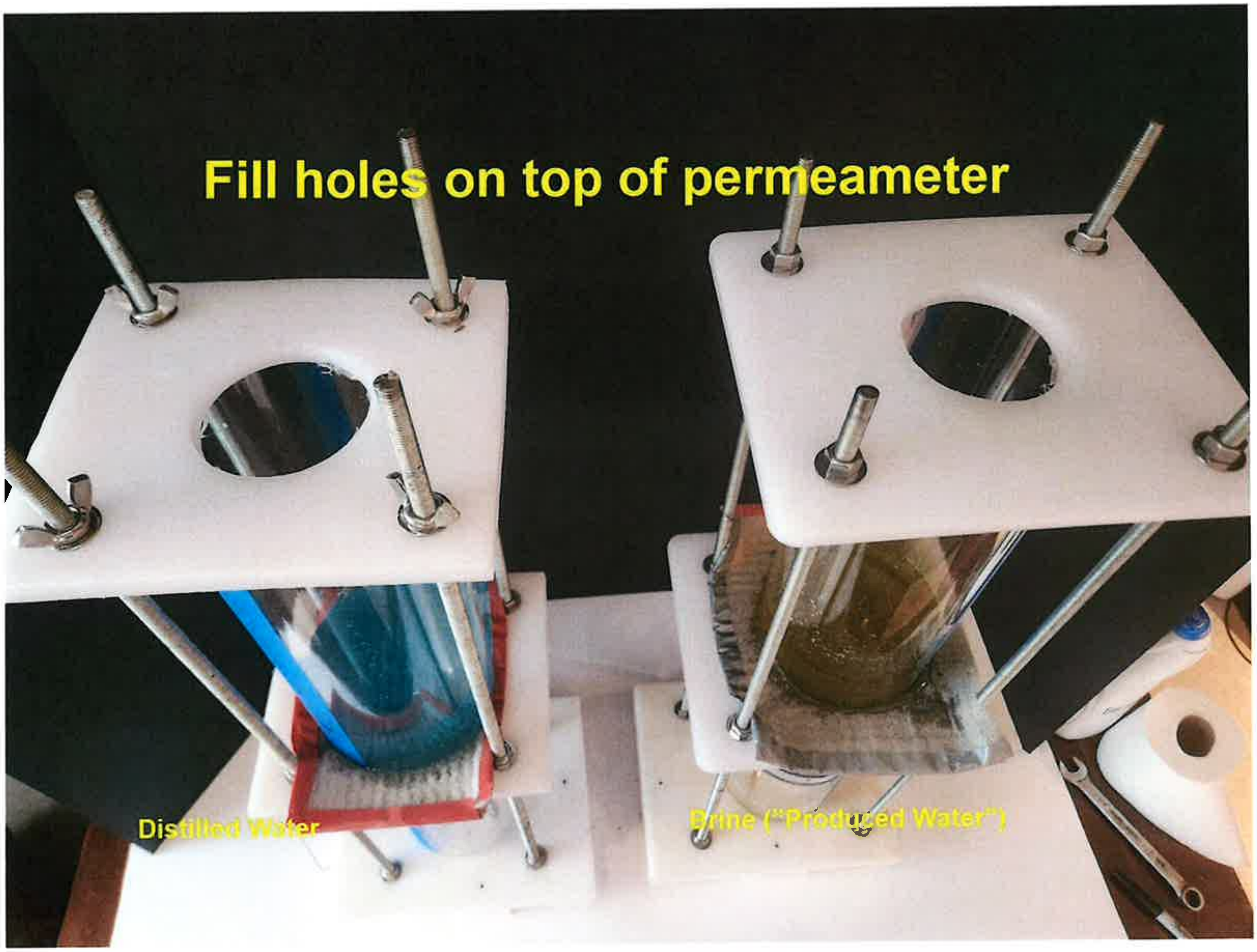
The following test compares the physical properties observed when GCL is exposed to a distilled water environment versus that of a Produced Water environment.

