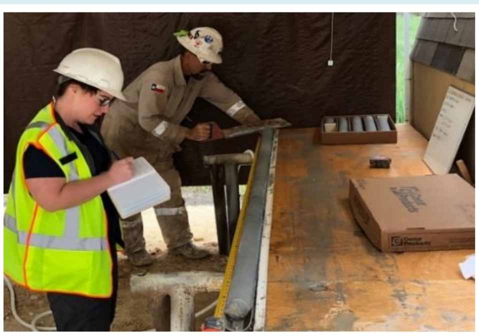
New Braunfels Utilities: Aquifer Storage and Recovery Demonstration Project

TWDB Contract No. 1600011957

By Arcadis U.S., Inc., ASR Systems LLC, INTERA Incorporated

March 2019

FINAL



Texas Water Development Board

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By:

Arcadis U.S., Inc.

ASR Systems LLC

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The contents of this report (including figures and tables) document the work of the following professionals.

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List of Acronyms and Abbreviations

≥	Greater than or equal to
°C	degrees centigrade
AFY	Acre-feet per year
Airport	New Braunfels Regional Airport
Arcadis	Arcadis U.S., Inc.
ASR	Aquifer storage and recovery
ASTM	American Society for Testing and Materials
bgs	below ground surface
Cascade Drilling	Cascade Drilling and Technical Services
CEC	Cation exchange capacity
CEO	Chief Executive Officer
cfs	cubic feet per second
City	City of New Braunfels
cm	centimeters
CO_2	Carbon dioxide
cP	centipoise
CRECs	Controlled recognized environmental conditions
DOR	Drought-of-record
DVD	Digital video disc
EAA	Edwards Aquifer Authority
EDR	Environmental Data Resources, Inc.
Edwards-BFZ Aquifer	Edwards Balcones Fault Zone Aquifer
ESA	Environmental Site Assessment
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
ft	feet
ft/d	feet per day
g/cm^3	grams per cubic centimeter
GBRA	Guadalupe-Blanco River Authority
GCDs	Groundwater conservation districts
Geo Cam	Geo Cam, Inc.
GMA	Groundwater Management Associates, Inc.
gpcd	gallons per capita day
gpm	gallons per minute
H_2S	hydrogen sulfide
HB	House Bill
HDD	Horizontal directionally-drilled
hp	horsepower
HRECs	Historical recognized environmental conditions
ID	Inner diameter
ILA	Interlocal Agreement
Kutscher Drilling	Kutscher Drilling, Ltd.
md	millidarcy’s
MG	Million gallons

mg/L	milligrams per liter
mgd	million gallon(s) per day
msl	mean sea level
NAVD	North American Vertical Datum of 1988
NBU Property	1.067-acre tract purchased by NBU during the design phase
NBU	New Braunfels Utilities
OD	Outer diameter
PDTM	Preliminary Design Technical Memorandum
Project	New Braunfels Aquifer Storage and Recovery Demonstration Project
psi	pounds per square inch
PVC	Polyvinyl chloride
RDM	Regional Dense Member
RECs	Recognized environmental conditions
RFB	Request for Bid
SDR	Standard dimension ratio
SWTP	Surface water treatment plant
TAWWA	Texas Section of the American Water Works Association
TBPLS	Texas Board of Professional Land Surveying
TCEQ	Texas Commission on Environmental Quality
TD	Total depth
TDS	Total dissolved solids
TSV	Target Storage Volume
TWDB	Texas Water Development Board (or the "Board")
TXDOT	Texas Department of Transportation
UIC	Underground Injection Control
USGS	U.S. Geological Survey
VFD	Variable frequency drive
WEAT	Water Environment Association of Texas
WPA	Wellfield Protection Area
XRD	X-ray diffraction
XRF	X-ray fluorescence

1. Executive summary

New Braunfels Utilities (NBU) is a municipally-owned public utility responsible for water, wastewater, and electric service for residents of the City of New Braunfels, Texas. Although NBU has a diverse inventory of water supply sources, about half of the supply is subject to curtailment by regulatory restrictions during periods of drought and low river flow. In addition to conservation efforts and additional water sources, NBU began evaluating aquifer storage and recovery (ASR) in 2011. Based upon a preliminary feasibility study, the Arcadis U.S., Inc. (Arcadis) team and NBU concluded that ASR can serve as a valuable water management strategy allowing NBU to capture and store potable water during periods when excess water is available and to recover that water from ASR storage during drought periods and to meet seasonal peak demands. Of three formations identified as viable for ASR storage, the brackish portion of the Edwards Aquifer was recommended as the most viable. However, there was limited information on the hydrogeology of that portion of the aquifer.

The 84th Texas Legislature appropriated $1,000,000 from General Revenue to the Texas Water Development Board (TWDB) to fund grants for demonstration projects for alternative water supplies (House Bill 1, General Appropriation Act, 2015 Legislature, Regular Session, page VI-60, Rider 25). The grants would fund groundwater conservation districts (GCDs) for demonstration projects or feasibility studies that will prove up ASR.

NBU and the Edwards Aquifer Authority (EAA) applied for and received Rider 25 funding provided through the TWDB to gather additional information on the stratigraphy and water quality of the brackish portion of the Edwards Aquifer to confirm its viability as an ASR location for NBU. Tasks completed as part of this project included: coordination with TCEQ; design and construction of a wireline core hole; design and construction of a monitoring well; data collection and analysis for reporting purposes; and engagement in presentations with the TWDB related to the project. In addition, NBU acquired a site for the coring and the monitor well. The NBU property will also be used for the first full-scale ASR well, as described below.

Wireline coring to a total depth of 1,096.8 feet below ground surface (bgs), in combination with a nearby monitoring well drilled to a depth of 940 feet bgs, provided important information on stratigraphy, lithology, potential storage intervals, water quality, potential production capacity, the potential for well clogging, limestone dissolution, and metals mobilization. The ground surface at the monitoring well was surveyed at 652.26 feet (NAVD 88). After sampling was completed in the Upper and Lower intervals of the Edwards Aquifer, the inflatable packer was removed, and the borehole was grouted up to the base of the Upper Edwards aquifer

Conclusions drawn from the data and information collected from the wireline core and the monitor well construction include:

- **Analysis of core data** suggested the presence of alternating bands of limestone and dolomite. The dolomite had higher porosities (i.e., up to 25 percent to 50 percent), including both primary (intergranular) and secondary (solution) features. The limestone intervals had lower porosities (i.e., 3 percent to 20 percent). Overall average porosity was about 30 percent.

- **The Regional Dense Member (RDM) confining layer** from about 710 to 734 feet bgs separates the Upper Edwards aquifer from the Lower Edwards aquifer. Limestone intervals with variable porosity, but low productivity, above and below the RDM contribute to the effectiveness of the confining layer while also supplementing the storage volume available within the overlying and underlying aquifers. However, the limestone intervals do not contribute much aquifer yield.

- **ASR storage** in the Upper Edwards aquifer would have excellent overlying confinement (200 feet to 545 feet bgs). ASR storage in the Lower Edwards aquifer would probably also have excellent underlying confinement provided by the Walnut Clay (950 feet bgs to 1,046 feet bgs), underlain by the Glen Rose limestone. Many ASR wells are operating successfully in brackish limestone and dolomite aquifers, provided adequate confinement is available.
- **Analysis of spinner log results** indicate that the primary producing feature in the Upper Edwards aquifer is near 630 feet bgs, but additional flow is found between about 580 feet bgs and about 660 feet bgs.
- **Static water levels** in both the Upper and Lower intervals ranged from 30 to 32 feet bgs. Under static storage conditions, a natural vertical gradient between the two intervals was not apparent, suggesting that an ASR storage "bubble" at the NBU property should be vertically stable when no injection or production is occurring.
- **The water level during pumping** in the Lower Edwards interval decreased by about 0.55 feet and 0.75 feet with estimated pumping rates of 8.5 gallons per minute (gpm) and 10 gpm, respectively.
- **Preliminary geochemical equilibrium** results were constrained by the unreliability of the first set of water quality lab results. However, a second set of samples provided excellent results. The geochemical equilibrium model analysis was completed using the second dataset. In the next phase of the NBU ASR program, a Lower Edwards aquifer monitor well will be constructed at the NBU property and tested for water quality.
- **Preliminary analysis** suggests a low likelihood of adverse geochemical interactions, including issues such as mobilization of arsenic. The relatively low pH of the Edwards Aquifer at the NBU property suggests the possible occurrence of elevated concentrations of carbon dioxide (CO_2). If present, release of CO_2 during ASR recovery is a possibility. However, this release typically would decline with successive cycles and with initial formation and maintenance of a buffer zone around the ASR well.

Based on the information gathered from the core and the monitor well, a Preliminary Design Technical Memorandum (PDTM) was prepared. The PDTM outlines: recommended well locations; ASR and monitor well design criteria; evaluation of aquifer confinement; the aquifer static water level; potential recharge and recovery flow rates; the anticipated radial extent of stored water; wellfield analytical and hydrogeologic modeling recommendations; wellfield facilities design criteria; interim recharge volumes and durations; a pump test and backflush water disposal design; provisions for potential future wellfield expansion; and a recommended project delivery method.

These data and design criteria provide strong technical support for NBU moving ahead with the next phase of NBU's ASR program. The next (third) phase will include permitting, design, construction and cycle testing of an initial ASR demonstration well. This Demonstration Well Phase will also include design, construction and observation of up to three additional monitoring wells. Two of the monitoring wells (one in the Upper and one in the Lower Edwards aquifer) will be at a remote location as required by the interlocal agreement between NBU and EAA. The third monitoring well will be in the Lower Edwards aquifer at the NBU property.

Recommended next steps include:

- Prepare and process an application to the Texas Commission on Environmental Quality (TCEQ) for a Class V Injection Well 5X25 (Experimental) Authorization to construct and operate a full-scale demonstration ASR well on the NBU property.
- Design the demonstration ASR well and three monitoring wells. Confirm the location for the two remote monitoring wells, subject to EAA approval.
- For the ASR well, specific design criteria include the following:
    - Design the ASR well for an anticipated recovery rate of 700 gpm assuming up to 200 feet of drawdown. This design criteria implies a recovery specific capacity of 3.5 gpm/foot, or higher. Complete pump testing to finalize the hydraulic design of the pump and confirm the motor horsepower requirements.
    - Confirm the design recharge flow rate through initial ASR operations. The recharge pressure within the well casing as measured at the wellhead flange will likely be limited so as not to exceed 30 pounds per square inch (psi). Assuming a depth to static water level of about 37 feet, total available recharge head will be about 107 feet. Assuming a recharge specific capacity of 3.0 gpm/foot, the design recharge rate will be in the range of 300 to 350 gpm (0.5 mgd).
- Use the conventional "Design, Bid, Build" delivery method to select the contractors and construct the ASR well and the monitoring wells.
- Begin interim ASR recharge as soon as the ASR well is constructed and tested. Interim recharge can continue during the period when the well is being equipped and wellhead facilities are being constructed. This duration may be several months, during which time a substantial volume of drinking water can be stored, assuming water is available for recharge from the NBU public water distribution system.
- Begin cycle testing after the operations and maintenance manual and NBU staff training are completed. The duration of cycle testing, and the volumes of water recharged and recovered will depend on the availability of water from the NBU distribution system. For the first ASR demonstration well, the Target Storage Volume (TSV) is estimated to be 1,289 acre-feet (420 million gallons) with an associated theoretical bubble radius of 677 feet.
    - Collect water quality samples from the new Lower Edwards monitoring well, and
    - Complete an updated geochemical analysis.

After the Demonstration Well Phase is completed, later tasks should include construction of an analytical model to evaluate the potential impacts, if any, of the operation of the first NBU ASR well on the freshwater zone of the Edwards Aquifer. That model will be developed before the ASR well is put into permanent operation under a TCEQ Class V UIC permit. That model and all previous work will then be used as the basis for designing the expansion of the NBU ASR wellfield.

2. Introduction

New Braunfels Utilities (NBU) is a municipally-owned public utility responsible for water, wastewater, and electric service for residents of the City of New Braunfels, Texas. Most of the NBU service area comprises the City limits within Comal County, with some customer service provided in eastern Hays and northern Guadalupe Counties. The water system serves an area of almost 90 square miles. In fiscal year 2016, NBU served 33,550 retail water connections. The system is rated as "Superior" by the Texas Commission on Environmental Quality (TCEQ) and includes the following major infrastructure:

- Over 500 miles of water mains ranging in diameter from two to thirty inches
- One 8.0-million gallon per day (mgd) surface water treatment plant (SWTP)
- Nine active Edwards Aquifer groundwater wells
- Six active Trinity Aquifer groundwater wells
- Eighteen (18) pump stations
- Storage capacity of approximately 18.3 million gallons (MG) is maintained in elevated and ground storage tanks.

NBU has a diverse inventory of water supply sources totaling almost 30,000 acre-feet of water per year (AFY). These current sources of water include:

- Run-of-river water rights for surface water from the Guadalupe River (permitted by TCEQ)
- Contracts with the Guadalupe-Blanco River Authority (GBRA) for stored surface water from Canyon Reservoir
- Groundwater production permits for water from the Edwards Balcones Fault Zone Aquifer (Edwards-BFZ Aquifer) from the Edwards Aquifer Authority (EAA)
- Groundwater wells in the Trinity Aquifer

In 2018, NBU signed a contract to purchase treated groundwater from GBRA through GBRA's Mid-Basin Water Supply Project. That water will become available in 2023.

Figure 2-1 shows the NBU service areas.

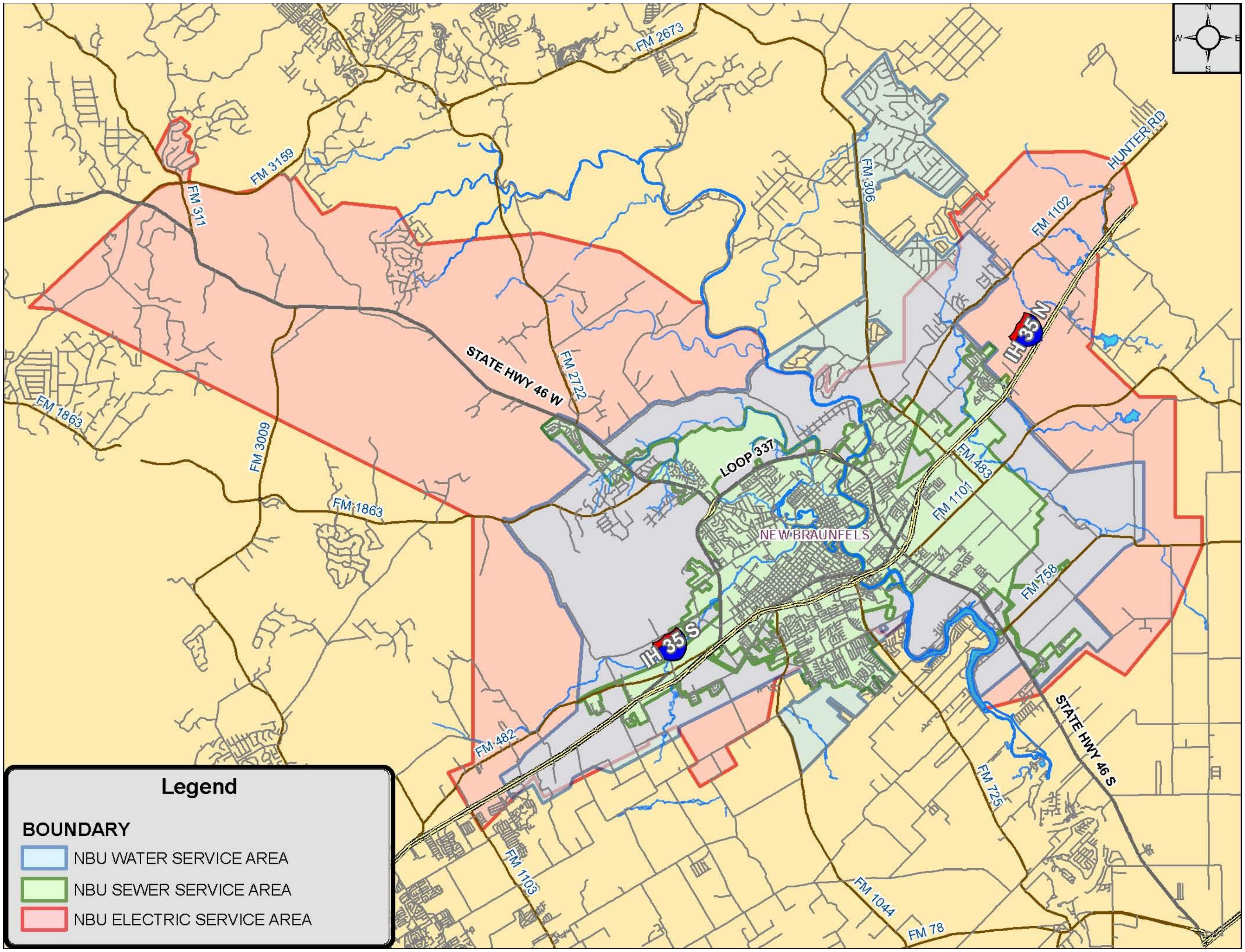


Figure 2-1: NBU service area map

Although NBU has a diverse inventory of water supply sources, about half of the supply is subject to curtailment during periods of drought and low river flow. NBU's run-of-river water can be diverted only when the flow of the Guadalupe River at New Braunfels is greater than 113 cubic feet per second (cfs); and water from the Edwards Aquifer is subject to reduction under EAA's Critical Period Management Rules and the Edwards Aquifer Habitat Conservation Plan. At the present time, the availability of NBU's water sources during severe drought (the "firm" yield") is about 17,500 AFY, and the reliable supply during non-drought periods is about 19,300 AFY (NBU *2018 Water Resources Plan*).