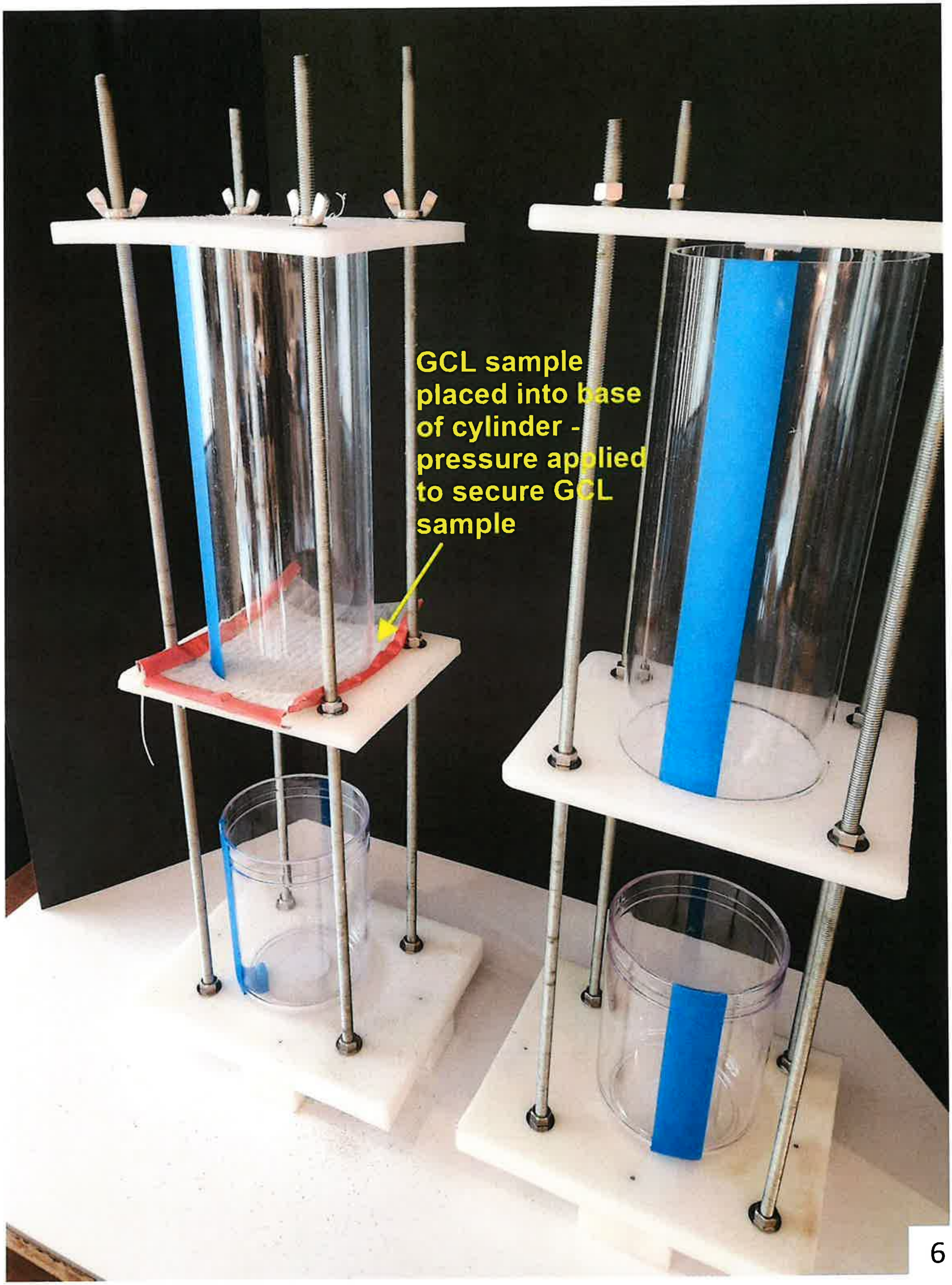
Testing Apparatus



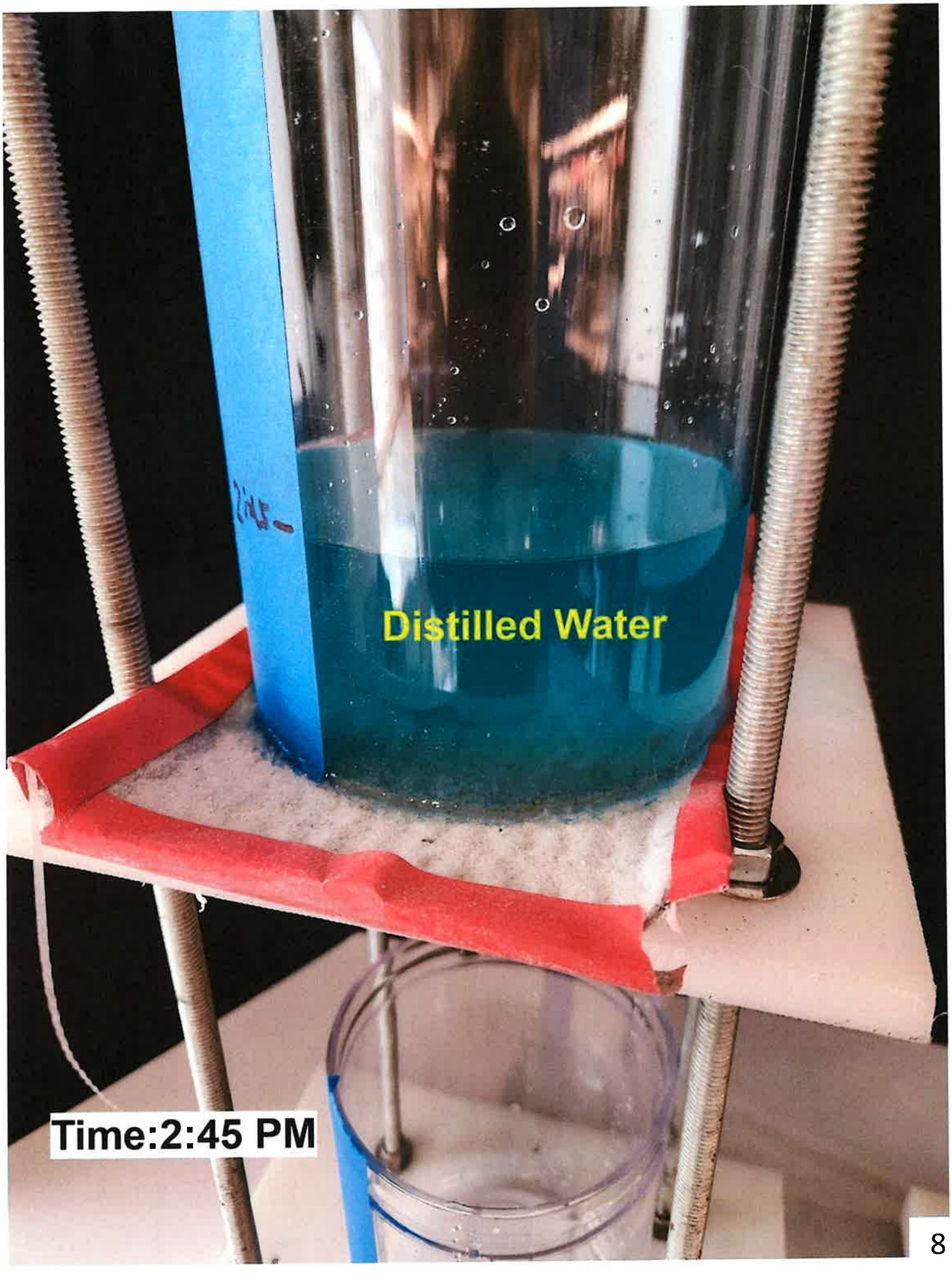
Two test vessels, side by side, one for distilled water, the other for produced water

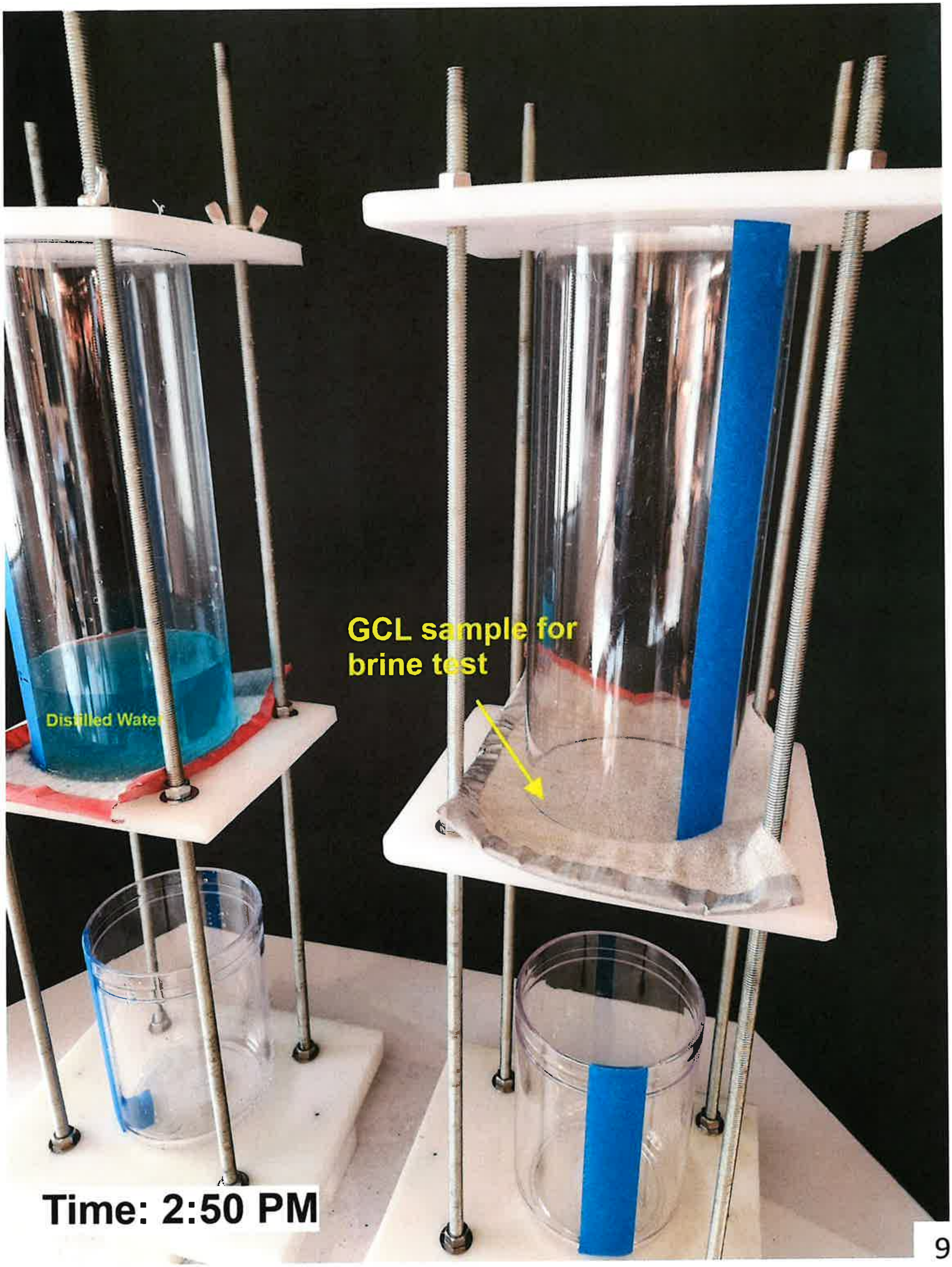

Perforated cylinder
base plate to hold
GCL sample
Receptacle to catch leachate

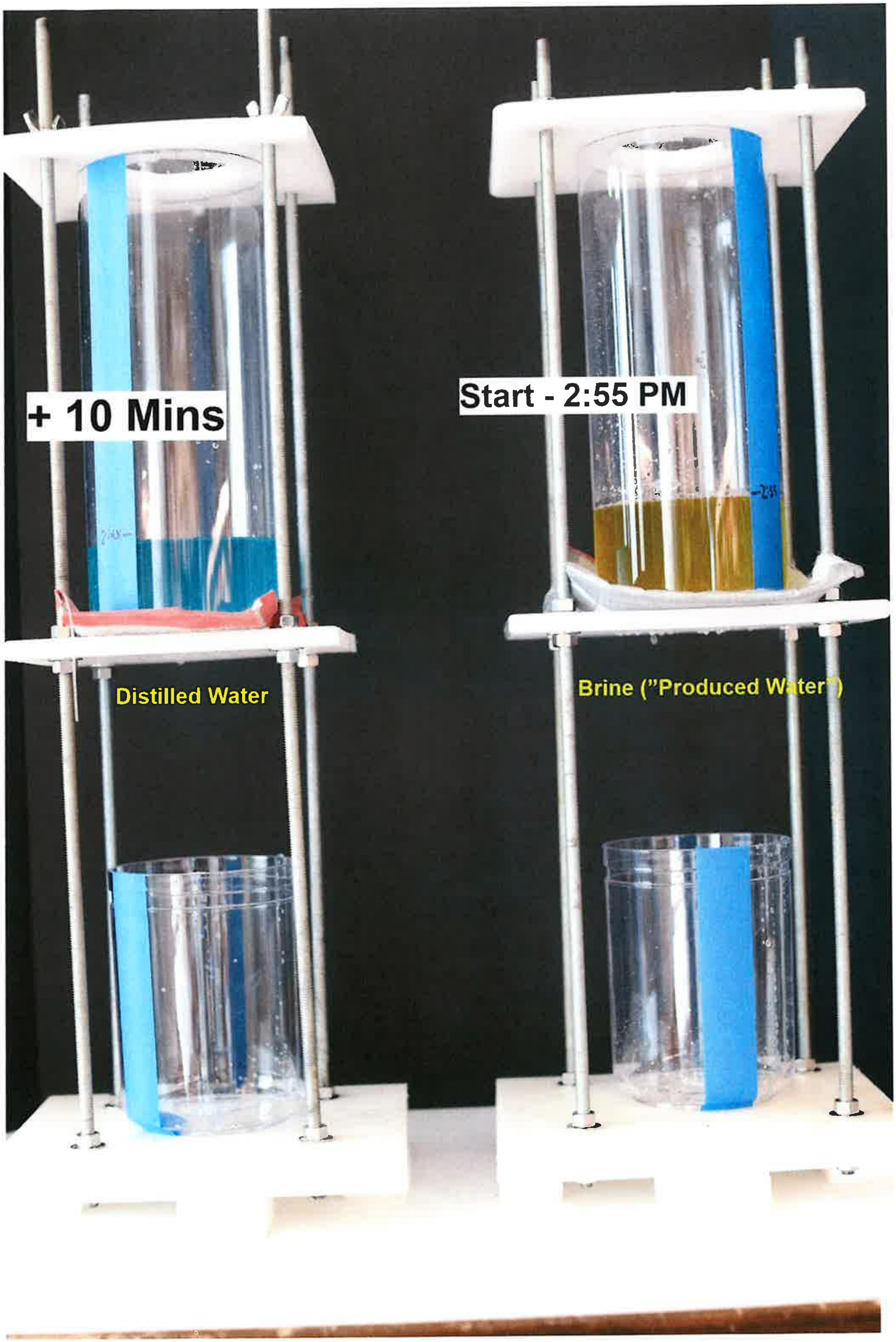

Fill holes on top of permeameter
Distilled Water
Brine ("Produced Water")

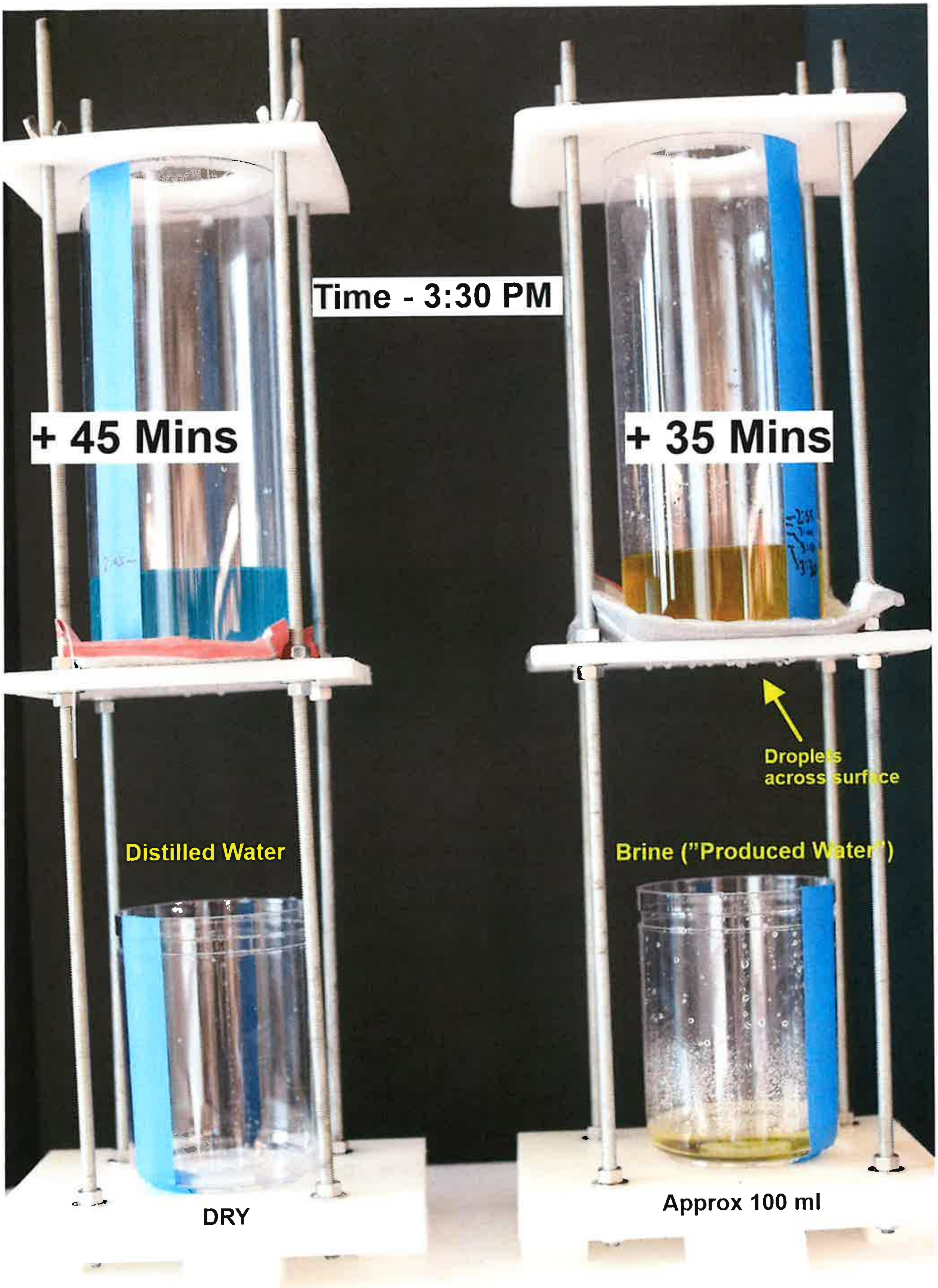