New Braunfels is one of the fastest-growing communities in the nation. The 2040 population within the NBU service area is estimated to be over 200,000 people. In order to meet its future water demand, NBU has a goal of reducing its unit water demand from 168 gallons per capita day (gpcd) to 120 gpcd by the year 2043. The 2043 annual water demand is estimated to be 29,775 AF, even with these enhanced water conservation measures (NBU *2018 Water Resources Plan*).

In addition to enhanced water conservation, NBU is seeking additional water sources, and investigating strategies to better manage its variable water supplies. In 2011, NBU engaged Malcolm Pirnie, at that time the Water Division of Arcadis U.S., Inc. (Arcadis), to conduct a preliminary evaluation of aquifer storage and recovery (ASR). In that effort, the Arcadis team evaluated the practical ASR applications that might be beneficial to NBU and its service area; gathered pertinent information and data on NBU's water system and future plans; and conducted a preliminary (Phase 1) feasibility study to assess the viability of ASR as an NBU water management strategy (NBU, 2012).

In order to meet NBU's needs during periodic droughts, including the 1950's drought-of-record (DOR), the concept of an ASR program would be to capture and store potable water during periods when run-of-river surface water is available (even during a repeat of the DOR) and when Edwards Aquifer water levels allow full use of NBU's permits; and to recover that water from ASR storage during drought periods and to meet seasonal peak demands.

Based on this preliminary feasibility study, the Arcadis team and NBU concluded that ASR can serve as a valuable water management strategy because NBU, like most water utilities in Texas, has the need to firm up the reliability of its supply. The major conclusions and recommendations from this study included the following:

- Based on a preliminary analysis of hydrogeologic data, there appeared to be three formations that could be viable for ASR storage, including the brackish portion of the Edwards Aquifer. The brackish portion of the Edwards Aquifer is found in the fast-growing southern portion of the NBU service area.
- The first step toward implementation of an ASR program for NBU should include additional data collection, and early and continual coordination with EAA and TCEQ.
- The initial phase of construction should include one to three ASR wells. For a single ASR well, the most cost-effective location would likely be a brackish Edwards Aquifer demonstration well at or near the New Braunfels Regional Airport (the "Airport"). The Airport is within the NBU service area. Successful results from this test well would potentially lead to other ASR wells at or near the Airport.

Following the feasibility study, NBU began discussions with EAA, and with the City of New Braunfels (the "City") and the Airport Advisory Board about the potential to develop NBU's first ASR wells in or near the Airport. NBU also initiated discussions with the Aviation Division of the Texas Department of Transportation (TXDOT), and the Federal Aviation Administration (FAA).

Because the brackish Edwards Aquifer has not been used as a significant source of water for municipal, industrial or agricultural purposes, there is limited information on the hydrogeology of that portion of the aquifer. The Arcadis team and NBU agreed that before an ASR well is drilled, additional data should be collected. It was also agreed that the data collection should include the construction of a continuous wireline core and a monitor well in the Edwards Aquifer at or near the Airport. The purpose of this report is to provide the results of that data collection effort by NBU, EAA and the Arcadis team.

2.1 Background on demonstration project for alternative water supplies funding

In 2011 the Arcadis team completed a state-wide assessment of ASR for the Texas Water Development Board (TWDB or the "Board"). The focus of that effort was a technical, institutional and legal analysis of why ASR had not been implemented more often in Texas, when it was being widely used as a management strategy in other states. The results of that study indicated that the impediments to ASR development in Texas were legal and institutional, not technical. The study also concluded that there was a lack of education on ASR's benefits as a water management and storage strategy.

Following the 2011 study, the TWDB increased education about the benefits of ASR and how the technology was being implemented in other states. The Texas Legislature also increased funding for studies and demonstration projects.

The 84th Texas Legislature appropriated $1,000,000 from General Revenue to the TWDB to fund grants for demonstration projects for alternative water supplies (House Bill 1, General Appropriation Act, 2015 Legislature, Regular Session, page VI-60, Rider 25). The grants would fund groundwater conservation districts (GCDs) for demonstration projects or feasibility studies that will prove up aquifer storage and recovery. The legislation required that the applicants for funding must be GCDs and that the applicants must provide matching funds. The TWDB was to issue an application notice by September 22, 2015, with applications due on November 3, 2015.

The TWDB determined that projects would be selected for funding based on the following criteria: overall approach and organization; methodology; qualifications and resources of the applicant's team; the reports and deliverables to be provided to the TWDB; and the applicants ability to perform and complete the project.

The TWDB received six applications, including an application prepared by the Arcadis team for EAA and NBU. The TWDB awarded three grants, including the demonstration project proposed by EAA and NBU. The proposed EAA/NBU project had a total budget of $563,000, with support from the TWDB being limited to $281,500.

On September 27, 2016, the TWDB and EAA executed a contract (Contract No. 1600011957) for the performance of the New Braunfels Aquifer Storage and Recovery Demonstration Project (the “Project”). In the contract, EAA is shown as the Contractor, and NBU is shown as a Participant. The results of that demonstration project are described in the following sections.

2.2 Study participants

As discussed above, the primary participants were EAA and NBU. They were supported by the Arcadis technical team comprised of:

- Arcadis U.S., Inc.;
- ASR Systems, LLC from Gainesville, Florida; and
- INTERA, Incorporated from Austin, Texas.

As the Project progressed, the following entities also participated in the demonstration project:

- Kutscher Drilling, Ltd, San Marcos, Texas (Kutscher Drilling) was the successful bidder for site preparation and construction of both the wireline core and the monitor well.
- Cascade Drilling and Technical Services, Peoria, Arizona (Cascade Drilling) was a subcontractor to Kutscher Drilling for drilling the wireline core.
- Groundwater Management Associates, Inc., Greenville, North Carolina (GMA) was a subconsultant to ASR Systems, LLC for hydrogeologic analysis and documentation of the recovered cores.
- Geo Cam, Inc., San Antonio, Texas (Geo Cam) conducted geophysical and porosity logging of the wireline core and the monitor well under the direction of the respective design engineers.
- Mineralogy, Inc., Tulsa, OK conducted laboratory analysis of selected cores.

2.3 Scope of work, and roles and responsibilities

In addition to project management, the Project generally consisted of:

- Coordinating with TCEQ so that the agency understands the NBU ASR program, this Project, and how the data and information collected in this Project will assist NBU in getting the necessary TCEQ authorizations to drill its first ASR well;
- Designing and constructing a continuous wireline coring of the brackish Southern Segment of the Edwards-BFZ Aquifer, and gathering data from the coring;
- Designing and constructing a monitoring well in the brackish Edwards Aquifer and gathering data and information during and after construction; and
- Delivering a final report and disseminating the research results through professional papers and presentations.

More specifically, the eight tasks making up the Project included:

Task 1: Project management

Arcadis provided overall project management, which consisted of: communication among EAA and NBU, and with the TWDB; project tracking; invoicing; scheduling; deliverables oversight;

and quality control. This task also included scheduling and attending periodic meetings and conference calls with TWDB staff and among the Project team.

For this effort, project management also included supporting NBU in three ancillary and very important subtasks:

- Working with EAA and negotiating an interlocal agreement between EAA and NBU;
- Assisting NBU in discussions and negotiations with the City, TXDOT Aviation and FAA; and
- Assisting NBU in the acquisition of a site for construction of the wireline core and the monitoring well.

Over a period of almost three years, EAA and NBU worked together to develop an understanding of NBU's ASR program, the need for additional data and the importance of this Project. Those discussions and negotiations resulted in the execution of an Interlocal Cooperative Contract (No. 17-837-EX) which is also known as the "Interlocal Agreement" or the "ILA." The ILA provides the authorizations that NBU needs to go through the phased implementation of its ASR program. It also provides for an ongoing Work Group, comprised of EAA, NBU and their consultants, which will conduct the studies and prepare the plans required in the ILA.   The ILA includes requirements for the construction of monitoring wells, performance of studies and development of plans to assure that the NBU ASR program does not have adverse consequences for the Edwards Aquifer and the Comal Springs. In the ILA, this Project is defined as the "Preliminary Work Phase." The permitting, design, construction, startup and cycle testing of NBU's first ASR well is defined as the "Demonstration Well Phase."

Because the City has funding arrangements with the federal government for the Airport, TXDOT Aviation and FAA approvals are needed for NBU to put an ASR wellfield on the Airport. NBU began discussions with TXDOT Aviation in November 2013, and over the following years, those discussions included the FAA, the City and the City's Airport Advisory Committee. During that period, the City worked with its consultants to develop a preliminary master plan for aeronautical development of the Airport. NBU then used that master plan to prepare a conceptual layout for an ASR wellfield with up to nine wells on the Airport property. That layout included ASR well sites, the linear easements necessary to get utilities to the well sites, and a 150-foot sanitary control easement around each well. That layout is also the basis for a lease agreement between the City and NBU that will allow NBU to get the FAA approvals it needs to construct the wellfield as its ASR program is implemented. The lease agreement provides NBU the ability to adjust well sites and construct monitoring wells, as needed. That lease agreement was being finalized at the time this report is being drafted.

Because the negotiations with TXDOT and the FAA were taking longer than expected, NBU decided to acquire its own property so the Project could be completed on schedule. After evaluating several sites, NBU acquired a 1.067-acre tract of land directly adjacent to the Airport. The site will be discussed in more detail in Section 4.

Task 2: Coordination with TCEQ

Two of the purposes for the Project are to obtain data and information necessary for NBU to fulfill its obligations to EAA under the ILA, and to develop a better understanding of the stratigraphy and water quality of the brackish Edwards Aquifer. Because the coring and monitor well are not being used to inject water into the aquifer or recover water for public use, no permits are required from TCEQ for the Project. However, a Class V Underground Injection Control (UIC) permit from TCEQ will be required when NBU moves forward with a full-scale ASR well in the next phase. Therefore, one of the tasks in the Project was to conduct a pre-application meeting with TCEQ.

The meeting was held with TCEQ on September 18, 2018. In addition to seven members of the TCEQ staff, the attendees included representatives from EAA, NBU, Arcadis, ASR Systems and INTERA.

In summary, the meeting included a discussion of the background on the NBU ASR program, the 2012 feasibility study and the Project. In addition to the technical discussion, the EAA and NBU representatives gave the TCEQ staff a general briefing on the perspectives of their organizations. TCEQ was particularly interested in the results of the wireline coring and the monitor well data collection.

The meeting also included a discussion of NBU's plans to submit an application for a Class V 5X25 authorization for the first ASR well, to be located on the NBU Property. The TCEQ staff discussed the general requirements for the application, including a narrative describing the scope of work for the demonstration ASR well project, the deliverables that TCEQ will receive and the goals of the cycle testing program. More specifically, TCEQ asked that the following be included in the application: the anticipated number of cycles; the goals of the testing program, along with the schedule and milestones; the water quality testing to be conducted; and the information to be provided to TCEQ (e.g., well logs and completion reports, results from each of the cycles, and water quality data). For each cycle, TCEQ would like to know the anticipated injection and recovery rates; durations of injection, storage and recovery; volume to be injected; and volume to be recovered.

The more-detailed meeting minutes are shown in **Appendix A**.

Task 3: Coring design

ASR Systems prepared the plans, specifications and technical bid documents necessary for NBU to select and engage a qualified contractor to do the wireline coring. The draft documents were reviewed by Arcadis and INTERA as part of the Project quality assurance process. The review included an effort to make sure that the coring technical documents were written in the same way as those for the monitoring well.

After review by EAA and NBU, the technical requirements were incorporated into NBU's standard bid documents. The Bid Schedule was organized with unit prices for most of the items so that adjustments could be made as field conditions dictated.

The final technical specifications are shown in **Appendix B**.

Task 4: Wireline coring

NBU used its standard procurement procedures to advertise, evaluate and select a qualified coring contractor to drill and recover the cores using the specifications developed in Task 3. NBU issued *Request for Bid (RFB) 02452 Aquifer Storage and Recovery (ASR) Continuous Wireline Core* on November 22, 2017. A pre-bid conference was held on December 12, 2017 at the NBU Service Center in New Braunfels, Texas.

In accordance with the RFB, bids were opened by NBU on January 9, 2018. Bids were received by Kutscher Drilling and MGC Contractors, Inc. The apparent low bidder was Kutscher Drilling. Arcadis and ASR Systems reviewed the Kutscher Drilling bid and recommended that NBU award the contract to that firm. Based on that recommendation, NBU requested that Kutscher Drilling provide all the required bond and insurance information, and ultimately engaged the company to conduct the work.

Notice to Proceed was issued by NBU to Kutscher Drilling on February 5, 2018. Preparation of the site, including construction of a gravel entrance road and drilling pad, was completed during the week of March 12, 2019. Kutscher Drilling's subcontractor Cascade Drilling began work on March 19, 2018. Coring was completed on April 5, 2018 to a total depth of 1,096.8 feet below ground surface (bgs).

Initial logging of the core hole to a depth of 536.5 feet bgs was completed by Geo Cam on March 26, 2018. A second log to total depth was completed on April 5, 2018.

GMA had a hydrogeologist on site throughout the coring process. He was responsible for photographing the cores, determining which cores would be frozen for laboratory analysis by Mineralogy, confirming the percent recovery (for payment purposes), and documenting the stratigraphy of the core hole.

Representatives of NBU were at the site periodically during the coring, and the EAA had geologists on site on a daily basis when coring was ongoing.

At the completion of the coring, all of the boxed cores were delivered for storage at the NBU Kuehler Wastewater Treatment Plant.

Figures 2-2 through 2-8 were taken during the coring process.

Figure 2-2: Cascade drilling rig

Figure 2-3: Closeup of coring operation

Figure 2-4: 2.5-inch core being removed from tool

Figure 2-5: Geologists measuring and analyzing 10-ft core

Figure 2-6: EAA geologist observing core analysis

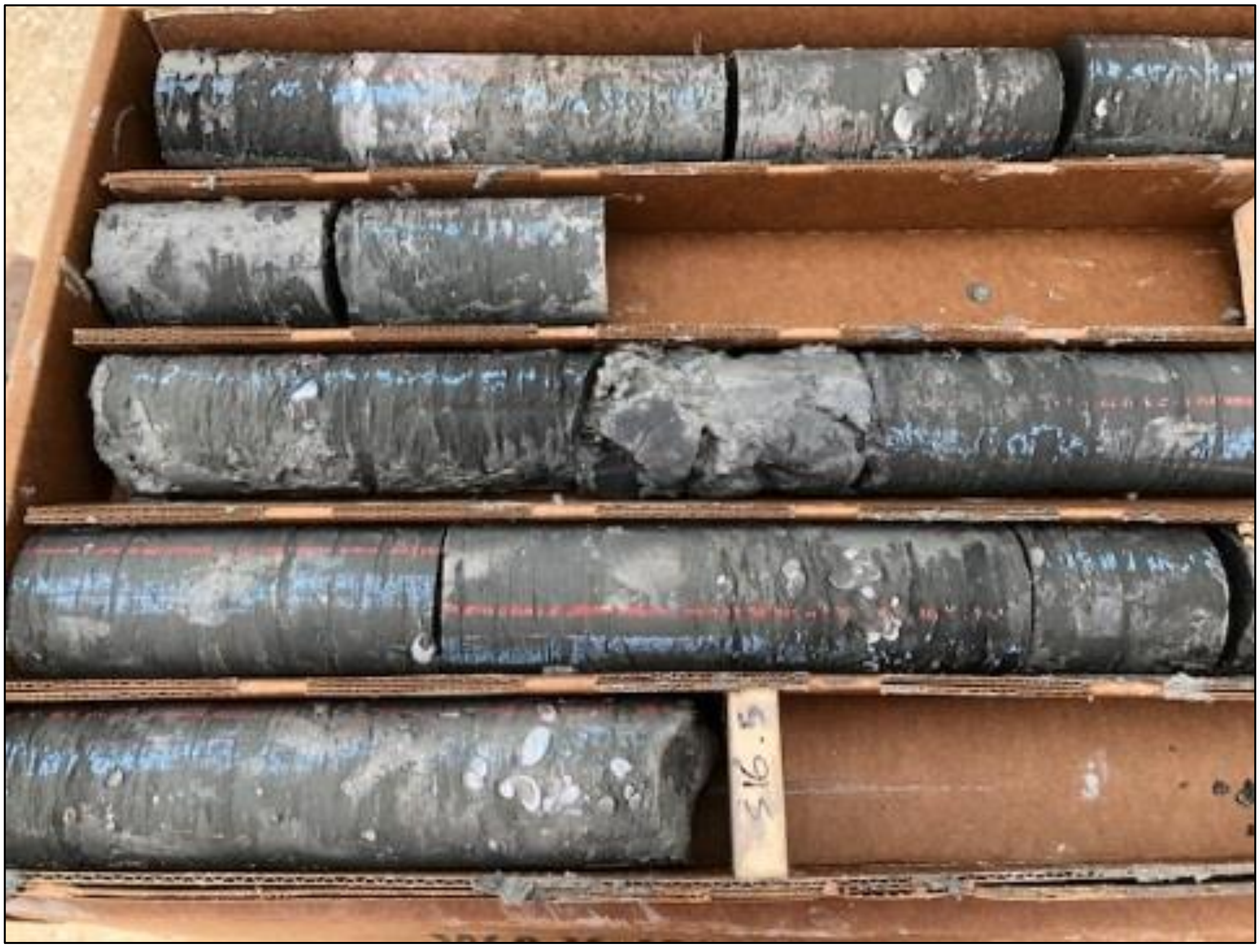


Figure 2-7: Cores labeled and boxed for storage

Figure 2-8: Initial logging of core hole

The coring, data collection and analysis are described in more detail in Section 5.1.