GCL sample placed into base of cylinder - pressure applied to secure GCL sample

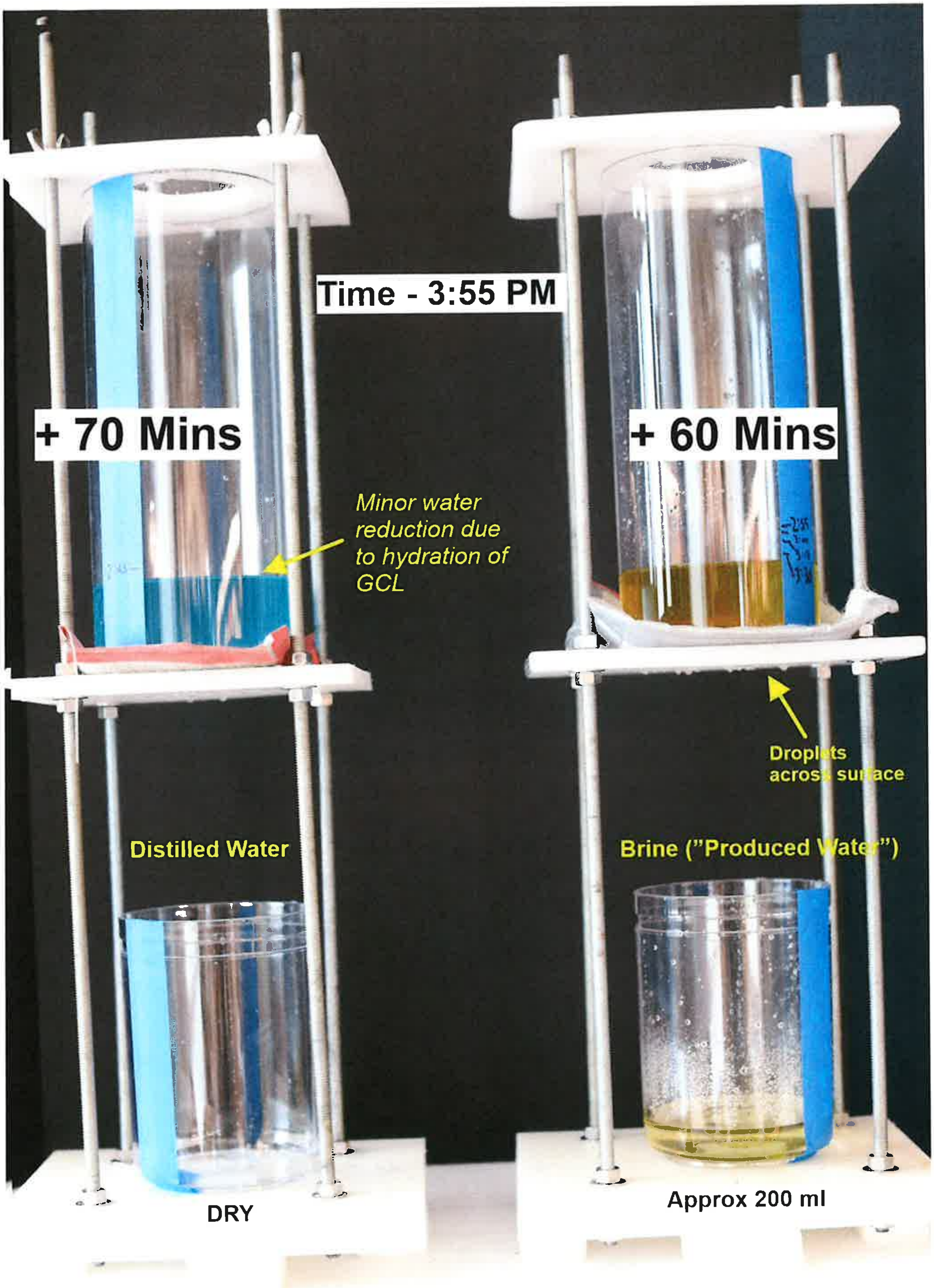

Fluid dyed for color effect
Distilled Water
140,000 TDS Saline Brine (to represent "Produced Water"
DISTILLED WATER
140K TDS BRINE

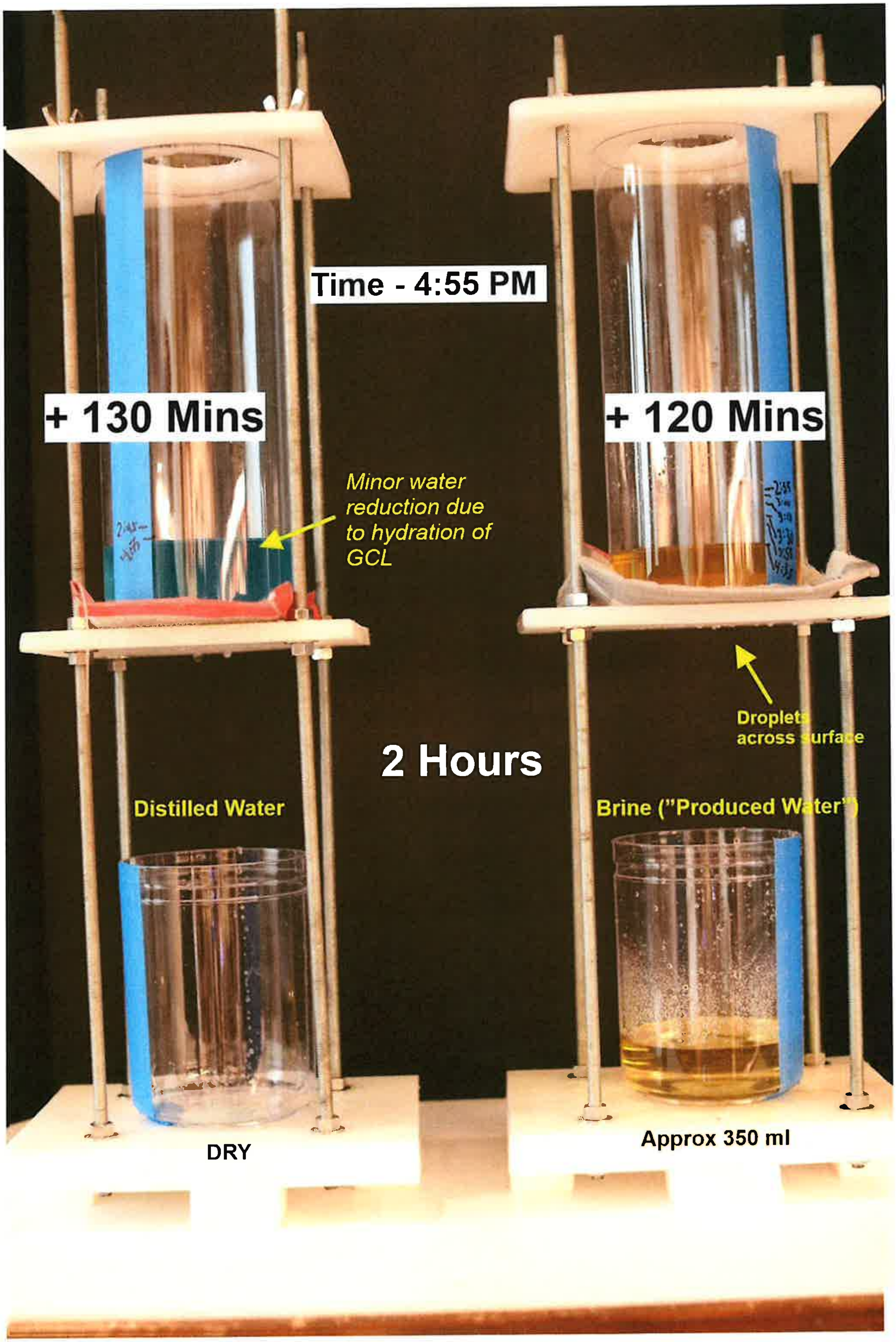

Distilled Water
Time:2:45 PM

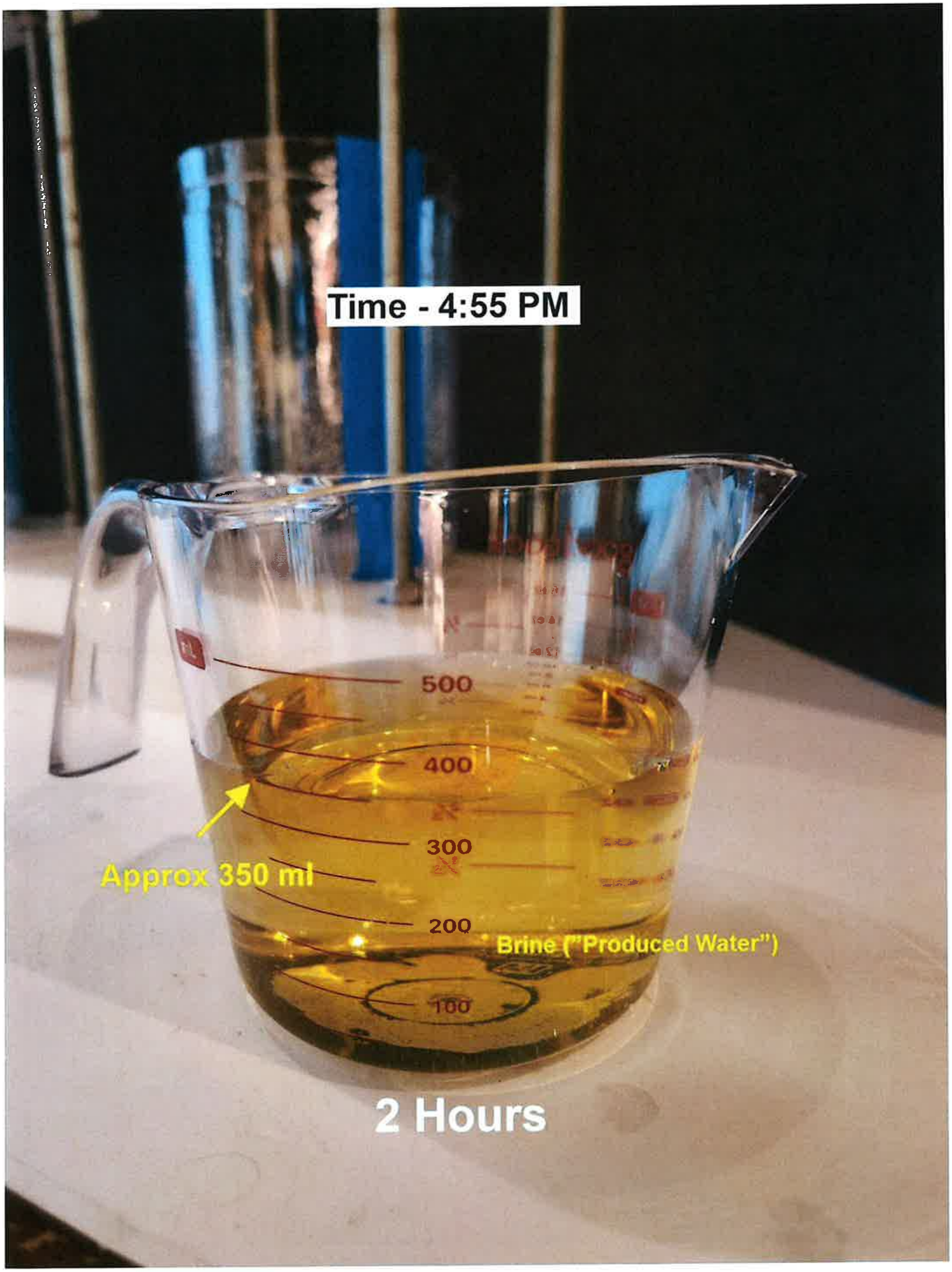

GCL sample for brine test
Distilled Water
Time: 2:50 PM

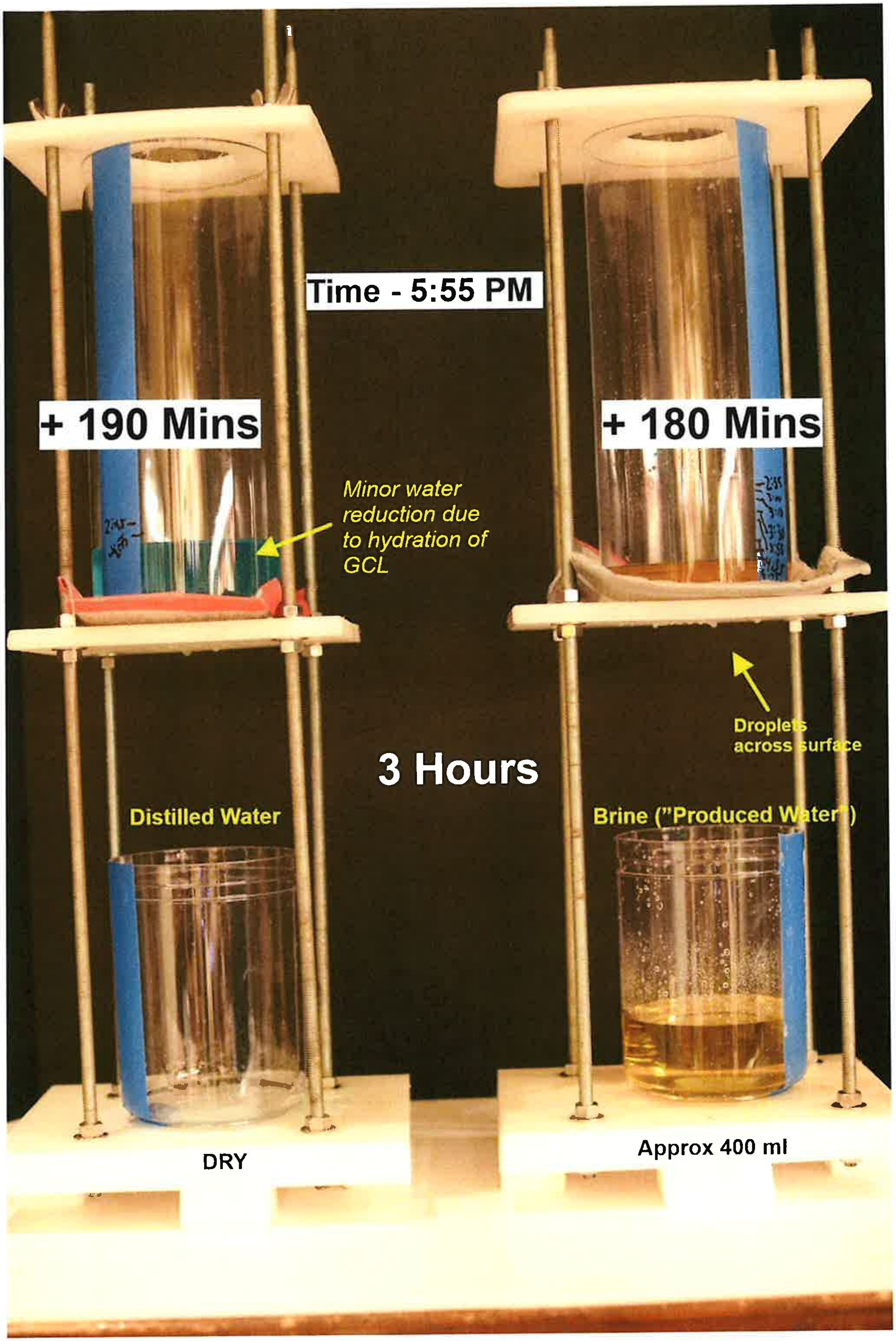

+ 10 Mins
Start - 2:55 PM
Distilled Water
Brine ("Produced Water")

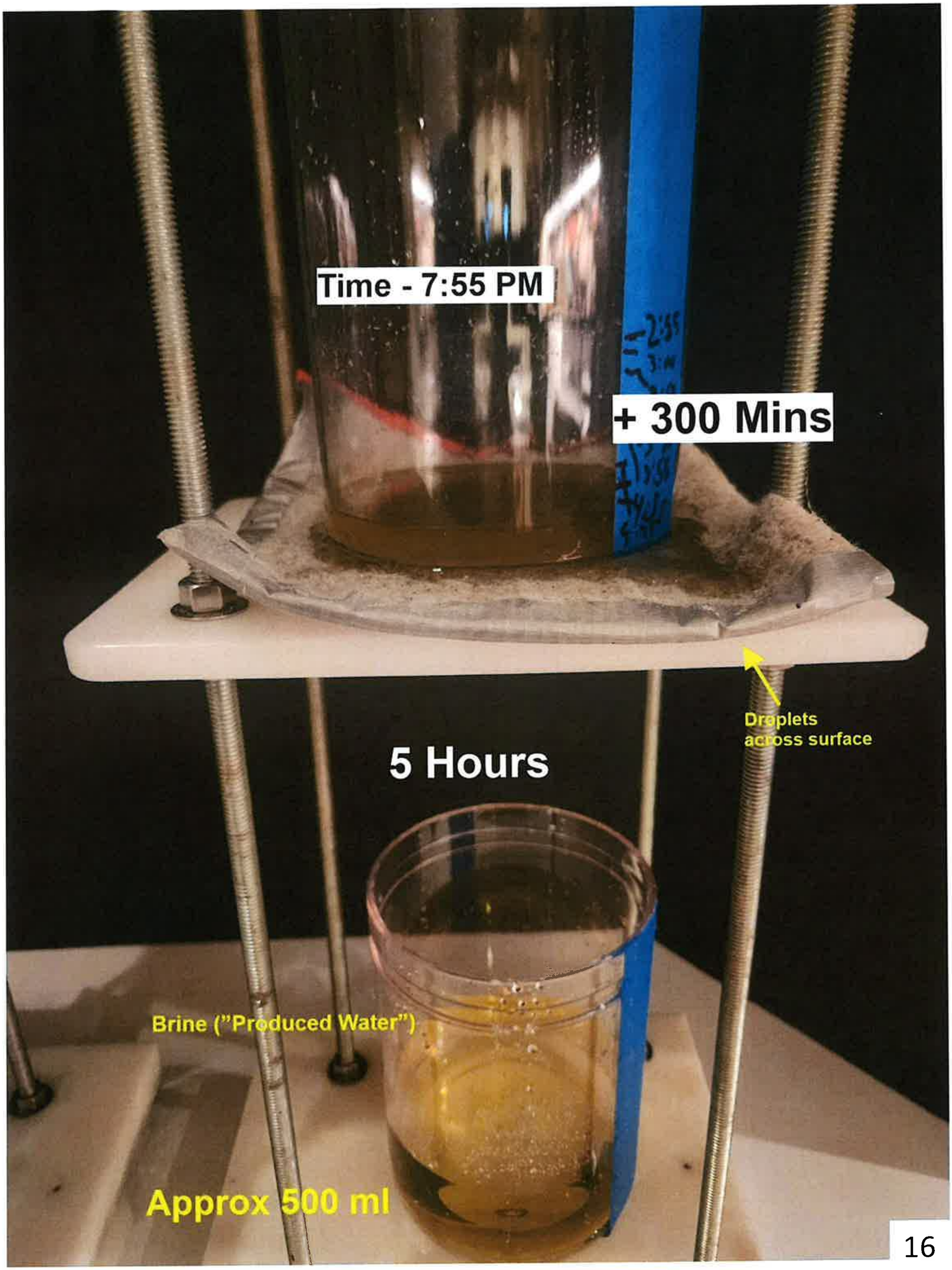

Time - 3:30 PM
+ 45 Mins
+ 35 Mins
Droplets across surface
Distilled Water
Brine ("Produced Water")
DRY
Approx 100 ml