Task 5: Monitor well design

INTERA prepared the plans, specifications and technical bid documents necessary for NBU to select and engage a qualified contractor to construct the monitor well. The draft documents were reviewed by Arcadis and ASR Systems as part of the Project quality assurance process. The review included an effort to make sure that the technical documents were written in the same way as those for the continuous wireline coring.

After review by EAA and NBU, the technical requirements were incorporated into NBU's standard bid documents. The Bid Schedule was organized with unit prices for most of the items so that changes could be made based on information gained during the coring.

The final technical specifications are shown in **Appendix B**.

Task 6: Monitor well construction and data collection

NBU used its standard procurement procedures to advertise, evaluate and select a qualified coring contractor to drill and develop the monitoring well using the specifications developed in Task 5. NBU issued *Request for Bid (RFB) 02451 Aquifer Storage and Recovery (ASR) Monitoring Well* on November 22, 2017. A pre-bid conference was held on December 12, 2017 at the NBU Service Center in New Braunfels, Texas.

In accordance with the RFB, bids were opened by NBU on January 9, 2018. Bids were received by Kutscher Drilling and MGC Contractors, Inc. The apparent low bidder was Kutscher Drilling. Arcadis and ASR Systems reviewed the Kutscher Drilling bid and recommended that NBU award the contract to that firm. Based on that recommendation, NBU requested that Kutscher Drilling provide all the required bond and insurance information, and ultimately engaged the company to conduct the work.

On March 27, 2018 EAA issued NBU a permit for construction of the monitor well.

NBU issued a Notice to Proceed to Kutscher Drilling for the monitor well on April 16, 2018. Drilling commenced during the week of April 23, 2018. The monitor well was completed to a depth of about 940 feet bgs on May 29, 2018. During construction, INTERA had a hydrogeologist on site as needed for supervision of the drilling, logging and water quality sampling.

A packer between the Upper and Lower intervals of the Edwards Aquifer was installed by Kutscher Drilling at approximately 720 feet bgs. Water quality samples were collected by EAA and INTERA and sent to a private laboratory for analysis. Geo Cam performed geophysical, neutron and sonic porosity, and spinner test (hydraulic) logging of the well.

Additional water quality samples were taken from the Lower interval of the Edwards Aquifer on August 10, 2018. Kutscher Drilling then plugged the well up to elevation 710 feet bgs. After plugging, the pump was reset and additional water quality samples were collected from the Upper interval of the Edwards Aquifer.

Representatives of NBU and EAA were at the site periodically during drilling of the monitor well.

Figures 2-9 through 2-10 were taken during the construction of the monitoring well.

Figure 2-9: Kutscher drilling rig

Figure 2-10: SDR 17 casing pipe

The monitor well construction, data collection and analysis are described in more detail in Section 5.2.

Task 7: Draft and final reports

Arcadis managed the preparation of the draft and final reports, with input from ASR Systems and INTERA for their technical portions of the Project.

The draft report was reviewed by EAA and NBU prior to submittal to the TWDB.

Task 8: Presentations

EAA, NBU and the Arcadis team have been engaged in presentations on the Project since its inception. TWDB representatives have also been involved in many of those presentations.

The presentations included the following:

- David Pyne (ASR Systems) and Fred Blumberg (Arcadis) participated in the ASR panel discussion at the TWDB's *Water for Texas 2017* Conference on January 25, 2017. The Project was included in the panel discussion.
- Fred Blumberg (Arcadis) and Matthew Webb (TWDB) gave a presentation on the Project at the 2017 Project Management Seminar in San Antonio, Texas on February 24, 2017. The seminar was sponsored by the San Antonio chapters of the Texas Section of the American Water Works Association (TAWWA) and the Water Environment Association of Texas (WEAT).
- Several presentations on the Project were made to the EAA Board of Directors, and the NBU Board of Trustees.
- NBU CEO Ian Taylor and Fred Blumberg (Arcadis) gave a presentation that included a discussion of the Project at the TAWWA/WEAT Summer Seminar in San Antonio on June 23, 2017.
- On August 17, 2017 Fred Blumberg (Arcadis) made a presentation on "ASR in Texas" that included information on the TWDB funding, the scope of work and status of the Project. The information was presented to the North Central Texas chapter of the American Water Works Association in Euless, Texas.
- On February 22, 2018 Fred Blumberg gave a presentation on the status of the Project to the Capital Area sections of TAWWA and WEAT.
- In early April 2018 Fred Blumberg (Arcadis) provided draft PowerPoint slides to Matthew Webb with the TWDB. Mr. Webb gave a presentation on the Texas ASR demonstration projects at the Collier Consulting conference in Austin, Texas.
- Mr. Webb also facilitated an ASR panel discussion at the American Ground Water Trust Seminar on June 6, 2018. Members of the Project team participated on the panel.
- A presentation on the Project and other ASR demonstration projects was given by members of the Project team at the *Texas Water 2018* conference in San Antonio on April 26, 2018. Participants included Matthew Webb (TWDB), Trino Pedraza (NBU), Mark Hamilton, P.G. (EAA) and Fred Blumberg (Arcadis).
- On June 6, 2018 Matthew Webb (TWDB) moderated a panel discussion on the ASR demonstration projects funded by Rider 25 at the American Ground Water Trust

conference in Austin, Texas. Paul Bertetti (EAA) and Fred Blumberg (Arcadis) were on the panel to discuss the Project.

- On June 15, 2018 Fred Blumberg gave a second presentation on the ASR demonstration projects to the Capital Area (Austin, Texas) Chapter of the TAWWA. The group had asked for an updated presentation on the Project.

3. Study objectives

The 2012 NBU ASR feasibility study included a preliminary evaluation of the hydrogeology in the area of NBU's service area and the Airport. Based on limited information the Arcadis team determined that moving from northwest to southeast, the water quality in the Edwards Aquifer changes from fresh (<1,000 milligrams per liter [mg/L] total dissolved solids [TDS]) to slightly saline and continues to get more brackish moving downdip. The location of the 1,000 mg/L TDS "bad water line," is generally near the Comal Springs, about five miles northwest of the Airport. However, brackish aquifers are not used extensively, and there is not a significant amount of well data.

Therefore, the overall objective of this Project was to gather additional information on the stratigraphy and water quality of the brackish portion of the Edwards Aquifer, and to better confirm its viability as a storage location for the NBU ASR program. As discussed below, wireline coring in combination with a nearby monitoring well provided the best method for augmenting knowledge of the brackish Edwards Aquifer.

While monitoring wells are a well-known method for gathering groundwater data, wireline coring has not been typically used for such research. Coring technology is more commonly used in oil and gas exploration for geological fieldwork. Collecting a core of the Edwards Aquifer in an area where there is little existing data can provide valuable information, and the opportunity for detailed lithologic analysis and comparison to geophysical logs obtained from a nearby monitoring well. The collected cores can also be analyzed to understand the geochemical changes that can ultimately affect the recovered water quality due to mixing between recharge water and native groundwater in the presence of aquifer minerals. Information gained in the coring effort also allowed INTERA to confirm its specifications (depth of well, and location of the packer between the Upper and Lower intervals) before the monitoring well was drilled.

For this Project, the collected cores were logged and photographed, and selected samples were frozen and shipped to a laboratory for analysis. The remaining cores were stored for later use in addressing questions about the storage formation and/or the recovered water.

The monitor well was used to gather logging data and water quality samples. The well will also be incorporated into the ASR wellfield for operational purposes.

Between the coring data and the monitoring well data, the Project provides important information on stratigraphy, lithology, potential storage intervals, water quality and potential for well clogging, limestone dissolution, and metals mobilization. The Project also provides preliminary information on the potential production capacity of wells in the brackish Edwards Aquifer near the Airport.

4. Study area

The study area for the Project is the 1.067-acre tract purchased by NBU during the design phase (the “NBU Property”). Although several sites were evaluated, this tract of undeveloped, agricultural land was selected because of its proximity to the Airport, and to NBU existing water, wastewater and electric service. Both the wireline core and the monitor well were constructed on the NBU Property. The NBU Property is shown on **Figure 4-1**.

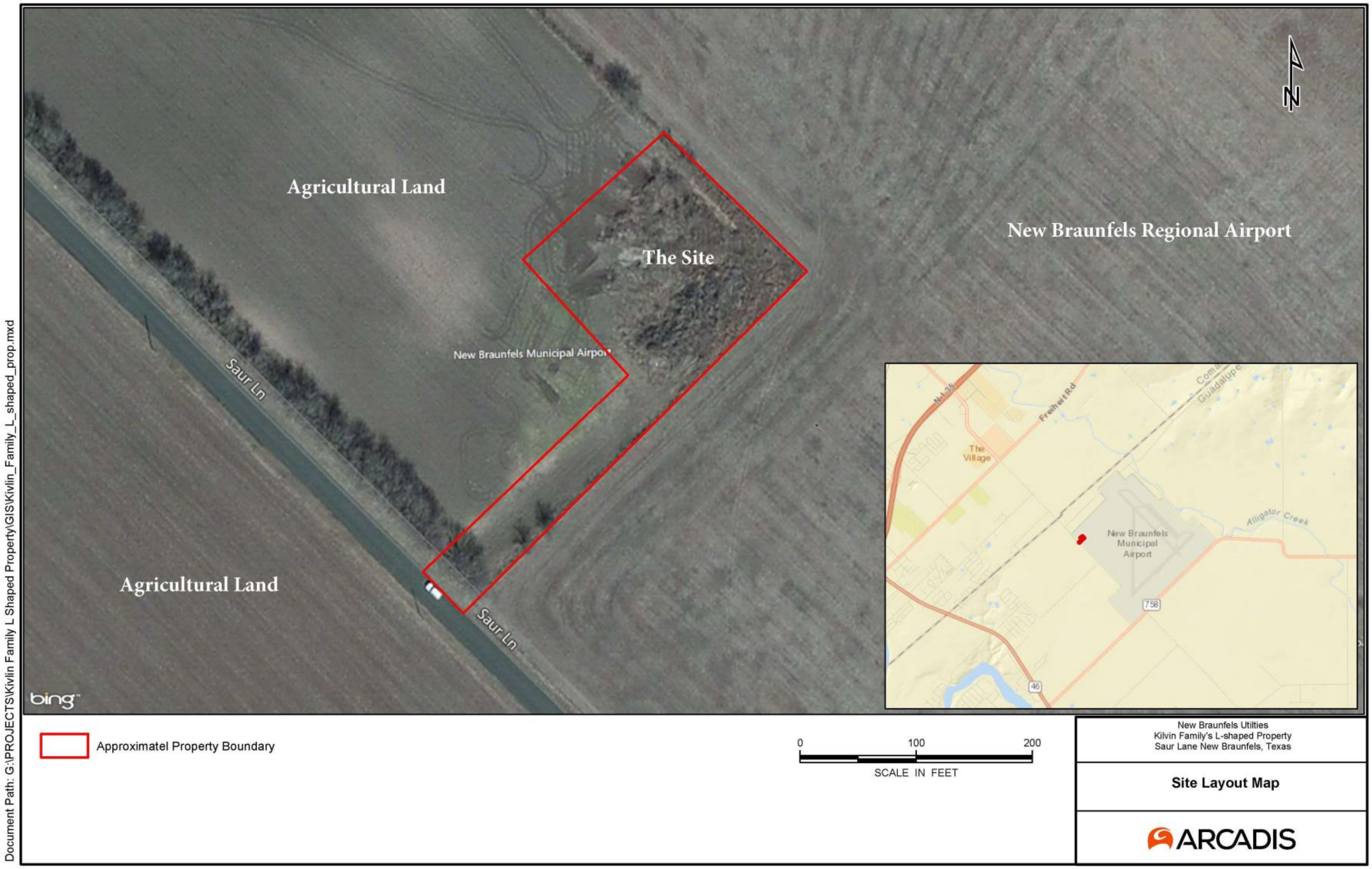


Figure 4-1: Study area—NBU property

The NBU Property is located approximately 653 feet above mean sea level (msl). The topography has a general gradient to the southeast based on the U.S. Geological Survey (USGS) 7.5-minute topographic map for New Braunfels East, Texas. According to Federal Emergency Management Agency (FEMA) flood plain panel data, the study area does not lie within either the 100-year or 500-year flood plain.

As part of its evaluation process, NBU engaged Arcadis to conduct a Phase I Environmental Site Assessment (ESA) of the proposed location for the coring and monitoring well. The assessment included gathering information from federal, state and local regulatory agencies. Arcadis engineers conducted a site visit on June 26, 2017 to observe the current use and environmental condition of the NBU Property.

In addition to the site visit, the Arcadis' scope of work included:

- Review of available environmental documents, including previous site assessments and investigations;
- Search for environmental liens;
- Review of property history through aerial photographs, city directories, ownership records, and historical mapping;
- Observation of adjacent properties and the local area to evaluate the potential for adverse environmental impact; and
- Use of Environmental Data Resources, Inc. (EDR) to identify sites of concern as required in the regulatory records review section of the American Society for Testing and Materials (ASTM) Standard for a Phase I ESA.

The goal of the Phase I ESA was to identify recognized environmental conditions (RECs), controlled recognized environmental conditions (CRECs), and historical recognized environmental conditions (HRECs) associated with the NBU Property in conformance with ASTM E1527-13. Arcadis found that the NBU Property did not have any identified RECs, CRECs or HRECs.

The Arcadis findings and conclusions were based on the results of a reconnaissance-level site visit, review of regulatory records, and a review of available and pertinent background information. The Phase I ESA was conducted in general accordance with the ASTM International Standard E1527-13, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.

NBU engaged Urban Civil (TBPLS Firm No. 10005900) to survey the locations of the core hole and the monitoring well within the NBU Property. A site location map is shown on **Figure 4-2**.

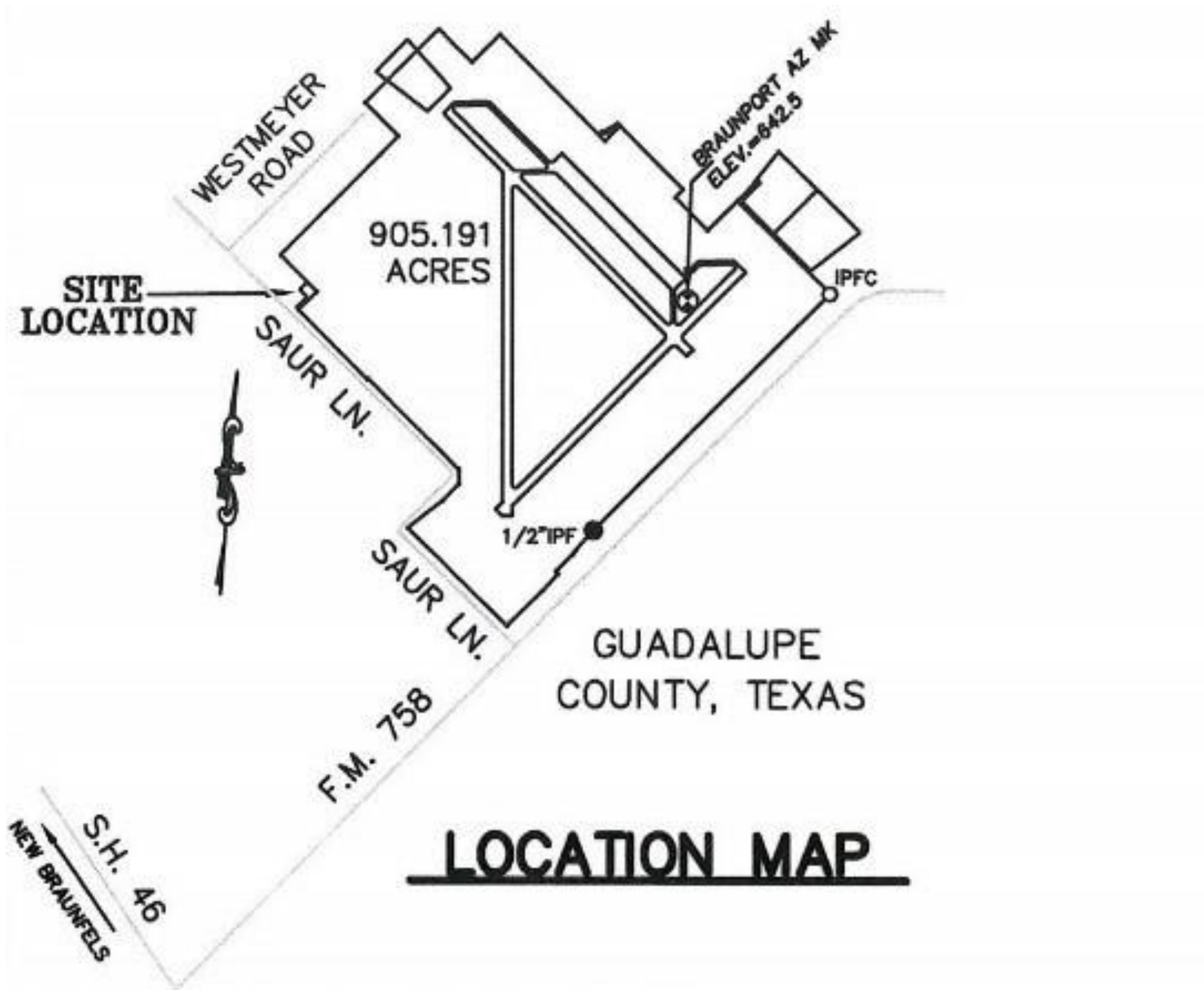


Figure 4-2: Location of NBU property

5. Data collection and analysis

5.1 Coring

Because a primary objective of this Project was to gather additional information on the stratigraphy and water quality of the brackish portion of the Edwards Aquifer, the Arcadis team recommended wireline coring in combination with a nearby monitoring well. Coring of the Edwards Aquifer in an area where there is little existing data provided valuable information, as described below.

The collected cores were logged and photographed, and selected samples were frozen and shipped to Mineralology, Inc. for analysis. The remaining cores were stored by NBU for later use in addressing questions about the storage formation and/or the recovered water.

5.1.1 Coring operations

A continuous wireline core hole was constructed on the NBU Property adjacent to the Airport. The purpose of the core hole was to confirm the lithology, geophysical and geochemical characteristics of the Edwards Aquifer at this location, the depth of which was previously estimated in an ASR feasibility assessment report for NBU (NBU, 2012). In response to concerns expressed by the EAA that the geology at this site may be different than previously expected due to the possible existence of a previously unknown buried fault in this area, it was decided to core the full depth from land surface to just below the top of the Glen Rose formation, which underlies the Edwards Aquifer. Actual formation depths were very close to those estimated in 2012, providing no indication of a newly-identified fault. The coring technical specifications are included in **Appendix B**.

Coring was conducted by Cascade Drilling under subcontract from Kutscher Drilling. Surface casing was set to a depth of 59 feet bgs. A continuous wireline HQ™ (2.5-inch) core was drilled to a total depth of 1,096.8 feet bgs. Temporary casing was set at the base of the Del Rio Clay at 540 feet bgs, reflecting concern that the clay may swell and inhibit subsequent coring operations. Coring was conducted seven days a week, starting on March 19, 2018, and was completed on April 5, 2018. GMA provided continuous resident observation by a hydrogeologist during all coring operations, as a subconsultant to ASR Systems.

Cores were obtained in 10-foot core runs, photographed immediately in one-foot intervals, marked as to top and bottom, and stored in wax-coated core boxes marked with the associated depth intervals. Overall core recovery was 94 percent. Twenty (20) selected core intervals, each one foot long, were stored in a freezer at the core site. Six of these frozen cores plus two unfrozen cores were subsequently sent to Mineralogy, Inc. for core lab analysis. The remaining frozen and unfrozen cores were transferred to storage at an NBU secure storage facility where they will be available if needed for supplemental inspection or lab analysis during the next few years.

Geophysical logs (gamma, caliper, resistivity) were obtained in the core hole in two logging runs, the first to 545 feet bgs prior to setting the temporary casing, and the second to the bottom of the core hole.

Several field measurements were made of water quality in the circulating water during core hole construction, generally reflecting the quality of water added from a nearby fire hydrant, but with some increase in conductivity with depth once the Edwards Aquifer was reached. Depth to static water level was measured at the beginning of operations on certain days. Upon completion of coring and data collection, the core hole was grouted back to land surface with neat cement grout, retrieving the temporary casing and surface casing. The location of the core hole was marked with a steel rod just below land surface and was subsequently surveyed, providing survey coordinates (29.704500°, -98.053611°), based on Geo Cam geophysical log records.

Appendix C contains a report by GMA entitled *"Aquifer Storage Recovery Coring Report, New Braunfels Utilities, New Braunfels, Texas,"* dated June 28, 2018. This report provides a complete summary of coring operations, including detailed lithology, geophysical logs, tops and bottoms of formations, core recovery percentages, intervals with apparent high porosity, and core intervals selected for further core lab analysis. A DVD file is included in the GMA report, and also in **Appendix E** of this report, with photos of the entire core, one foot per photo. Filenames on the photos denote the core depths, facilitating review of cores of specific interest. An electronic photo file was provided to NBU, the EAA and the TWDB.

Data from the coring operation was utilized to finalize the design of the adjacent monitor well, including: depth of 10-inch casing; borehole depth for the Upper Edwards; borehole depth for the Lower Edwards, and the setting depth for an inflatable packer opposite the Regional Dense Member (RDM) confining layer between the Upper and Lower Edwards aquifers.

5.1.2 Core lab analysis

Six frozen cores and two unfrozen cores from the Edwards Aquifer were sent to Mineralogy, Inc. for core lab analysis. Intervals were selected for core lab analysis based on evaluation of the cores and the geophysical logs. A detailed summary report from the laboratory, *"Core Lab Report"*, is provided in **Appendix D.** Lab analyses included the following:

- X-ray diffraction
- X-ray fluorescence
- Cation exchange capacity
- Acid insoluble residue
- Porosity
- Permeability
- Vertical hydraulic conductivity
- Grain density
- Thin section petrography
- Scanning electron microscope

The core lab results generally support the GMA lithologic analysis of the cores, and the geophysical logs, suggesting the presence of alternating bands of limestone and dolomite, with higher porosities up to about 25 percent to 50 percent, including both primary (intergranular) and secondary (solution features) in the dolomite intervals, and lower porosities in the limestone intervals, mostly primary porosity in the range of 3 percent to 20 percent. Overall average porosity is about 30 percent.

The RDM confining layer separating the Upper Edwards aquifer from the Lower Edwards aquifer should be an effective confining layer from about 710 to 734 feet bgs. Confinement is probably supplemented by limestone intervals with variable porosity but low productivity above the RDM (about 680 to 710 feet) and below the RDM (734 to about 740 feet). These intervals adjacent to the top and bottom of the RDM probably contribute to the effectiveness of the confining layer while also supplementing the storage volume available within the overlying and underlying aquifers, but do not contribute much to the yield of the Upper or Lower Edwards aquifers. ASR storage in the Upper Edwards aquifer would have excellent overlying confinement (200 feet to 545 feet bgs). ASR storage in the Lower Edwards aquifer, at such time as it may be implemented by NBU, would probably have excellent underlying confinement provided by the Walnut Clay from about 950 feet bgs to 1,046 feet bgs, underlain by the Glen Rose limestone, which is believed to be relatively unproductive locally and several hundred feet thick.

Storage of drinking water in ASR wells in brackish aquifers has been proven feasible for over 35 years. Many ASR wells are operating in brackish limestone and dolomite aquifers. Successful operation is often dependent upon whether these aquifers have adequate confinement, above and below. Successful ASR operations have been demonstrated in confined aquifers containing saline groundwater up to 20,000 mg/L TDS and seawater (TDS ≥ 35,000 mg/L).

5.2 Monitor well

A monitor well was drilled and constructed on the NBU Property, adjacent to the Airport. The primary purpose of the monitor well was to determine the groundwater quality in the Edwards Aquifer in the intervals above and below the RDM, and to potentially get a qualitative estimate of the potential productivity of those intervals. Monitor well technical specifications are provided in **Appendix B**.

5.2.1 Drilling and construction operations

Drilling was conducted by Kutscher Drilling. Drilling oversight and support was performed by INTERA. Starting April 23, 2018, a hole was started in the northwest corner of the property. The coordinates for the well reported on the driller log are 29.70475 N, -98.05339 E.

In the following paragraphs we discuss the drilling in three phases: above the Edwards Aquifer, in the Edwards Aquifer above the RDM, and in the Edwards Aquifer below the RDM.

Above the Edwards Aquifer

A 28-inch hole was drilled to 59 feet bgs and a 20-inch steel casing installed and cemented. A 7-3/8-inch hole was drilled to 545 feet bgs. During drilling, significant water was encountered in the gravels at about 200 feet bgs (estimated in the field between 50-100 gallons per minute (gpm), with TDS of approximately 500 mg/L), and caving of gravels occurred in the hole just below the surface casing due to the amount of water being produced. Kutscher Drilling placed a packer in the 7-3/8-inch hole at about 75 feet bgs, and filled the hole with concrete to about 30 feet bgs to seal off the gravels. A 19-inch bit was used to drill out the concrete in the surface casing region to 50 feet bgs, and then the 7-3/8-inch bit was used to drill the remainder of the concrete and clean the hole to 545 feet bgs.

EAA logged the hole and picked the top of the Georgetown formation at 533 feet bgs. A 15-inch bit was used to overream the hole to 545 feet bgs, and 10-inch SDR-17 PVC casing was set to 545 feet bgs and cemented using the tremie method in 100-foot lifts, with approximately two hours of wait time between lifts.

Edwards Aquifer: above the RDM

On May 18, 2018, a 6-3/4-inch bit was used to start drilling in the Edwards Aquifer at about 545 feet bgs. A strong odor of hydrogen sulfide (H_2S) was encountered at about 600 feet bgs, and significant water was produced from the formation at about that depth. Field estimates indicated about 9,700 mg/L TDS at that depth, and the water had a blackish-grey color.

Additional water was produced in the interval from 600 feet bgs to 660 feet bgs. Estimates of TDS ranged from 9,900 mg/L at 620 feet bgs to 8,600 mg/L TDS at 660 feet bgs. Drilling continued to 710 feet bgs near the top of the RDM, and the well was developed at about 500 gpm for about two hours. Logging and sampling of the Upper interval are described in Sections 5.2.2-5.2.4.

Edwards Aquifer: below the RDM

On May 25, 2018, a 6-3/4-inch bit was used to drill through the RDM into the Lower interval, with a desired total depth of 940 feet bgs. According to the driller, the well produced more water starting at 740 feet bgs. The produced water, which would be a combination of water from both the Upper and Lower intervals, was estimated at about 10,000 mg/L TDS. The driller noted additional water produced at 780 feet bgs, with an estimated TDS of produced water at about 9,900 mg/L. The driller noted additional water produced between from 790 to 820 feet bgs. Produced water continued to have an estimated TDS of 9,900 mg/L down to the total depth of 940 feet bgs.

The Lower interval was developed by air lifting for two to three hours, with a maximum estimated production rate during development of 800 gpm, based on timing the filling of the frac tank that was used for temporary storage. Geo Cam then ran a geophysical log to total depth.

An inflatable packer was set from 719-729 feet bgs, with a 4-inch steel pipe in the center. The packer was inflated successfully on June 11, 2018, about two weeks after the RDM was first drilled. The objective of the packer was to allow sampling of the Lower interval through the 4-inch steel pipe, isolated from the Upper interval. The pipe inlet was set just below the packer, and the packer inflated to 400 pounds per square inch (psi). Inspection of the core at this depth indicated that the RDM should provide a relatively smooth surface for creating a good packer seal. A 1.5 horsepower (hp) pump was set inside the 4-inch pipe for sampling of the Lower interval. Sampling of the Lower interval is described in Sections 5.2.3 and 5.2.4.

After the Lower interval sampling, the packer and the 4-inch pipe were removed, and the well was plugged back to 710 feet bgs. The purpose of the plugging was to complete the well as an Upper interval monitoring well. The 1.5 hp pump was set at 630 feet bgs, at the location of the primary producing interval, based on the spinner log.

5.2.2 Interval productivity

Although the primary goal of the monitoring well was to obtain water quality measurements from the Upper and Lower Edwards intervals, the well showed significant productivity in a relatively small diameter (6-3/4 inches) hole. To get a better estimate of where the productivity was occurring in the Upper interval, a spinner log was taken prior to drilling through the RDM. The spinner log was run by Geo Cam using a 50 hp pump at 300 gpm for about one hour. Prior to stabilizing the flow rate at 300 gpm, the pump produced 395 gpm, and the well drew down from 37 feet below datum to 180.5 feet below datum, for a specific capacity of about 2.8 gpm/foot.

Analysis of the spinner log results indicate that the primary producing feature in the Upper interval is near 630 feet bgs, but additional flow is found between 575 and 630 feet bgs.

No estimate is available for the productivity of the Lower interval, only that additional water was noted to be produced during drilling.

5.2.3 Groundwater quality sampling

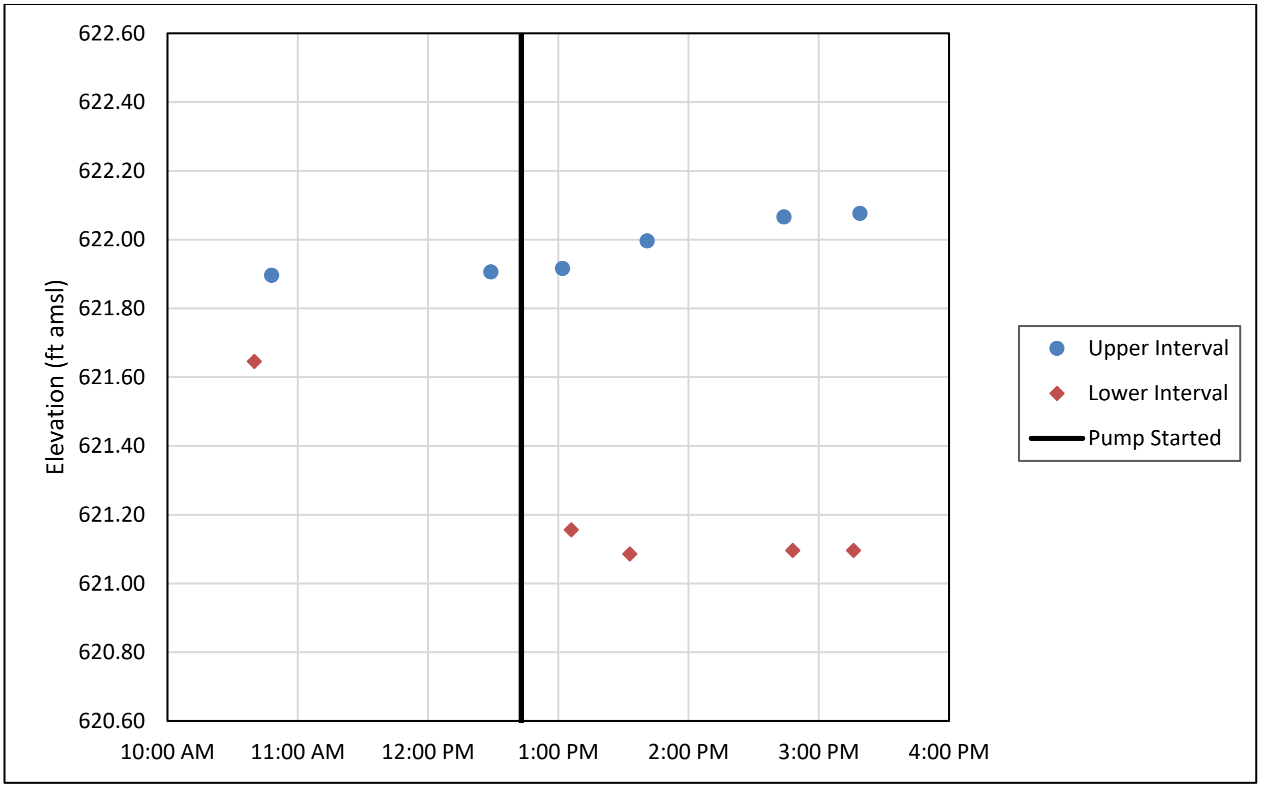
Water quality samples were collected by EAA and INTERA for analysis at a private laboratory. Four groundwater quality sampling events were performed at the monitor well. The first sampling event (Upper interval event #1) occurred in parallel with the spinner logging described in Section 5.2.2, at the end of the testing. The second sampling event (Lower interval event #1) took place after the inflatable packer was set, as described at the end of Section 5.2.1. Lab results from these first two sampling events contained inconsistencies (cation/ion balances were below acceptable standards), so both of the intervals were resampled. The Lower interval was resampled with the same packer configuration (the packer remained in place) and pump in the 4-inch pipe (Lower event #2). The Upper interval was resampled after the well was plugged back to 710 feet bgs (Upper event #2).

A detailed discussion of the groundwater quality is contained in Section 5.3.2.

5.2.4 Groundwater levels

Groundwater levels were measured periodically during the Lower interval sampling events when both the Upper and Lower intervals could be monitored simultaneously. One of the key questions is whether a vertical gradient exists between the Upper and Lower intervals (separated by the RDM). **Figure 5-1** shows the water levels measured in the Upper and Lower intervals during Lower interval sampling events #1 and #2. For both cases, the packer was inflated to 400 psi.

With ground surface surveyed at 652.26 feet (NAVD 88), measured static levels in both intervals ranged from 30 to 32 feet bgs over the course of the different sampling events. For both events, the water level in the Lower interval decreased under pumping conditions. For the first event, the water level decreased about 0.55 feet with an estimated pumping rate of 8.5 gpm. For the second event, the water level decreased about 0.75 feet with an estimated pumping rate of 10 gpm.