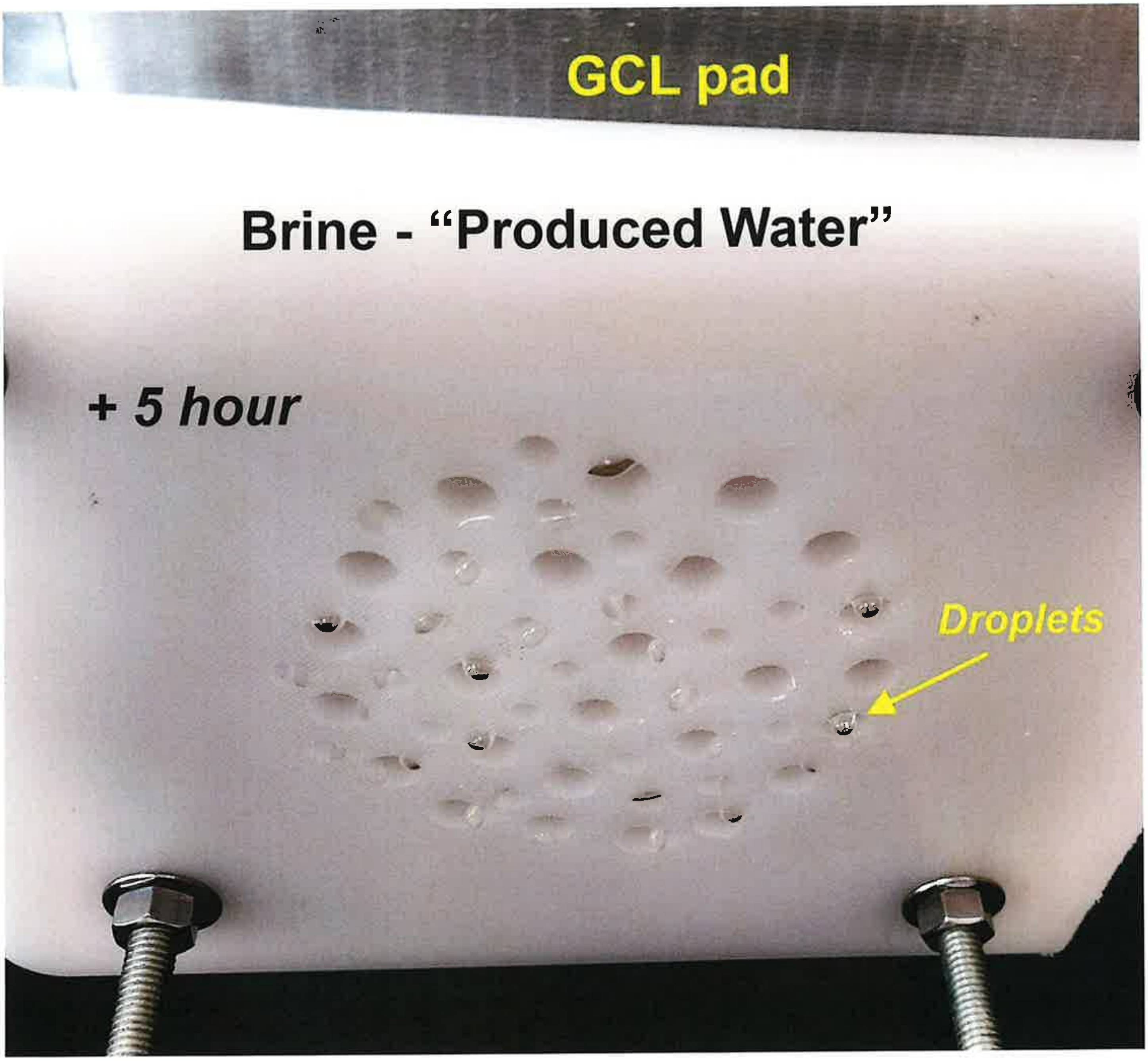

Time - 3:55 PM
+ 70 Mins
+ 60 Mins
Minor water reduction due to hydration of GCL
Droplets across surface
Distilled Water
Brine ("Produced Water")
DRY
Approx 200 ml

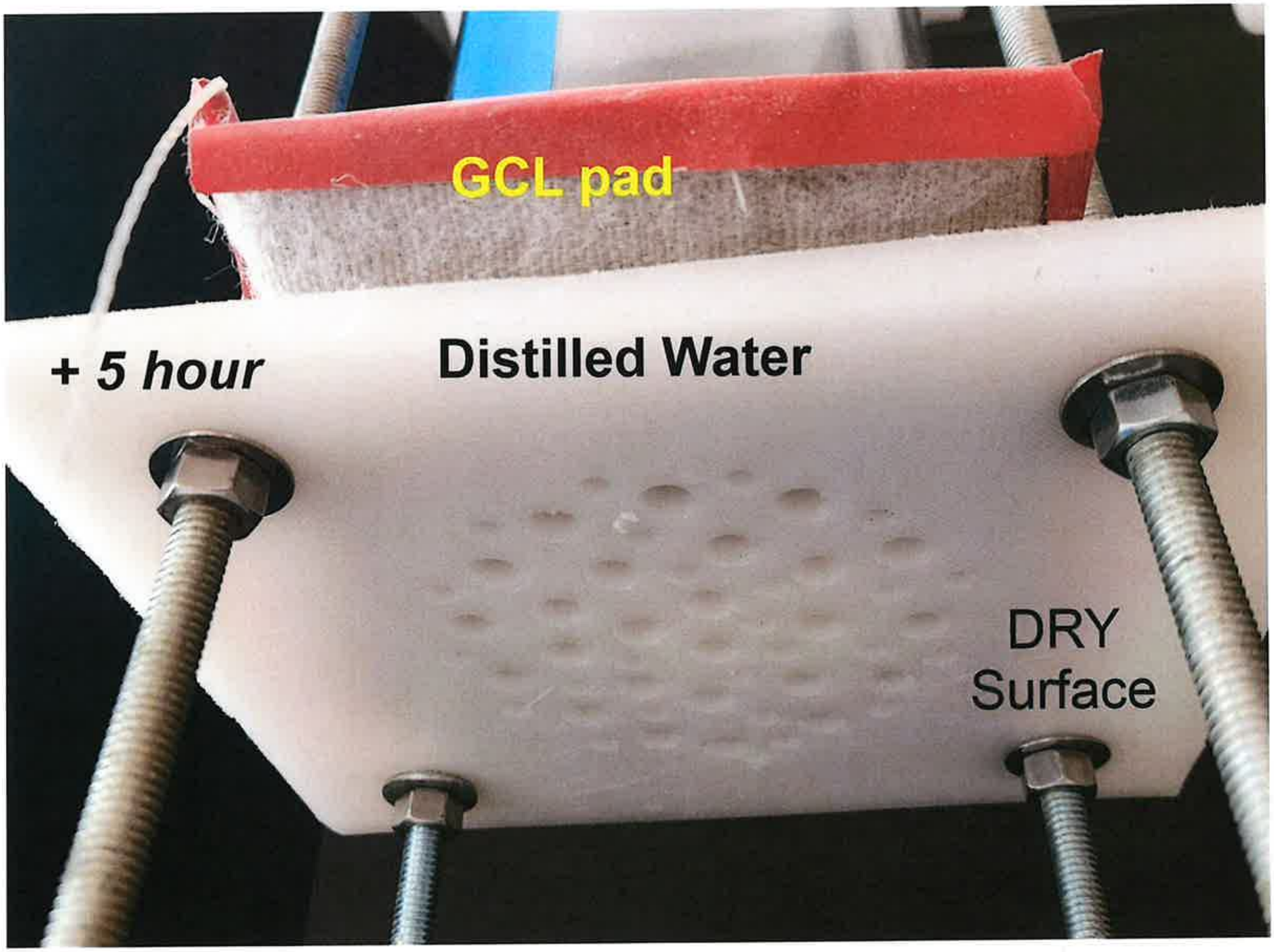

Time - 4:55 PM
+ 130 Mins
+ 120 Mins
Minor water reduction due to hydration of GCL
Droplets across surface
2 Hours
Distilled Water
Brine ("Produced Water")
DRY
Approx 350 ml

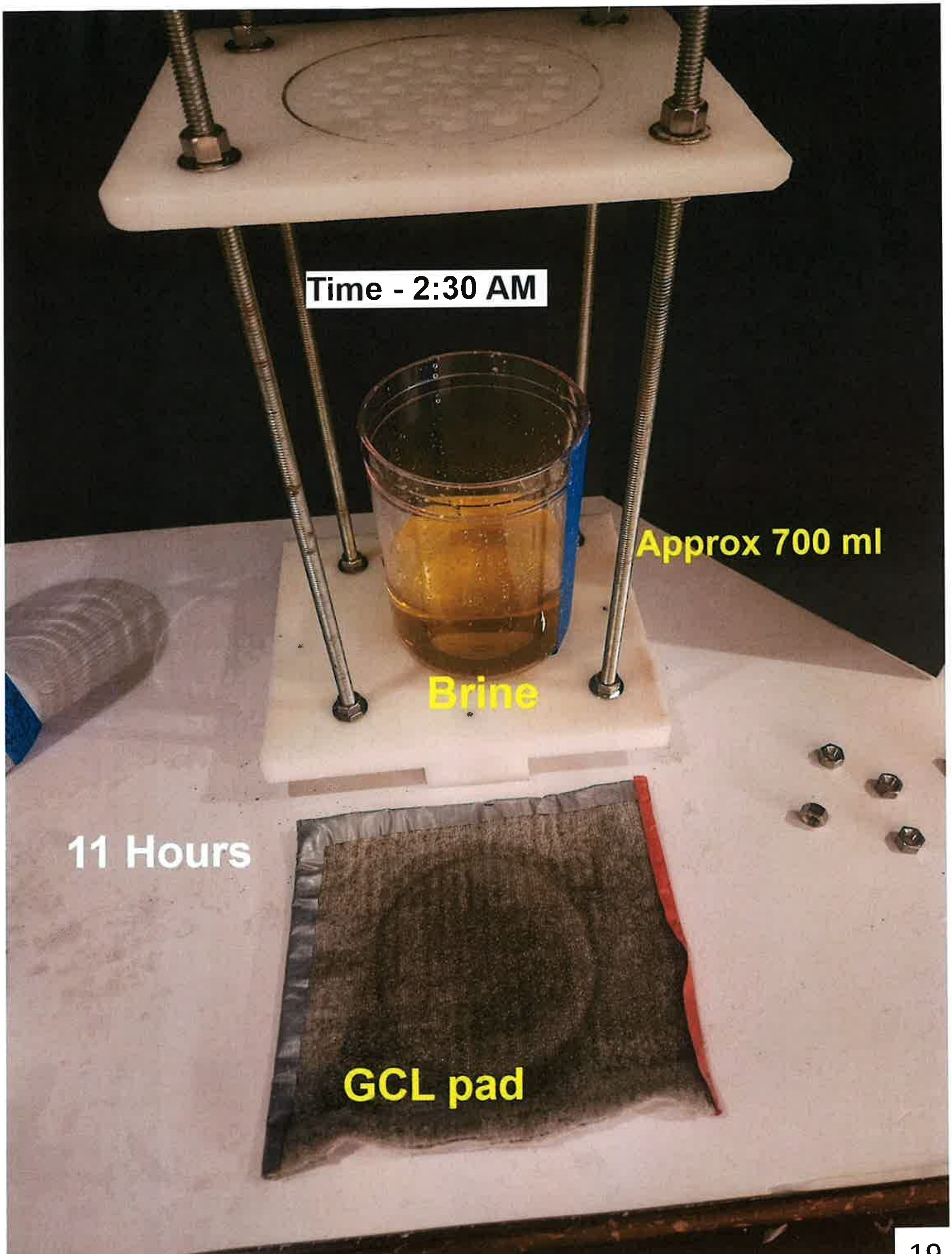

Time - 4:55 PM
500
400
Approx 350 ml
300
200
Brine ("Produced Water")
100
2 Hours