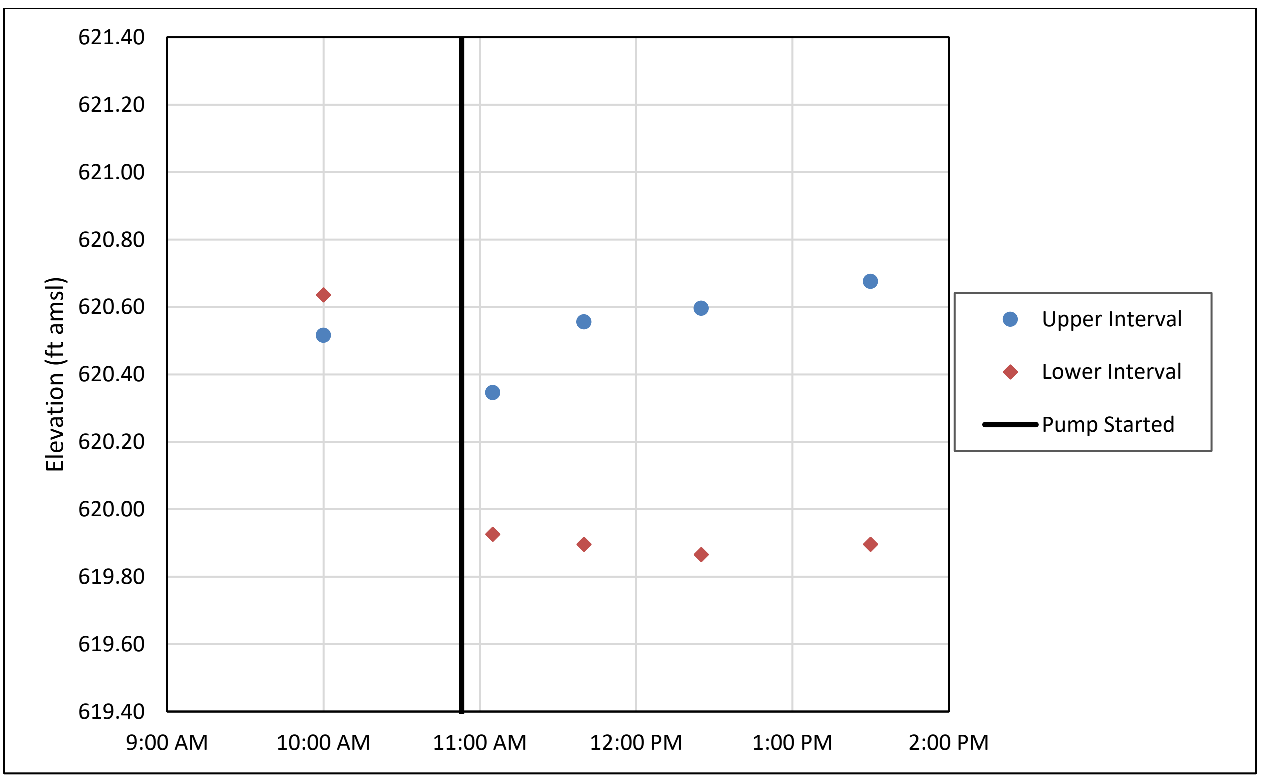


Figure 5-1: Water levels in the Upper and Lower intervals during water quality sampling events #1 (top) and #2 (bottom) of the Lower interval.

Figure 5-1 shows only a few inches of static head difference between the two intervals. For the first sampling event, starting heads in the Upper interval were measured at 3 inches above the Lower interval head using e-line. For the second sampling event, starting heads in the Upper interval were measured at 1.4 inches below the Lower interval head. Therefore, at this site, the gradient between the Upper and Lower intervals appears to be very small, and the direction of the gradient undetermined or possibly reversing with changes in overall water level. Because of the apparent lack of natural vertical gradient between the two intervals, under static storage conditions (when neither recharge nor recovery are occurring), there will be little or no forces trying to drive water across the RDM (either recharge water downward or native groundwater upward). Although these assumptions will need to be confirmed during later phases, it appears that an ASR storage "bubble" at the NBU Property should be vertically stable when no injection or production is occurring.

Of note in the finding of low vertical gradient across the RDM is a measurement of water level of 65 feet bgs (after stabilization overnight) taken during the coring operation, which is much lower than was measured in the monitor well. The coring operator indicated that they had just encountered water below the RDM, and thus the measurement could be representative of the Lower interval. One potential explanation for the higher static water level in the Lower interval in the monitor well compared to this one measurement during coring is a difference in density between the native groundwater in the Lower interval, and fresher water that may have been introduced during drilling, or due to a small downward natural gradient between the Upper and Lower intervals. However, we consider this to be unlikely due to the gradient being typically vertically upward across the RDM (even accounting for density differences) in other wells in the area, as discussed below.

For comparison to the NBU Airport location, in the "Girl Scout" and "Paradise" monitoring wells used by EAA closer to Comal Springs, the head difference between the Upper and Lower intervals is typically about 0.5 to 0.75 feet based on data from August 2017 through July 2018, with the Lower interval typically having a higher head than the Upper interval (EAA, 2018), meaning the gradient is upward.

At another location in the brackish Edwards Aquifer north-northeast along strike between Buda and Austin, a monitor well drilled for Barton Springs Edwards Aquifer Conservation District shows a difference between the heads in the Upper and Lower intervals (Upper minus Lower) ranging between -0.2 feet (Lower head above Upper head) and 1.6 feet (Upper head above Lower head). The head deeper in the Lower interval is typically higher, so the overall trend would be one of an upward gradient between the Lower and Upper intervals. Note that these heads were reported as equivalent fresh water heads, due to the difference in water quality between the Upper and Lower intervals.

5.3 Geochemical analysis

The purpose of conducting a geochemical analysis is to evaluate whether recharge of treated drinking water from production wells in the freshwater portion of the Edwards Aquifer, generally more than four miles away to the northwest, from treated surface water from the Guadalupe River, or a blend of water from the two different sources, might react with the water quality in the brackish portion of the Edwards Aquifer at the NBU ASR wellfield site, and/or react with the minerals in the aquifer at this site, causing geochemical issues that might adversely affect wellfield operations or recovered water quality. Such reactions might include such potential issues as mobilization of metals; precipitation reactions that may clog a well; solution reactions that could affect borehole stability; clay formation; clay swelling, or release of gases such as carbon dioxide or hydrogen sulfide.

The starting point for a geochemical analysis is to obtain representative samples of the recharge water quality and the native groundwater quality in the storage aquifer, plus lab and lithologic analysis of cores in the storage aquifer.

5.3.1 Recharge water quality

NBU provided a representative water quality lab analysis for water from the Guadalupe River, treated to drinking water standards. Constituents analyzed were those needed for a thorough geochemical analysis. This was supplemented by representative water quality records for the last four years for constituents monitored routinely during treatment plant and distribution system operations. NBU also provided comprehensive water quality data from Production Well #5, which produces water from the freshwater Edwards Aquifer. The characterization of potential recharge water quality was comprehensive and excellent. These data are provided in **Appendix J**.

5.3.2 Groundwater quality

As described in Section 5.2.3, a water quality sample was pumped from the NBU ASR monitor well upon completion of spinner logging, after the well had been pumped for at least two hours at approximately 300 gpm. At that time, the casing was set at 545 feet bgs and the borehole had been drilled to 710 feet bgs, so this was a sample of the Upper Edwards interval. Field measurements at the time of sampling, including four TDS measurements, showed results of about 10,000 mg/L, and a temperature of about 26ºC. The static water level was 30.5 feet below the wellhead, measured prior to spinner logging and after an overnight period for the water level to recover upon completion of drilling to 710 feet bgs the previous day.

A second sample was pumped from the well following final setting of the inflatable packer on June 11, 2018. The pumping rate was 8.5 gpm from a small sampling pump set just below the inflatable packer in a 6-7/8-inch borehole. At least two casing and borehole volumes were pumped from the Lower Edwards aquifer prior to sampling. Both field and laboratory measurements indicate that this Lower interval sample also contained about 10,000 mg/L TDS. Because of the potential for movement of water from the Upper to Lower intervals during drilling and after the hole was open prior to packer emplacement (Section 5.2.1), there is some uncertainty associated with the sample water quality. For other wells in the area, the TDS typically increases with depth, so if the Lower interval sample is affected by commingling from the Upper interval, the Lower interval would have a higher TDS than the measured 10,000 mg/L.

TestAmerica lab reports for the two sampling events, one for the Upper Edwards aquifer and one for the Lower Edwards aquifer are included in **Appendix G** and **Appendix H,** respectively. The two samples have similar water quality. However, the anion-cation balance for the Upper Edwards sample is off by 82 percent. Normally, this balance should be within five percent to support a reliable geochemical equilibrium model analysis. The lab analytical data from this first sample for the Upper Edwards is considered unreliable because the balance exceeds five percent. Unfortunately, the laboratory did not retain a sample volume for a repeat analysis.

A draft geochemical memorandum was prepared, pending repeat sampling of the Upper Edwards and Lower Edwards aquifers, to be conducted after the inflatable packer was removed and the borehole grouted up to the base of the Upper Edwards aquifer.

Repeat sampling of the Upper Edwards aquifer was conducted on September 13, 2018 after the inflatable packer was removed and the borehole grouted up to the base of the Upper Edwards aquifer. The monitor well was pumped until water quality stabilized prior to sampling. The resulting lab report from ALS Houston is also included in **Appendix G**. The anion-cation balance for this second laboratory analysis was within five percent.

5.3.3 Geochemical analysis – final technical memorandum

A geochemical equilibrium model analysis was conducted to evaluate whether recharge of treated drinking water from the NBU distribution system might cause any adverse geochemical reactions when mixed with the brackish water in the Edwards Aquifer at the NBU Property site, and the minerals in the aquifer. The geochemical analysis was based upon the Mineralogy, Inc. report (**Appendix D**) and the GMA Core Report (**Appendix C**), supplemented by the water quality data provided by NBU **(Table 5-1**).

As discussed above, water samples were pumped from the Upper Edwards aquifer at the adjacent monitor well when the open borehole was at 710 feet bgs. Subsequently a second sample was pumped from the Lower Edwards aquifer in the same monitor well but below an inflatable packer set at 720 feet, within the RDM confining layer. This sample data was compared to representative recharge water quality data provided by NBU. **Table 5-1** shows the input water quality data for the geochemical analysis. Results are included in a Geochemical Analysis Technical Memorandum (**Appendix F**).

Final conclusions in the initial analysis were severely constrained by the unreliability of the first water quality lab results for the Upper Edwards interval. For the geochemical analysis to proceed at this location, it was necessary to: remove the inflatable packer; plug back the monitor well with grout to about 710 feet bgs; and re-sample the Upper Edwards interval. The plugging activities were completed on or about August 31, 2018, essentially restoring the natural confinement that existed between the Upper Edwards and Lower Edwards aquifers. Repeat sampling of the Upper Edwards aquifer was conducted on September 13, 2018. The initial geochemical analysis was then updated to reflect the water quality data from the second sample from the Upper Edwards aquifer.

The final geochemical analysis using reliable water quality data is attached as **Appendix F**. It suggests a low likelihood of adverse geochemical interactions, including issues such as mobilization of arsenic. The relatively low pH of the Edwards Aquifer at this site suggests the possible occurrence of elevated concentrations of carbon dioxide (CO_2), although this constituent was not measured at the initial sampling. If present, release of CO_2 during ASR recovery is a possibility; however, this would tend to be a transitional issue and would steadily decline with successive cycles and with initial formation and maintenance of a buffer zone around the ASR well.

In the next phase of the NBU ASR program, a new Lower Edwards monitor well, probably cased to about 740 feet bgs and open hole to about 940 feet bgs, will be constructed and tested for water quality. The geochemical equilibrium model analysis can then be updated again.

Table 5-1: Geochemical analysis – water quality input data

New Braunfels Utilities, Texas
Aquifer Storage Recovery Program
Prepared by ASR Systems, NBU, Arcadis June 27, 2018

		Recharge Water Quality (See Note 3)			Aquifer Water Quality	
Constituent	**Unit**	**Well 5 on 12-16-14**	**Edwards Aquifer (Well 5)(2)**	**Treated Surface Water (WTP)**	**Upper Edwards Aquifer**	**Lower Edwards Aquifer (1)**
Field Measurements						
pH		7.76	7.55	7.91	6.66 (lab)	
Specific Conductivity	µmhos/cm	544			14,500	
Temperature	°C	22.7		10 to 25		
Turbidity	NTU		0.22			
Dissolved Oxygen	mg/l					
Total Alkalinity	mg/l	188	244 (217)	174 (164)	269	
Total Dissolved Solids	mg/l		359	262	8,490	
Color	PCU					
Eh	mv					
Hydrogen Sulfide	mg/l				present	
Lab Measurements						
Chloride	mg/l		19 (23.8)	30 (25.1)	1,220	
Fluoride	mg/l		0.25 (0.63)	0.23	3.04	
Sulfate	mg/l		31 (51.2)	30 (30.1)	691	
Carbonate Alkalinity	mg/l		<10	<10	<5	
Bicarbonate Alkalinity	mg/l		244	174	269	
Silica (SiO_2)	mg/l		12.3	11.7	12.4	
Calcium	mg/l		84.8	56.2	762	
Magnesium	mg/l		16.7	17.3	358	
Sodium	mg/l		11.3 (8.6)	12.6 (7.5)	1,370	
Potassium	mg/l		1.46	2.19	66.1	
Iron, Total	mg/l		<0.01	<0.01	<101 (ug/l)	
Iron, Dissolved	mg/l		<0.01	<0.01	<101 (ug/l)	
Aluminum	mg/l		<0.01	0.18	<50 (ug/l)	
Copper	mg/l		0.006	0.1	<2.0 (ug/l)	
Manganese, Total	mg/l		<0.01	<0.01	<11.6 (ug/l)	
Manganese, Dissolved	mg/l		<0.01	<0.01	<11.6 (ug/l)	
Zinc	mg/l		0.046	<0.01	<3.55 (ug/l)	
Cadmium	mg/l		<0.005	<0.005	<0.854 (ug/l)	
Selenium	mg/l		<0.01	<0.01	<1.08 (ug/l)	
Nitrate	mg/l		1.9	0.7	<20.6	
Phosphorus, Total as P	mg/l		<0.1	<0.1	<0.04	
Phosphorus, Orthophosphate as P	mg/l		<0.2	<0.2	0.234	
Ammonia	mg/l		<0.1	0.7	3.94	
Total Kjeldahl Nitrogen	mg/l		1	2	4.81	
Total Organic Carbon	mg/l		<1	2.59	1.25	
Dissolved Organic Carbon	mg/l		<1	2.54	<.285	
Arsenic	µg/l				4.34 (ug/l)	
Strontium	µg/l				17 (ug/l)	
Dissolved Inorganic Carbon	mg/l				84.7	
Calcium Hardness as CaCO3	mg/l		205	144		
Chlorine	mg/l		3.17			

Notes:

(1) Lab Results for Lower Edwards are pending as of 6/27/18

(2) Well 5 is at Landa Park, with a ground storage reservoir. This is Point of Entry (POE) #5

samples collected June 6, 2018.

(4) Yellow highlight constituents in Column A are those for which no data is currently available regarding recharge water quality

To ensure no cross-formational leakage across the RDM during subsequent ASR operations, the inflatable packer was removed, and the well was plugged back to about 710 feet bgs. These actions were completed on or about August 31, 2018. essentially restoring the natural confinement that existed between the Upper Edwards and Lower Edwards aquifers.

In the next phase of the NBU ASR program, a new Lower Edwards monitor well, probably cased to about 750 feet bgs and open hole to about 940 feet bgs, will be constructed and tested for water quality. A monitor well that is isolated to the Lower Edwards will resolve any remaining uncertainty (Section 5.3.2) regarding the representativeness of the water quality samples taken from the Lower interval.

Despite the issues with the laboratory analysis, the preliminary analysis discussed in **Appendix F** suggests a low likelihood of adverse geochemical interactions, including issues such as mobilization of arsenic. The relatively low pH of the Edwards Aquifer at this site suggests the possible occurrence of elevated concentrations of carbon dioxide (CO_2), although this constituent was not measured at the initial sampling. If present, release of CO_2 during ASR recovery is a possibility; however, this would tend to be a transitional issue and would steadily decline with successive cycles and with initial formation and maintenance of a buffer zone around the ASR well.

6. Preliminary design technical memorandum

The data collected in previous tasks and preliminary design criteria, taken together, provide a basis of design for proposed ASR facilities to be constructed during a third phase of the NBU ASR program. The first phase was an ASR Feasibility Assessment (NBU, 2012). The second phase was summarized in this report, including construction and testing of a core hole and a monitor well. The third phase will include permitting and design of an initial ASR well and wellhead facilities, and associated monitor wells. Subsequent phases would include construction and cycle testing of an initial ASR demonstration well. The preliminary design criteria include location of wells; ASR and monitor well design; confinement; static water level; recharge and recovery flow rates; radial extent of stored water; wellfield analytical and hydrogeologic modeling; wellfield facilities design; interim recharge; pump test and backflush water disposal; provisions for potential future wellfield expansion, and project delivery.

This Preliminary Design Technical Memorandum (PDTM) provides the information typically provided in a 30 percent preliminary engineering report, with the exception of conceptual drawings and supporting calculations.

6.1 Location of wells

Two monitor wells and the first ASR well will be located on the NBU Property, adjacent to the Airport.

The Upper Edwards monitor well was constructed as part of this Project. Upon completion of that monitoring well, the inflatable packer at 720 feet bgs was removed and the well was plugged from the bottom at 940 feet bgs to a depth of 710 feet bgs, at the top of the RDM that separates the Upper Edwards aquifer from the Lower Edwards aquifer.

The second monitoring well, a Lower Edwards well, will be constructed at least 100 feet from the Upper Edwards monitor well and at least 100 feet from the core hole location. It should also be located at least 100 feet from any Lower Edwards ASR well that might be constructed at this location and at least 70 feet from any Upper Edwards ASR well. The separation distances are intended to minimize the potential for downhole collision between adjacent wells because wells are not always drilled straight and plumb.

The Lower Edwards monitor well will provide reliable measurements of water level and water quality for this potential ASR storage interval and would also enable monitoring of any changes in water level or water quality associated with ASR operations in the Upper Edwards aquifer.

An alternative option for NBU would be to construct a larger diameter monitoring well in the Lower Edwards aquifer that could be tested for water quality and for hydraulic characteristics; equipped initially as a monitoring well, and later equipped as an ASR well. This would increase initial well construction cost but would expedite subsequent equipping of the well and placing it into service, with the potential to double the ASR recovery yield of the site.

Pursuant to terms of the ILA, at least one new monitoring well will be needed. This monitoring well may be a dual-completion well. The primary purpose of such a monitor well will be to monitor remote water level effects resulting from ASR operations. Exact location remains to be determined, however it should be at sufficient distance from the ASR wellfield so that it is beyond the expected radial extent of the stored drinking water, and between the wellfield and

Comal Springs, which is about five miles to the north-northwest. A distance from the center of the planned ASR wellfield of at least 1,000 feet is recommended. A location south of IH-35 is most likely.