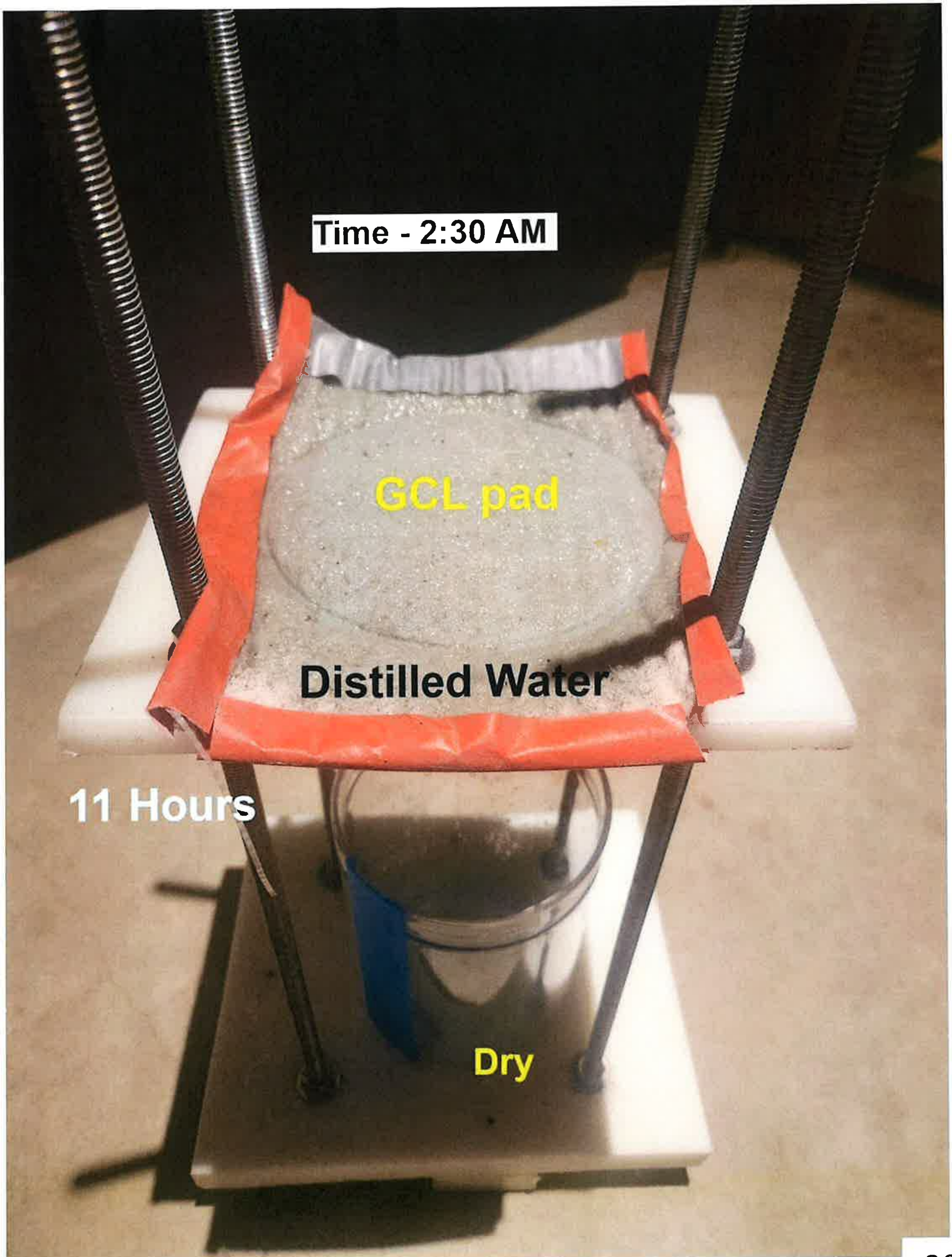

Time - 5:55 PM
+ 190 Mins
+ 180 Mins
Minor water reduction due to hydration of GCL
Droplets across surface
3 Hours
Distilled Water
Brine ("Produced Water")
DRY
Approx 400 ml


Time - 7:55 PM
+ 300 Mins
Droplets
across surface
5 Hours
Brine ("Produced Water")
Approx 500 ml