NBU's first ASR well will also be constructed near the eastern corner of the NBU Property, probably about 15 feet from each side of the Airport property line. The exact location remains to be determined. This ASR well would be in the Upper Edwards aquifer. As mentioned above, provision should be allowed for a possible future Lower Edwards ASR well to be located at least 70 feet away from the Upper Edwards ASR well, along the southeast side of the property. Alternatively, this could be the "larger diameter monitoring well" in the Lower Edwards aquifer, referenced above.

6.2 Monitor well design

The monitor wells would be designed to maintain whatever confinement exists between the Upper Edwards and the Lower Edwards aquifers. Such confinement is provided primarily by the RDM which, at the NBU Property, extends from 710 to 734 feet bgs and may be supplemented by overlying and underlying semi-confining layers that may extend from about 680 feet to about 740 feet bgs. These "aquitards" provide some porosity and increased yield but are probably not highly productive intervals, based on well driller observations regarding produced water flows during well construction, supplemented by geophysical logs, including a spinner log for the Upper Edwards aquifer.

Subject to EAA approval, the dual-completion monitor well required in the ILA would be designed as follows:

- The initial step involves setting and grouting a nominal 18-inch surface casing to the base of the surficial deposits at a depth of approximately 75 feet bgs. A nominal 18-inch borehole would be drilled to just below the top of the Person Formation, which, at the NBU Property is at a depth of 583 feet bgs, and a 12-inch ID SDR-17 PVC well casing would be grouted to land surface.
- The Georgetown Formation overlying the Person Formation would be cased out because the Georgetown was found to be non-productive in the monitor well constructed for this Project. The subsequent preliminary geochemical analysis suggested that the Georgetown Formation may also be a primary source for the H_2S evident in the Upper Edwards aquifer.
- The casing would be grouted in a series of lifts, not exceeding 200 feet each, separated by sufficient time to manage heat of hydration which weakens PVC. The first lift would utilize the positive displacement method, as required by EAA well construction regulations, to raise the grout level outside the casing to just above 500 feet bgs. Subsequent lifts would utilize a tremie line to raise the grout level to land surface.
- A nominal 12-inch borehole would then be extended to the base of the Lower Edwards producing interval which, at the NBU Property, is at about 940 feet bgs. A nominal 5-inch ID SDR-17 PVC casing would be set to about 760 feet, with 200 feet of slotted PVC or SS304 well screen to 940 feet bgs. A gravel formation pack will be provided from the base of the borehole up to 750 feet bgs, overlain by a thin layer of sand and a bentonite seal. The annular space would then be grouted with sulfate-resistent neat

cement grout up to about 710 feet bgs using a tremie line. A sampling pump and water level transducer would be set in each monitoring interval.

An alternative design for the ILA-required monitoring well would be to construct a separate smaller monitor well in each aquifer. This would eliminate any potential for internal flow between aquifers during or after the construction period, providing higher confidence in the reliability of the resulting water level and water quality data. A separation distance between the two monitor wells of at least 70 feet would be appropriate. As expected, the site area required for two adjacent monitor wells would be greater than for a single dual-completion well open to both intervals. The choice between a dual-completion or "two-well" design would be based on discussions with NBU, EAA, and on preliminary cost estimates from drillers. It is possible that construction of two separate monitor wells would be less complex and less expensive than construction of a single, dual-completion monitor well.

According to the ILA, up to five monitor wells may be required for the NBU ASR program, primarily between the wellfield at the Airport and Comal Springs. The purpose of these wells is to gather data, ensuring that ASR wellfield operations have no adverse impact upon Comal Springs flow rates or water quality. With five miles separation distance between the Airport and Comal Springs, and three known faults in between, no hydraulic or water quality impact is anticipated. It will be important to provide one or more monitor wells near the expected edge of the subsurface storage bubble in the Upper Edwards aquifer, but it may take a few years for stored water to reach that radius. For preliminary planning purposes, a radius of at least 1,000 feet is suggested.

6.3 Confinement

Two core sections from the RDM were analyzed for vertical hydraulic conductivity, as described in the Mineralogy, Inc. core lab report provided in **Appendix D**. Results are shown in **Table 6-1**.

Table 6-1: Results of core permeability testing

Core Depth (ft)	Length (cm)	Intrinsic Permeability (md)
724.8 to 725.8	13.04	0.0028
729.2 to 730.3	16.02	0.0109

A common unit of measurement of intrinsic permeability is "millidarcy's" (md). The average of the two values is 0.0068 md. For hydrologic applications, values may range from 0.001 to 0.0001 md for relatively impermeable materials such as granite and unweathered clay, to 10^7 to 10^8 md for permeable materials such as well-sorted gravel and highly-fractured rocks. Intrinsic permeability can also be expressed in terms of "length squared," such as m^2, cm^2 or ft^2. One millidarcy is equal to 9.87×10^{-12} cm^2, so the average of the two samples is 6.7×10^{-14} cm^2.

These lab results can be utilized to develop a very preliminary estimate of the number of days that a given head differential across the RDM confining layer and adjacent potential overlying and underlying semi-confining layers would theoretically be required for brackish water to move upward through the confining layer under the head differential induced by pumping the Upper Edwards aquifer.

A more thorough assessment of this theoretical travel time for brackish water to move upward through the RDM confining layer can be calculated later based on results from a long-term, high flow-rate pumping test of the Upper Edwards aquifer, typically more than 48 hours' duration, with monitoring of water level response in one or more storage zone monitor wells. Leakance of the confining layers can be calculated from the observed monitor well water level response. For the Upper Edwards aquifer, it can be safely assumed that virtually all leakance would be from below, through the RDM.

Based on water availability analysis in the Phase 1 feasibility study, NBU would need to recover water from ASR storage for up to 210 days, which is the likely maximum duration of ASR continuous recovery during a repeat of the DOR. Even during a repeat of the DOR, there would be opportunities for aquifer recharge.

Ultimately, actual ASR operating performance at the initial ASR well during an extended summer recovery period will provide an improved basis for confirming or revising earlier leakance estimates. If there are any local faults or joints in the RDM, particularly within the immediate vicinity of the ASR wellfield and surrounding area where water is stored, a short circuit through the confining layer may potentially occur.

To the extent that upconing of brackish water becomes a greater challenge than expected, several options are available. Reduced individual well pumping rates during ASR recovery would reduce the head differential across the Lower confining layer, extending the duration of the ASR recovery period. Use of horizontal directionally-drilled (HDD) ASR wells would reduce the head differential while increasing the production rate from individual ASR wells. With HDD wells, the number of well sites would be reduced. Alternatively, the Lower Edwards aquifer could also be utilized to support or supplement ASR operations, in addition to the Upper Edwards aquifer. Any upconing that occurs during an extended ASR recovery period from the Upper Edwards aquifer would then be with fresh water from the Lower Edwards, not brackish water. If actual leakance is much higher than expected, ASR operations in the Upper Edwards aquifer would tend to gradually freshen water at the top of the Lower Edwards aquifer.

To use Darcy's law to estimate the velocity of vertical upward water movement through the RDM, we need to estimate hydraulic conductivity from intrinsic permeability. Hydraulic conductivity is a property of both the porous media and the fluid that is flowing through it. Intrinsic permeability is a property of just the porous media.

The equation for calculating hydraulic conductivity (K) from intrinsic permeability is:

$$K = \frac{k\rho g}{\mu} \qquad \text{Equation 1}$$

Where k is intrinsic permeability, g is the acceleration of gravity, ρ is the density of water, and μ is the absolute viscosity of water.

The viscosity of water varies with temperature and pressure, being more viscous at lower temperatures. ASR recharge will most likely occur primarily during fall and winter months. The ambient groundwater in the Upper Edwards aquifer is warm (26^{o}C), but the recharge water average temperature is assumed to be about 10^{o}C. Aquifers tend to have excellent thermal storage properties, so the water recovered from ASR storage during summer months will most likely be cool, approximately 10^{o}C. Viscosity changes due to pressure variation are less pronounced for the expected range of operating pressures. The viscosity of the water is likely to be about 1.306 centipoise (cP). Given a density of water of about 1.0 g/cm^3 at that temperature and an intrinsic permeability of 6.7x10^{-14} cm^2 the corresponding hydraulic conductivity from Equation 1 would be 1.4x10^{-5} ft/d.

Darcy's equation is utilized to calculate the estimated darcy velocity of vertical upward water movement through the RDM confining layer during an ASR recovery period:

$$v = \frac{K\Delta h}{b} \qquad \text{Equation 2}$$

where:

v = darcy velocity through the confining layer (ft/d)

K = vertical hydraulic conductivity (ft/d)

Δh = head differential across the confining layer (feet)

b = thickness of the confining layer (feet)

A very preliminary estimate of maximum head differential across the confining layer is 200 feet, induced by pumping the ASR well at an assumed flow rate of 700 gpm. This maximum head differential would be at the base of the well, where upconing potential from the Lower Edwards aquifer would be the greatest, diminishing rapidly with increasing radial distance from the well. The thickness of the confining layer is at least 24 feet (the thickness of the RDM) and probably effectively somewhat more than that, considering overlying and underlying semi-confining layers. A conservative assumption for current purposes is 24 feet, relying only on the RDM. Given the pumping head differential of 200 feet, the estimated darcy velocity would be 1.2x10^{-4} ft/d. With a conservatively-high estimated porosity of 0.1 based on the Mineralogy, Inc. core lab analysis, the interstitial velocity would be 1.2x10^{-3} ft/d.

During a seven-month ASR recovery period, water movement through the confining layer would theoretically be 0.25 feet, which is insignificant. Analysis of the two cores from the RDM for vertical hydraulic conductivity suggests that the RDM may provide an effective lower confining layer for ASR operations in the Upper Edwards aquifer. Hydraulic conductivity estimates in the lab and in the field are known to be scale-dependent, so this estimate of water movement through the confining layer needs to be confirmed through a long-term, high rate pumping test, and by operational performance during summer peak recovery periods.

6.4 ASR well design

The Upper Edwards ASR well would be constructed as follows:

- The first step would be to set a 30-inch diameter, carbon steel surface casing to a depth of 75 feet bgs, installed inside a 36-inch borehole. A nominal 29-inch hole would be drilled to a depth of 586 feet bgs (just below the top of the Person Formation) and 24-inch OD (21-inch ID) PVC SDR-17 Certa-Lok well casing would be set and grouted to land surface in stages not exceeding 200 feet, thereby managing heat of hydration. The first stage of grouting would utilize the positive displacement method to bring the grout up to just above 500 feet bgs. The remaining stages would be placed using a tremie pipe in the annular space between the well casing and the borehole wall, raising the tremie pipe steadily as the grout level rises. Sufficient time would be provided between stages for the grout to set and for the heat of hydration to be managed. Typically, this is about 12 to 24 hours between stages. A mechanical integrity test would then be conducted, before drilling out the cement plug at the bottom of the casing. A plumbness and alignment test would also be conducted. A video log would then be conducted to confirm that no "egging" of the PVC casing has occurred due to heat of hydration. The borehole would then be drilled out to a depth of 710 feet bgs.

- A stainless steel 1.5-inch external water level measuring tube would be installed along with the casing in the annulus, re-entering the casing just above the bottom via a fabricated, stainless steel fitting. At the wellhead the tube would be oriented so that it does not interfere with planned final orientation of the wellhead piping.
- If NBU elects to construct a Lower Edwards ASR well and equip it initially as a monitor well, the well design and construction would be similar, but the casing and hole depths would be greater, similar to those for the Lower Edwards monitor well.

6.5 Static water level

For the Upper Edwards aquifer, the static water level in the monitoring well was at 37 feet below the wellhead flange. This was measured during well construction with the well casing set at 545 feet bgs and the borehole at 710 feet bgs, during the spinner logging and prior to drilling through the RDM.

The monitor well was subsequently deepened to 940 feet bgs and an inflatable packer set between the Upper and Lower Edwards aquifers. Water levels measured above and below the packer are typically slightly different, higher or lower, but within about one foot of each other. This may possibly reflect a buoyancy effect because the Upper Edwards aquifer and Lower Edwards aquifer were interconnected for about two weeks during construction and prior to setting the packer, potentially allowing flow of water down the borehole, displacing more saline water in the Lower Edwards aquifer and causing water levels to increase. This has been observed at other ASR wells in brackish or saline aquifers.

During construction of the adjacent core hole, a static water level was measured when the core hole had been drilled to 766 feet bgs. After allowing water levels to stabilize overnight, the depth to static water level was 65 feet.

6.6 Recharge and recovery flow rates

For the NBU monitor well constructed as part of this Project, produced water flow rates during reverse air well construction were estimated at about 500 gpm in the Upper Edwards, increasing to about 800 gpm during drilling through the Lower Edwards. This is a rather substantial flow rate for a 6-7/8-inch open borehole. During a spinner logging and sampling event in the Upper Edwards, the well was pumped at about 300 gpm and the specific capacity was measured at 2.8 gpm/foot of drawdown. With a much larger borehole diameter (21 inches) a significantly higher production rate is anticipated from this aquifer. For preliminary planning purposes it is tentatively assumed that the borehole yield would be 700 gpm with up to 200 feet of drawdown. This implies a recovery specific capacity of 3.5 gpm/foot, or higher. Pump testing of the ASR well following completion of well construction will be needed prior to finalizing the hydraulic design of the pump and confirming the motor horsepower requirements.

The design recharge flow rate will also need to be confirmed through initial ASR operations. Based upon experience at other karst limestone and dolomitic brackish aquifers, recharge specific capacity in such aquifers is typically about 80 percent to 100 percent of the recovery specific capacity. Recharge pressure within the well casing as measured at the wellhead flange would most likely be limited to not exceed 30 psi (70 feet) for a variety of design and practical operational reasons. Assuming a depth to static water level of about 37 feet, total available recharge head would be 107 feet, or perhaps slightly greater. Assuming a recharge specific capacity of 3.0 gpm/foot, the design recharge rate would be about 300 to 350 gpm (0.5 mgd).

From the 2012 ASR feasibility study, the planned recharge rate was 4.0 mgd and the planned recovery rate was 9.0 mgd for the entire ASR wellfield. With the preliminary assumptions discussed above regarding individual well recharge and recovery rates, eight ASR wells would be needed to achieve recharge goals while nine ASR wells would be needed to achieve recovery flow rate goals. Providing firm capacity with one well assumed to be out of service under design conditions, a total of ten ASR wells would be needed. After the first ASR well has been constructed, tested and placed into operation, the overall ASR program plan should be updated to match NBU's evolving needs, constraints and opportunities, thereby ensuring water supply adequacy and reliability during a severe drought.

6.7 Radial extent of stored water

Porosity of the full thickness of the Edwards aquifer has been investigated through geophysical logging, including neutron and sonic porosity logs. For the Upper Edwards aquifer, dolomitic bands of high porosity, typically between 25 percent and 50 percent, were interspersed with limestone bands of lower porosity, typically between 3 percent and 20 percent. Geophysical logs are included in **Appendix K**. Based upon spinner log results in the Upper Edwards aquifer, supplemented by well driller observations regarding produced water flows, production is primarily from 580 to 650 feet bgs, with a small supplemental contribution between 650 and 710 feet bgs. Accordingly, it appears likely that most of the recharge and recovery flows will occur in the middle to lower portions of the storage interval, but porosity storage may extend through the full aquifer thickness.

Porosity was also determined for the eight cores sent to Mineralogy, Inc. for core lab analysis, as presented in **Appendix D**. Porosity for cores from producing intervals ranges from 24 percent to 35 percent.

For preliminary planning purposes, a bulk porosity for the Upper Edwards is estimated to be about 30 percent, extending over an aquifer thickness of about 130 feet. Nine ASR wells, each recovering water during a drought at one MGD per well for 210 days, would recover a total of 1,890 MG or 5,800 AF. This is the Recovered Water Volume. The Buffer Zone that will be required in this brackish aquifer is estimated at the same volume. A Buffer Zone is required around the ASR wellfield so that the recovered water is fresh, not brackish. The Target Storage Volume (TSV) is the sum of the Recovered Water Volume, and the Buffer Zone Volume. For nine ASR wells the TSV is estimated to be 11,600 AF. The associated "bubble" radius of the stored water is about 2,031 feet. This would be the theoretical radius from the center of the wellfield, assuming uniform porosity and permeability in the aquifer. If both the Upper Edwards and Lower Edwards aquifers were developed for ASR storage, the radius would be less.

The stored water would tend to extend further in the dolomitic layers within the storage aquifer, which would have higher productivity, and less distance in the limestone layers which are less productive but provide considerable storage volume. Considering the multiple uncertainties at this early phase of ASR wellfield development, it seems appropriate to assume that the radial extent of the ASR storage volume might extend to a radius of 2,500 feet from the center of the 10-well wellfield.

For the first ASR demonstration well, the corresponding TSV would be about 1,289 AF. The associated theoretical bubble radius would be 677 feet.

Whether for the initial ASR demonstration well or the entire wellfield, the “bubble” may actually become slightly oval-shaped, oriented downgradient to the southeast, to the extent that the aquifer experiences natural groundwater flow as a result of a regional gradient. For deep, confined ASR storage aquifers the lateral groundwater movement is typically quite slow, on the order of a few feet per year, and is not a significant constraint upon long-term ASR operations. For NBU, results of planned pump testing at the initial ASR well will provide initial data useful for estimating the lateral groundwater flow rate due to the regional gradient.

An offsite monitor well, constructed pursuant to the ILA agreement, should be located at least 1,000 feet from the initial ASR well site. This well would be appropriate for monitoring water levels and water quality beyond the range of influence of the demonstration well. Such a monitor well location would become quite useful for operational monitoring purposes as the wellfield expands and the stored water bubble expands beyond the second monitor well during recharge periods and contracts during recovery periods.

6.8 Wellfield analytical and hydrogeologic modeling

A wellfield analytical model will be developed during or after construction of the demonstration ASR well, based upon aquifer and well hydraulic characteristics determined from a baseline pumping test of the well. This would provide a preliminary estimate of theoretical distance-drawdown effects associated with ASR operations during recharge and during recovery. To develop such an analytical model, it will be necessary to construct and test an ASR well and at least one more monitor well in the NBU ASR wellfield area, obtaining basic information on well and aquifer hydraulic properties. Those properties include well yield, specific capacity, specific injectivity, transmissivity, storativity and leakance. Such information is not available for the confined, brackish portion of the Edwards Aquifer.

Development of a hydrogeologic model for the wellfield area would be appropriate at such time as initial wellfield facilities have been constructed, tested and operated for at least several months to a year. Such a hydrogeologic model would provide an improved basis of design for the ASR wellfield expansion to its planned capacity, whether nine mgd or some other target established to meet NBU’s evolving needs. Operating performance of the first ASR well, and construction and testing of additional ASR wells, will provide the opportunity for model development and enhancement. Water level and water quality response at monitor wells, and at the ASR wells will provide data to support model refinement. Water level response in this confined aquifer will reflect changing well interference, mounding and buoyancy during both recharge and recovery.

6.9 Wellhead facilities design

Engineering design of wellhead and well equipping facilities for the initial ASR well and monitor wells, and early tasks in the NBU procurement process, can proceed in parallel with permitting of the demonstration ASR well. Flexibility will be incorporated into the engineering plans and specifications, and the associated bid documents to accommodate a reasonable range of possible flow rates, water levels and hydraulic performance. Upon completion of well construction and testing, final detailed design adjustments relating to pump selection and performance, motor horsepower requirement, and required electrical capacity, can be evaluated as part of the contractor's shop drawing review and approval process. Adjustments to operational control systems and associated telemetry are typically made during startup and initial cycle testing.

Well, wellhead and well equipping facilities will be designed at one time for a single procurement process. However, the bid documents may be presented in two parts: (i) well construction; and (ii) wellhead facilities construction. If selected as a single bid package, bidders may select the parts that they wish to bid on, as part of a team. Alternatively, NBU may elect to bid the project through multiple, separate bid packages such as well construction, wellhead facilities construction, and instrumentation and control.

Facilities required for interim recharge will be part of the wellhead facilities construction bid package as an early deliverable. Recharge could commence as soon as the ASR demonstration well construction and pump testing have been completed and could continue until the permanent pump has been installed and the well is ready to start cycle testing. That period is typically several months. Interim recharge facilities would most likely include some of the permanent wellhead piping, valves, fittings and wellhead flange that are typically readily available with a short lead time for delivery. If water is available for recharge during this period, a considerable volume may be stored, although the recharge flow rate may be restricted. Because there will be no pump in the well during interim recharge, there is no way to backflush to waste and thereby control any well clogging.

Wellhead facilities would include the following principal components:

- Pump
- Motor
- Variable frequency drive (VFD)
- Sealed wellhead flange
- Power supply
- Bidirectional magnetic flowmeter
- Air/vacuum relief valves
- Downhole flow control to prevent cascading during recharge, if necessary
- Wellhead piping and fittings, including strainer, sampling taps, pressure gages, water level transducer, etc.
- Side-port recharge inlet at wellhead flange
- Trickle flow of water during extended no-flow periods
- Discharge to waste
- Re-disinfection
- Lightning protection
- Instrumentation and control, and telemetry
- Wellhouse building

- Access road, fencing, lighting, drainage, security provisions, as necessary
- Emergency backup generator, if desired by NBU

The facilities to be designed may also include a degasification facility and repump station. These facilities may or may not be required pending further evaluation of whether or not CO_2 is present at elevated concentrations in the water recovered from ASR storage. If present, concentrations are expected to decline with time as the native groundwater is displaced radially by the stored drinking water. Future sampling of the Upper Edwards aquifer and subsequent update of the previous preliminary geochemical analysis is planned to address this issue. If the water sampling and geochemical analysis update indicate that CO_2 could be a significant issue, then provision for these facilities will be added to the design.

6.10 Interim recharge

As discussed above, ASR recharge can begin as soon as the ASR well is constructed and tested. Interim recharge can continue during the period when the well is being equipped and wellhead facilities are being constructed. This duration may be several months, during which time a substantial volume of drinking water can be stored, assuming such water is available for recharge. No pump is set in the well, so backflushing cannot be conducted. As a result, average recharge flow rate may be less than expected for subsequent permanent operations. Temporary facilities may be utilized, usually incorporating some of the permanent wellhead piping, valves and fittings.

For example, if the initial ASR well is constructed and tested by September 2019, and interim recharge starts in October 2019, the well will be equipped and ready for ASR recovery operations beginning in the summer of 2020. During a period of six or seven months, NBU may have stored approximately 100 MG (307 AF). Half of this volume may be considered a contribution toward formation of a Buffer Zone for this well, separating the stored drinking water from the surrounding brackish groundwater. The remaining 50 MG would be available for recovery during 2020 to help meet peak demands. Assuming an ASR well production rate of one mgd, this would supplement peak water supplies by one mgd for 50 days. During the next year, the buffer zone volume and associated recovery duration would be increased, enabling recovery at one mgd for a longer period of time. Under the EAA's Rules and the ILA, the water stored in ASR wells is not subject to regulatory restrictions during a severe drought.

6.11 Pump test and backflush water disposal

Upon completion of well construction, pump tests will be conducted to determine well yield, specific capacity, well efficiency and aquifer hydraulic characteristics such as transmissivity, storativity and leakance. During these tests, the produced water will be brackish and will need to be discharged to waste without causing adverse environmental effects.

After being equipped with a pump, motor and associated wellhead facilities and placed into operation, the initial ASR well, and any future ASR wells, will require periodic backflushing to waste to reverse well clogging. Backflushing will purge the well of any accumulated particulates. If clogging is due to microbial activity in the well bore or adjacent aquifer, or due to subsurface geochemical reactions, other procedures will need to be implemented to rehabilitate the well. Such other procedures will also require disposal of water. Backflush frequency remains to be determined through operating experience, however a reasonable assumption for initial planning purposes for an open borehole in a confined, dolomitic limestone aquifer is about once a month.

Soils in the ASR wellfield area are characterized as dense clay with essentially zero capacity for local aquifer recharge, such as through infiltration ponds. The area is relatively flat, with no nearby natural drainage system or ditches. An NBU wastewater pipeline crosses the Airport to the south of the NBU Property. The closest manhole on this sewer pipeline is approximately 2,200 feet from the ASR well site.

A permanent pipeline and air-gap structure will be needed to convey pump test and backflush water from the ASR well or wellfield to the NBU wastewater line. The initial pipeline would be parallel to Saur Lane along the east side of the road. Location and depth of the pipeline will need to provide for the potential widening of Saur Lane. Pipeline capacity should be sufficient to backflush one ASR well at a time with a flow rate up to 1,400 gpm. Individual ASR well production rates will vary, with some being higher and some being lower than the average flow rate during ASR recovery. Backflush flow rates will most likely be greater than production flow rates.

Backflush water quality for each well may initially be brackish, reflecting native groundwater quality. NBU's McKenzie Wastewater Treatment Plant can accept up to about 1,000 gpm with a TDS concentration of up to 14,000 mg/L, without causing adverse effects. With careful planning, ASR operations should be capable of staying within this constraint. Discharges can also be temporarily stored on site and then released at a slower flow rate. Over time, as the ASR stored water volume in the aquifer steadily increases, the local aquifer will transition from brackish to fresh, and any associated salinity issue with backflushing operations will decrease in significance.

6.12 Provisions for potential future wellfield expansion

The layout and design of initial wells and wellhead facilities at the NBU Property should provide for future wellfield expansion in the adjacent Airport property to the south and east of the site. Conceptual master plans for the Airport were previously developed that include nine additional well sites. If the Lower Edwards aquifer is also developed for ASR, the number of required well sites to achieve a firm capacity of at least nine mgd would be reduced, assuming two adjacent wells at each site, one in the Upper Edwards aquifer and one in the Lower Edwards aquifer. If NBU needs additional peaking capacity or water supply reliability compared to projections in the 2012 ASR feasibility study, additional ASR wells and higher flow rates may be appropriate as a basis of design.

Provisions for these potential additional wells should be considered in the design for the initial ASR well. Such considerations should also include, but not be limited to, the following:

- Changing static, recharge and pumping water levels due to well interference, mounding, and buoyancy
- Location of easements and pipeline connections to the existing transmission and distribution system
- Power supply for future wells
- Instrumentation and control systems
- Possible need for degasification and re-pump station for CO_2 removal

- Site access to wells and other wellfield facilities
- Long-term provision for future replacement wells
- Maintaining control over the water stored underground, such as with deed restrictions on adjacent land; local ordinances, or establishment of a Wellfield Protection Area (WPA)
- Updated assessment by NBU regarding the desired recovery rate from ASR storage; the duration of peak season recovery compared to the 210 days estimated in the ASR feasibility study, and drought reliability goals

6.13 Project delivery

Conventional "Design, Bid, Build" project delivery is recommended for the next phase of the ASR program, and for well design, permitting, and construction in the subsequent phase, during which the wellfield would probably be expanded from a single ASR well to its full design capacity. This delivery method is recommended because well and wellfield development projects entail inherent uncertainty, and therefore risk, regarding individual well yields and performance characteristics. Individual well yield estimates during design may vary by 50 percent during subsequent construction and testing, affecting the number of wells required, electrical requirements, pump setting depths, etc. A lump sum bid price is appropriate for contractor procurement purposes, but a unit price bid schedule is also needed, with which to adjust the bid price based upon circumstances experienced in the field.

7. Conclusions and recommendations

One of the many advantages of ASR as a water management strategy is the opportunity to plan and implement an ASR program in incremental steps, with each phase building upon the knowledge gained in previous stages. The objectives of this Project are to gather additional information on the stratigraphy and water quality of the brackish portion of the Edwards Aquifer, and to better confirm its viability as a storage location for the NBU ASR program. As discussed in this report, the Project fulfilled those objectives. The paragraphs below summarize the conclusions founded on the analysis of data and information, and provide recommendations based on those conclusions.

7.1 Conclusions.

Summarized below are the major conclusions drawn from the data and information collected from the wireline core and the monitor well construction:

7.1.1 Project tasks

The Project tasks were completed in conformance with the Rider 25 application submitted to the TWDB in November 2015, and Contract No. 1600011957 between the TWDB and EAA. The completed tasks included: coordination with TCEQ; design and construction of the wireline core hole; design and construction of the monitoring well; data collection and analysis for reporting purposes; and engagement in presentations with the TWDB related to the Project.

7.1.2 Project objectives

The objectives of the Project were met by wireline coring, in combination with construction and testing of a nearby monitoring well. Using both technologies provided the best method for augmenting knowledge of the brackish Edwards Aquifer.

By collecting a core of the Edwards Aquifer to a total depth of 1,096.8 feet bgs, the Arcadis team and EAA gathered valuable information for detailed lithologic analysis and comparison to geophysical logs obtained from the monitoring well. The collected cores were also analyzed to understand the geochemical changes that can ultimately affect the recovered water quality due to mixing between recharge water and native groundwater in the presence of aquifer minerals. Information gained in the coring effort allowed INTERA to confirm its monitoring well specifications before the well was drilled. The monitoring well will be incorporated into the ASR wellfield for operational purposes.

Between the coring data and the monitoring well data, the Project provided important information on stratigraphy, lithology, potential storage intervals, water quality and potential for well clogging, limestone dissolution, and metals mobilization. The Project also provided preliminary information on the potential production capacity of wells in the brackish Edwards Aquifer near the Airport.

7.1.3 Core lab results

The core lab results supported the on-site lithologic analysis of the cores, and the geophysical logs. The analysis of the core data suggested the presence of alternating bands of limestone and dolomite, with higher porosities up to about 25 percent to 50 percent, including both primary (intergranular) and secondary (solution) features in the dolomite intervals, and lower porosities in the limestone intervals, mostly primary porosity in the range of 3 percent to 20 percent. Overall average porosity was about 30 percent.

7.1.4 RDM confining layer

The RDM confining layer separating the Upper Edwards aquifer from the Lower Edwards aquifer should be an effective confining layer from about 710 to 734 feet bgs. Confinement is supplemented by limestone intervals with variable porosity but low productivity above the RDM (about 680 feet bgs to 710 feet bgs) and below the RDM (734 feet bgs to about 740 feet bgs). These intervals adjacent to the top and bottom of the RDM contribute to the effectiveness of the confining layer while also supplementing the storage volume available within the overlying and underlying aquifers, but they do not contribute much to the yield of the Upper or Lower Edwards aquifers.

7.1.5 ASR storage

ASR storage in the Upper Edwards aquifer would have excellent overlying confinement (200 feet to 545 feet bgs). ASR storage in the Lower Edwards aquifer, at such time as it may be implemented by NBU, would probably have excellent underlying confinement provided by the Walnut Clay from about 950 feet bgs to 1,046 feet bgs, underlain by the Glen Rose limestone.

Many ASR wells are operating successfully in brackish limestone and dolomite aquifers. Successful operation is dependent upon such aquifers having adequate confinement, above and below the storage formation.

7.1.6 Construction and data collection

The construction and data collection associated with the monitoring well allowed the Arcadis team and EAA to determine the groundwater quality in the Edwards Aquifer in the intervals above and below the RDM, and to get a qualitative estimate of the potential productivity of those intervals. The monitor well was drilled to a total depth of 940 feet bgs. It was then plugged back to a depth of 710 feet bgs after water quality was resampled in the Upper and Lower intervals of the Edwards Aquifer.

7.1.7 Spinner log

A spinner log was taken prior to drilling through the RDM. Analysis of the spinner log results indicate that the primary producing feature in the Upper interval is near 630 feet bgs, but additional flow is found between about 580 feet bgs and about 660 feet bgs.

7.1.8 Ground surface

The ground surface at the monitoring well was surveyed at 652.26 feet (NAVD 88). Static levels in both intervals ranged from 30 feet bgs to 32 feet bgs over the course of the water quality sampling events. For both events, the water level in the Lower interval decreased under pumping conditions. For the first event, the water level decreased about 0.55 feet with an estimated pumping rate of 8.5 gpm. For the second event, the water level decreased about 0.75 feet with an estimated pumping rate of 10 gpm. At this site, the gradient between the Upper and Lower intervals appears to be very small, and the direction of the gradient undetermined or possibly reversing with changes in overall water level. Because of the apparent lack of natural vertical gradient between the two intervals, under static storage conditions, there will be little or no forces trying to drive water across the RDM. Although these assumptions will be confirmed during later phases, it appears that an ASR storage "bubble" at the NBU Property should be vertically stable when no injection or production is occurring.

7.1.9 Preliminary geochemical equilibrium

A preliminary geochemical equilibrium analysis was conducted to evaluate whether recharge of treated drinking water from the NBU distribution system might cause any adverse geochemical reactions when mixed with the brackish water in the Edwards Aquifer at the NBU Property. Because final conclusions were constrained by the unreliability of some water quality lab results, it was necessary to resample the Upper and Lower Edwards aquifer intervals. In the next phase of the NBU ASR program, a new Lower Edwards monitor well will be constructed and tested for water quality. The full geochemical equilibrium model analysis will then be completed.

7.1.10 Preliminary analysis

Despite the issues with some of the laboratory results, the preliminary analysis discussed in **Appendix F** suggests a low likelihood of adverse geochemical interactions. The relatively low pH of the Edwards Aquifer at this site suggests the possible occurrence of elevated concentrations of CO_2. If present, release of CO_2 during ASR recovery is a possibility. However, this would tend to be a transitional issue and would steadily decline with successive cycles, and with initial formation and maintenance of a buffer zone around the ASR well.

7.1.11 Conclusion

Based on the data collection and analysis performed during the Project, there is strong technical support for NBU moving ahead with the next phase in the implementation of its ASR program at the NBU Property and/or the adjacent Airport.

7.2 Recommendations

The data collected and analyzed in the Project provide a basis for recommendations moving forward with the NBU ASR program, and for design of proposed ASR facilities to be constructed during a next phase of the program. The next (third) phase will include permitting and design of an initial ASR well and wellhead facilities, and associated monitor wells, followed by bidding, construction and cycle testing of the initial ASR demonstration well. Two monitoring wells will also be designed and constructed. One will be the ILA-required monitoring well, and the other will be an operational monitoring well in the Lower Edwards Aquifer at the NBU Property. The next phase is defined in the ILA as the "Demonstration Well Phase." The following paragraphs provide a summary of the recommended "next steps" and associated responsibilities.

7.2.1 Updated geochemical analysis

Using the water quality data provided by the resampling of the monitoring well, the Arcadis team will update the geochemical analysis performed in the Project. The updated analysis will be provided to NBU, EAA and the TWDB, and it will be used as part of the application to TCEQ for the construction and operation of the demonstration ASR well.

7.2.2 Application to TCEQ

Using the information and data collected in this Project, the draft Project report and the updated geochemical analysis, NBU and the Arcadis team will prepare and process an application to TCEQ for a Class V Injection Well 5X25 (Experimental) Authorization to construct and operate a full-scale demonstration ASR well on the NBU Property.

7.2.3 Design of demonstration ASR well and monitoring well

While the application is being processed by TCEQ, NBU and the Arcadis team will design the demonstration ASR well and the Lower Edwards monitoring well, both to be constructed on the NBU Property; and the ILA-required dual-completion monitoring well to be constructed at a new site between the Airport and the Comal Springs. The ILA monitoring well will be located at least 1,000 feet from the first ASR well. The Arcadis team will support NBU in the selection of the site for the ILA monitoring well. The design of the wells and the location for the ILA monitoring well will be subject to approval by EAA.