GCL pad
Brine - “Produced Water”
+ 5 hour
Droplets

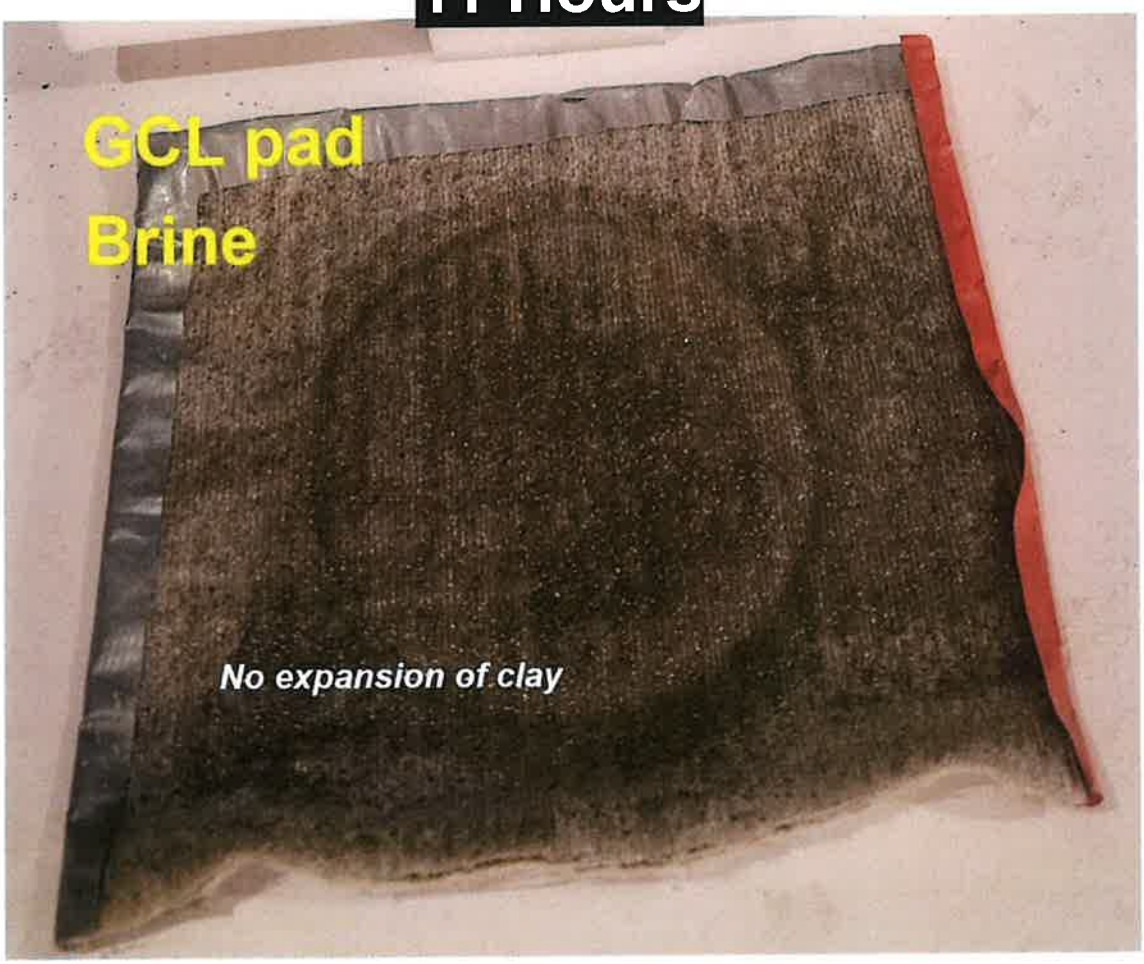

GCL pad
+ 5 hour
Distilled Water
DRY
Surface


Time - 2:30 AM
Approx 700 ml
Brine
11 Hours
GCL pad


Time - 2:30 AM
GCL pad
Distilled Water
11 Hours
Dry


GCL pad
Distilled Water
Significant
expansion of clay

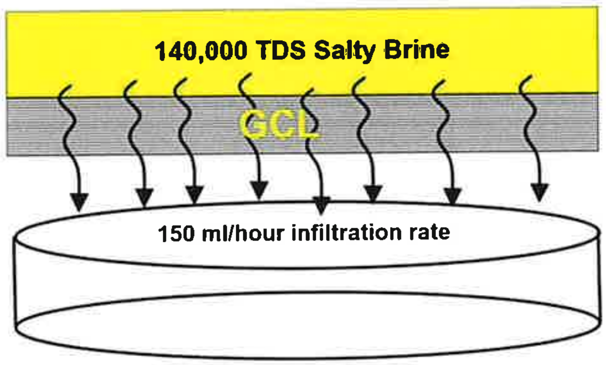
11 Hours


GCL pad
Brine
No expansion of clay

Summary of Test Results

Infiltration rate calculation for GCL in Produced Water Environment

Circular Couple of 5" Diameter - 2.5" Radius



This is based on ATMOSPHERIC PRESSURE CONDITIONS -Actual conditions can add 10-20 PSI which will accelerate leakage through GCL

5" Diameter circle (2.5" = 0.208 ft)

Formula for area of circle

πr^2 $3.1214 \times (0.208)^2 = 0.135 \text{ ft}^2$

150 ml = 5.07 ounces = 0.0396 gallons per 0.135 ft^2

0.0396 gallons per 0.135 ft^2 = 0.293 gallons per ft^2 per hour

0.293 gallons per ft^2 per hour = 0.00488 gallons per minute per ft^2

1 acre of GCL covers 43,560 ft^2

43,560 ft^2 x 0.293 gallons per hour = 12,763 gallons per hour per acre of GCL
= 213 gallons per minute (GPM) per acre of GCL

= 304 barrels per hour per acre of GCL
= 7,293 barrels per day per acre of GCL
= 219,000 barrels per month per acre of GCL

Under atmospheric conditions, using 140,000 TDS brine to simulate "Produced Water", the GCL has practically no ability to impede fluid migration with lab tested leakage rates of as much as 213 gpm per acre of applied GCL.

GCL is not a suitable alternative to natural clay barriers in commercial produced water or landfill applications.

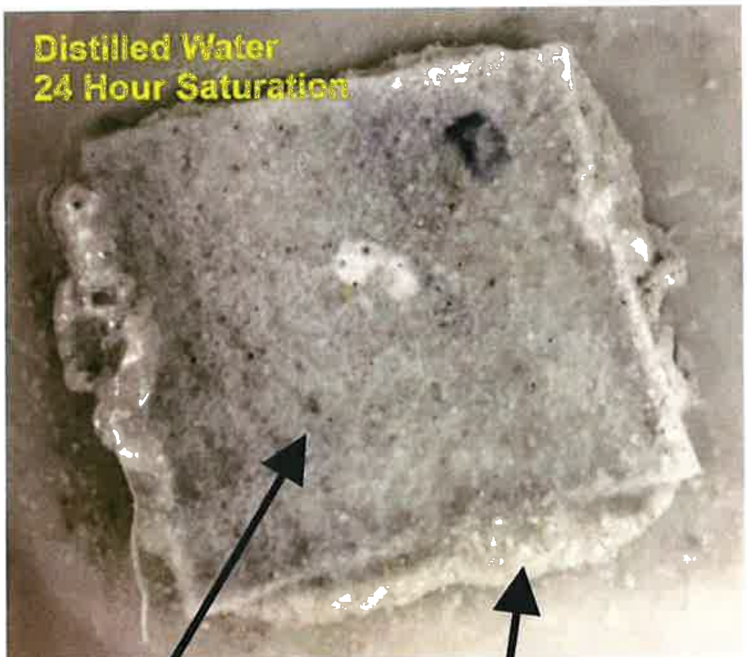
Reliance on a GCL to protect groundwater beneath a commercial waste or water facility is not recommended.

Supplemental Information

Raw GCL Sample with edges taped to reduce bentonite from shaking out

Supplemental Information

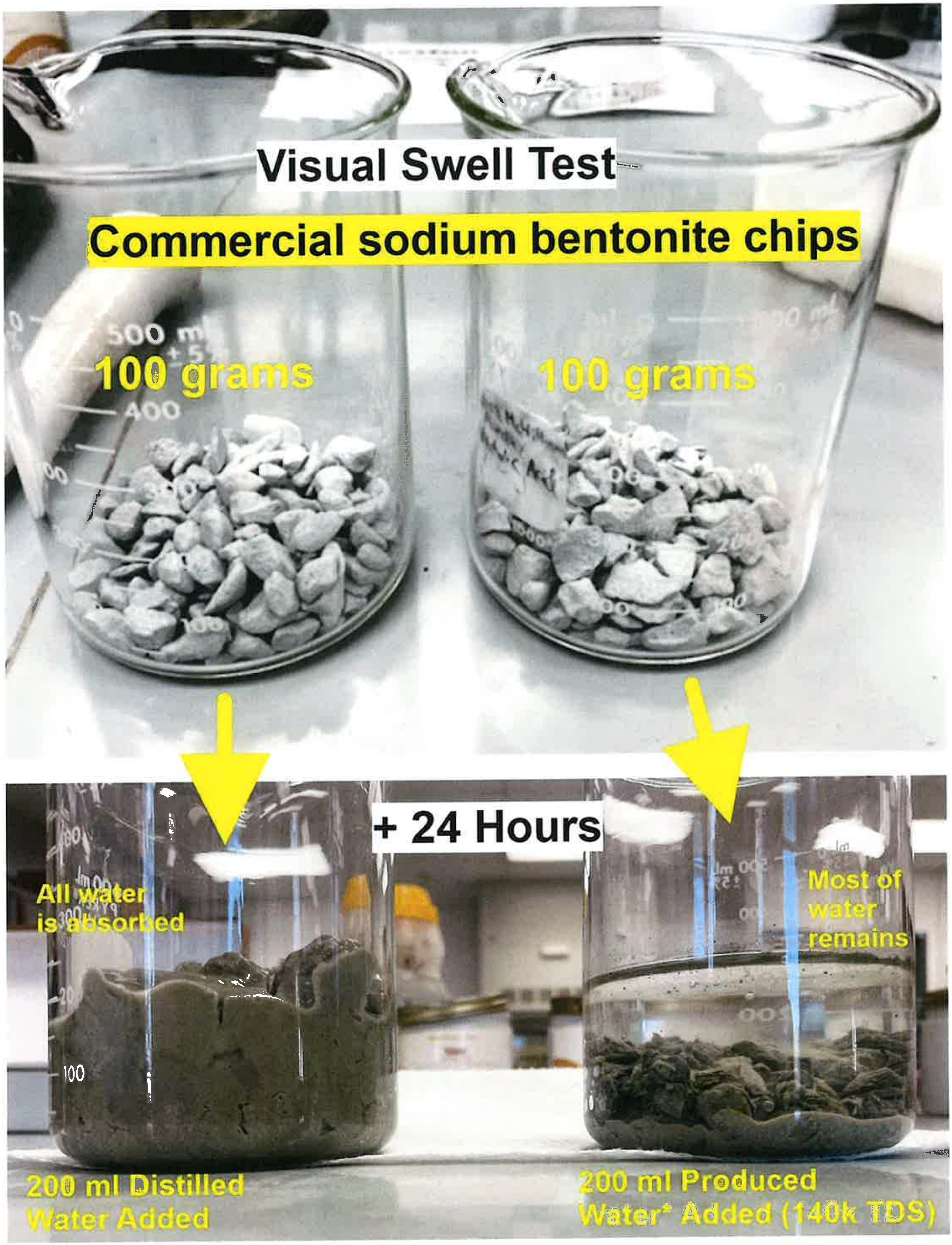
GCL Test - Physical Appearance after saturation with Distilled Water versus Produced Water



Stitched fabric seams almost indiscernable as bentonite has expanded

Swelled bentonite oozing out of sides

No observable swelling of clay. Stitching pattern of GCL still discernable.



Produced Water sourced from Martin County, Wolfcamp Production

Supplemental Information

ASTM Recommended GCL selection process

GCL Selection Process

When designing a GCL, it is imperative that a leachate sample is obtained and submitted for testing as early as possible in the design process to ensure the proper solution is selected

Step 1	• Collect sample of leachate or coal ash
Step 2	• Initial leachate chemical analysis • GCL proposed for proxy testing
Step 3	• GCL proxy testing to validate product selection • Write performance-based GCL specification
Step 4	• Long-term permeability testing
Step 5	• Finalize GCL product selection

https://www.mineralstech.com/business-segments/performance-materials/cetco/environmental-products/products/gcl

Nothing like this is required by the Texas RRC.