Before the Lower Edwards monitoring well is designed, NBU should consider whether or not to oversize the well so that it could later be utilized as an ASR well. Monitoring wells tend to lose some of their value once the TSV has been developed, particularly when they are located close to the ASR well(s). Oversizing this well would allow NBU to convert it to an ASR well at a later date.

7.2.4 Anticipated recovery rate

The Arcadis team will design the ASR well for an anticipated recovery rate of 700 gpm assuming up to 200 feet of drawdown. This design criteria implies a recovery specific capacity of 3.5 gpm/foot, or higher. The results of a pump test of the ASR well will be used to finalize the hydraulic design of the pump and confirm the motor horsepower requirements.

7.2.5 Recharge flow rate

The design recharge flow rate will be confirmed by the Arcadis team through initial ASR operations. The recharge pressure within the well casing as measured at the wellhead flange will likely be limited so as not to exceed 30 psi (70 feet). Assuming a depth to static water level of about 37 feet, total available recharge head will be about 107 feet. Assuming a recharge specific capacity of 3.0 gpm/foot, the design recharge rate will be in the range of 300 to 350 gpm (0.5 mgd).

7.2.6 Construction delivery method

The Arcadis team recommends that NBU use the conventional “Design, Bid, Build” delivery method to select the contractors and construct the ASR well and the two monitoring wells. The Arcadis team will likely prepare the technical bid documents so that NBU can select one or two contractors for construction of the ASR well, and the ASR wellhead and ancillary facilities.

7.2.7 Interim ASR recharge

As discussed above, NBU can begin interim ASR recharge as soon as the ASR well is constructed and tested. Interim recharge can continue during the period when the well is being equipped and wellhead facilities are being constructed. This duration may be several months, during which time a substantial volume of drinking water can be stored, assuming water is available for recharge from the NBU distribution system.

7.2.8 Cycle testing

NBU can begin cycle testing after the Arcadis team has provided an operations and maintenance manual and training for the NBU staff. The duration of cycle testing, and the volumes of water recharged and recovered will depend on the availability of water from the NBU distribution system. For the first ASR demonstration well, the Arcadis team estimates that the TSV will be about 1,289 AF (420 MG). The associated theoretical bubble radius would be 677 feet.

7.2.9 Water quality sampling

While NBU is conducting the cycle testing, the Arcadis team recommends that water quality samples be collected from the new Lower Edwards monitoring well, and that a geochemical analysis be completed. That analysis, along with data collected during the cycle testing can serve as the basis for TCEQ permitting for permanent operation of the ASR well on the NBU Property.

7.2.10 Post demonstration well phase tasks

After the Demonstration Well Phase is completed, later tasks should include construction of an analytical model to evaluate the potential impacts, if any, of the operation of the first NBU ASR well on the freshwater zone of the Edwards Aquifer. Under the terms of the ILA, that model must be developed before the ASR well is put into permanent operation under a TCEQ Class V UIC permit. That model and all previous work will then be used as the basis for designing the expansion of the NBU ASR wellfield.

8. Acknowledgements

The Arcadis team sincerely appreciates the continual and ongoing support and cooperation of the leadership and staffs of NBU and EAA; the TWDB; and Kutscher Drilling.

At NBU, specific acknowledgement goes to: Retired Executive Director Roger Biggers, P.E. and current CEO Ian Taylor, P.E. who initiated the feasibility study and the ASR program; former Director of Water Services Trino Pedraza; Chief Engineer Mike Short, P.E.; Project Manager Dean Watkins; Water Treatment and Compliance Manager Brent Lundmark; Project Administrator Ashley Zimmermann; and Administrative Assistant Desirae Medellin.

At EAA, we appreciate the support, input and cooperation of: General Manager Roland Ruiz; Assistant General Manager Brock Curry; and the members of the ILA Work Group, including Mark Hamilton, P.G., Dr. Paul Bertetti, and Jennifer Adkins Schudrowitz, P.G.

At the TWDB, we particularly appreciate the support of Matthew Webb, Hydrologist in the Innovative Water Technologies Division.

Kutscher Drilling has been a family-owned business since 1925. That company was responsible for drilling both the core hole and the monitoring well. We particularly appreciate the assistance and hard work of owner Daniel Kutscher and Operations Manager Christy Aylesworth.

9. References

Edwards Aquifer Authority, July 2018. Well data on Comal Springs monitoring wells. Email exchange from Paul Bertetti.

New Braunfels Utilities, May 2012. Preliminary evaluation of aquifer storage and recovery as a water supply and management strategy.

New Braunfels Utilities, June 2018. 2018 water resources plan.

Texas Water Development Board, February 2011. An assessment of aquifer storage and recovery in Texas. Report No. 0904830940.

10. Appendices

10.1 Appendix A. TCEQ meeting minutes

RECORD OF MEETING

Subject:

NBU ASR Coordination Meeting with TCEQ

Department:

NBU Water Services

Arcadis Project Nos.:

40256004.0000

Meeting Location:

TCEQ, Building F

Meeting Date:

September 18, 2018

Participants:

See Attached Sign-in Sheet

Copies:

Ashley Evans, PE

Debbie Arizpe

(Arcadis)

Minutes by:

Fred M. Blumberg

Issue Date:

September 20, 2018

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On September 18, 2018 representatives of New Braunfels Utilities (NBU), the Edwards Aquifer Authority (EAA), Arcadis U.S., Inc. (Arcadis), ASR Systems, LLC, and INTERA Incorporated met in person and by speaker phone with members of the Texas Commission on Environmental Quality (TCEQ). The purposes of the pre-application coordination meeting were to brief the TCEQ Underground Injection Control (UIC) permitting staff on the NBU ASR program and the current demonstration project; and to obtain guidance for submittal of an application for a Class V 5X25 authorization for the first NBU full-scale ASR well.

The attendees are shown on the attached sign-in sheet.

The discussion topics and action items are summarized below.

DISCUSSION TOPICS

1. **NBU ASR Program**.
   Fred Blumberg with Arcadis provided background on the 2012 NBU feasibility study, the need for additional data on the brackish portion of the Edwards Aquifer, and the ongoing Texas Water Development Board (TWDB)-funded demonstration project. He also discussed the NBU water supply inventory, NBU's water resources planning efforts and the need for storage of water when it is available.

2. **Wireline Coring**.
David Pyne with ASR Systems described the design and construction of the wireline core from a depth of about 70 feet below ground surface (bgs) to approximately 1,100 feet bgs, the core samples that were analyzed in the field and in the laboratory, and the results confirming the anticipated stratigraphy of the Edwards Aquifer at the NBU Property.

3. **Monitoring Well**.
Neil Deeds with INTERA described the design and construction of the monitoring well to a depth of about 940 feet bgs; and the water quality and productivity information gained in the process. The discussion included a description of the upper and lower intervals of the Edwards Aquifer, and the Regional Dense Member (RDM) confining layer between the intervals. The upper and lower confining layers were also discussed.

TCEQ staff asked if the 30 TAC Section 331.19 limitations on drilling and injecting into the Edwards Aquifer would apply to the proposed NBU ASR well. After discussion, TCEQ confirmed that those limitations did not apply because the NBU Property and the proposed ASR wellfield at the New Braunfels Regional Airport are located outside the defined area.

4. **NBU and EAA Perspectives**.
Trino Pedraza with NBU discussed the importance of the ASR program to New Braunfels. He also discussed the proposed NBU legislation to authorize storage of potable blended ground and surface water. Paul Bertetti with EAA provided TCEQ with a summary of the interlocal agreement between EAA and NBU, and the various requirements for studies, sampling and mitigation plans and monitoring wells to assure that the NBU ASR program does not have detrimental consequences for the Comal Springs or the freshwater portion of the Edwards Aquifer.

5. **Schedules**.
Fred Blumberg and Trino Pedraza discussed the schedule for finishing the TWDB-funded project and submittal of an application to TCEQ for the 5X25 authorization. The draft report is being prepared for review by NBU and EAA before submittal to the TWDB. Additional water quality samples have been collected from the upper interval of the aquifer, and the geochemical analysis will be updated in the next month. It is NBU's intent to submit an application to TCEQ before the end of the year.

6. **TCEQ Questions and Input**.

Lorrie Council, David Murry and Bryan Smith with TCEQ discussed the general requirements for an application, including a narrative describing the scope of work for the ASR well project, the deliverables that TCEQ will receive and the goals of the cycle testing program. More specifically, TCEQ asked that the following be included in the application: the anticipated number of cycles; the goals of the testing program, along with the schedule and milestones; the water quality testing to be conducted; and the information to be provided to TCEQ (e.g., well logs and completion reports, results from each of the cycles, and water quality data). For each cycle, TCEQ would like to know the anticipated injection and recovery rates; durations of injection, storage and recovery; volume to be injected; and volume to be recovered.

In response to a question, the TCEQ staff stated that it would likely take at least 60 days to review the application and issue an authorization. The processing time will depend on the completeness of the application and the number of questions that must be addressed.

ACTION ITEMS

1. Lorrie Council asked Fred Blumberg to resend the two documents previously provided to TCEQ with the initial meeting request (the 2012 feasibility study, and the grant application to the TWDB for Rider 25 funding). Those documents were provided to Ms. Council on September 19, 2018.
2. David Murry offered to send David Vance with Arcadis a markup of the Class V Injection Well Authorization application showing which sections are applicable for a 5X25 ASR well. That markup was provided to Mr. Vance on September 19, 2018.

10.2 Appendix B. Coring and monitor well technical specifications

10.2.1 Appendix B.1. Specifications for NBU ASR core hole

Specifications for NBU ASR Continuous Wireline Core Hole, 27 August 2017

INVITATION TO BID

New Braunfels Utilities (NBU) invites submittal of bids for continuous wireline coring at one site near the New Braunfels Regional Airport, southeast of New Braunfels, Texas. This is part of the second phase of an Aquifer Storage Recovery (ASR) program to augment the City's water supply capacity to help meet peak demands and improve overall water supply reliability. The coring project is generally described as follows.

The selected site is at a parcel of land owned by NBU, near the New Braunfels Regional Airport. Work at the site will include continuous wireline coring from 50 ft to approximately 1,025 ft depth. Specifications for the core drilling project accompany this Invitation to Bid.

Arcadis-U.S. Inc. is directing the overall NBU ASR development program, assisted by ASR Systems LLC, Gainesville, Florida and INTERA Inc., Austin TX. For this specific work effort, Groundwater Management Associates, Inc., Greenville, NC will provide resident hydrogeologist observation services during coring, under subcontract with, and under the supervision of, ASR Systems. Together, these companies comprise the consultant team for NBU for this project.

The project site is within the groundwater regulatory authority of the Edwards Aquifer Authority (EAA). NBU has obtained the authorizations for the work needed from EAA. All other construction-related licenses, permits and authorizations, if any, must be obtained by the selected contractor prior to initiating work.

The contractor shall provide documentation along with its bid on contractor's equipment, personnel, and experience during the past five years in performing this type of work and at these depths.

All bids must be submitted in sealed envelopes bearing on the outside: the title "NBU ASR Continuous Wireline Core Hole;" and the name of the bidder and its address. No bid security is required. Evidence of insurance will be required within seven days following notification by NBU of planned award of the project to the selected bidder.

NBU reserves the right to reject any or all bids, to waive any informality in any bid or to re-advertise for bids. Selection will be made by NBU based upon bid price, applicable experience within the past five years, and project references.

Interested and experienced continuous wireline core drilling contractors are invited to submit bids for this project. Bids are due no later than **4:00 pm local time, (date)**, on the bid form provided herein. Any bid received after this date and time will not be considered. Bids shall be delivered to New Braunfels Utilities, 263 Main Plaza, New Braunfels, TX 78130. Any questions should be directed to Mr. David Pyne, ASR Systems LLC (352-336-3820) (dpyne@asrsystems.ws).

Ian Taylor, P.E.
Chief Executive Officer
New Braunfels Utilities

PROJECT OBJECTIVE

The objective of the continuous wireline core hole is to define in detail the stratigraphy, lithology and mineralogy of the aquifers and confining layers at this site, to a depth of approximately 1,025 ft.

BACKGROUND INFORMATION

The location of the planned continuous wireline core hole is New Braunfels, Texas, near San Antonio. The client is New Braunfels Utilities (NBU). The 1.067-acre site is owned by NBU and is adjacent to the New Braunfels Regional Airport. It is accessed via Saur Lane, a paved road. **Figure 1** shows a survey of the site parcel. The core hole site coordinates from Google Earth are: 29° 14' 42.82" N, 98° 03' 12.47" W. Prior to arrival of coring equipment, access to the site from Saur Lane will be cleared by NBU along the south property line, which is fenced. Existing piles of fill dirt, building debris and small trees around the coring site will be cleared and leveled by NBU to provide for coring operations. NBU has surveyed the property, establishing permanent markers at corners. A local permanent datum and associated elevation has been established at the intersection of the L2 and L3 property lines shown on Figure 1.

The soil cover is clay. NBU will provide gravel for the access route and coring site to facilitate coring operations during any wet weather. An NBU fire hydrant on Saur Lane is at the end of the site access route, approximately 200 ft from the core hole site. NBU will provide a connection at the fire hydrant, including a control valve, flowmeter and backflow preventer. Water for coring operations will be provided at no charge. The contractor is responsible for providing up to approximately 200 feet of hose or temporary piping to convey water from the fire hydrant to the drill site.

The Edwards aquifer at this site contains brackish water. Any brackish water produced during construction of the core hole shall be discharged to an NBU sanitary sewer manhole in a 24-inch wastewater gravity trunk main. The manhole is located approximately 2,000 feet from the coring site on adjacent New Braunfels Airport property, immediately adjacent to Saur Lane. Conveyance may be via a temporary hose or pipeline, or through collection in a frac tank and conveyance by tanker truck to a sanitary sewer manhole. Approval by the County Engineer will be needed to lay a temporary pipeline along the Saur Lane right-of-way. No additional approval will be required from NBU for discharge of small brackish water flows into the manhole.

By separate contract, a six-inch monitor well will later be constructed at the same site, approximately 200 feet from the core hole, and near the northwest corner of the property. Monitor well construction may potentially overlap with the latter half of core hole drilling. Data from the coring in the upper portion of the Edwards aquifer will guide construction and sampling of the monitor well. The two projects will be bid separately at the same time. Contractors may bid one or both projects. If two separate contractors are selected to complete this work, instead of one contractor doing both projects, coordination between the two contractors will be required regarding scheduling, placement of equipment and material laydown areas, and possible joint use of facilities required for both projects. The primary initial objective of the monitor well project is to provide reliable water quality data from upper and lower portions of the Edwards aquifer. If an ASR well is later constructed at or near this site, the monitor well will also be utilized during aquifer performance testing and during subsequent operations.

This project is to construct a continuous wireline (HQ) core hole (3.8 in hole diameter; 2.5 in core diameter) from 50 ft below ground surface to an anticipated depth of up to about 1,025 feet. The target aquifer is the brackish portion of the Edwards Aquifer, which is expected to occur from a depth of about 475 to 975 feet, based on limited regional information. The intention is to core 10 feet into the underlying Glen Rose Limestone. Geologic formations expected to be encountered during drilling are as follows:

Formation	**Top**	**Base**	**Description**
Alluvium	0	~50	very thin layer of alluvial flood plain deposits
Taylor Clay	50	100	mixture of clay, sand and marl
Austin Chalk	100	380	mostly chalk and marl
Eagle Ford Group	380	415	shale, siltstone and limestone
Buda Limestone	415	455	fine grained, hard, massive limestone
Del Rio Clay	455	515	calcareous and gypsiferous clay
Georgetown	515	575	fine to coarse grained limestone, chert nodules abundant
Edwards Group	575	975	various characters of limestone and dolomite
Walnut Clay	975	1015	marine clay formation
Upper Glen Rose	1015	?	alternating limestone, dolomite and marl

There is uncertainty regarding depths of the formations, reflecting very limited available local data from existing wells, plus the possibility of buried faults in this area. Total coring depth may perhaps need to extend to about 1,100 ft. Casing will need to be set to the base of the Del Rio Clay. Except for shallow alluvium and the Del Rio Clay, the formations encountered are expected to be capable of remaining open borehole, however that is not certain. A “Regional Dense Member (RDM)” may be encountered at a depth between approximately 700 to 750 ft. This is a thin, limestone, semi-confining layer approximately 20 ft thick. Identification and characterization of this layer is important for project purposes.

During core hole construction, the NBU consultant team will have a geologist onsite to initially characterize core lithology; measure core recovery percentage; photograph the cores; wrap cores (if necessary) and store them.

NBU recognizes that each bidder will tend to have his own means and methods for obtaining continuous HQ wireline cores with acceptable core recovery efficiency. Reflecting the expected consolidated nature of the formations through which most of the coring will occur, high core recovery efficiency is expected. The “Payment for Coring” section below addresses NBU’s high expectations and is intended to provide motivation for the coring contractor to conduct coring operations in a manner that meets NBU’s expectations. The primary interval of interest for achieving high core recovery efficiency is the Edwards aquifer, estimated to occur from 575 ft to 975 ft. Achieving high core recovery efficiency in overlying and underlying formations is also important.

SEQUENCE OF OPERATIONS

Equipment and Materials:

The contractor shall provide whatever equipment, materials and procedures are necessary to achieve project objectives. Equipment shall be in good working condition, not subject to repeated failure that would delay progress. Materials and equipment (temporary casings, casing shoes, core barrels, core catchers, core boxes, grout tubing, grout, bentonite, and other materials as needed) shall be stored on site prior to starting coring operations. Site security for this equipment and materials is the sole responsibility of the contractor.

Provide a temporary construction trailer at the site for shared use by the contractor's employees and also by the ASR Systems geologist and any authorized visitors to the site, such as NBU, Edwards Aquifer Authority, ARCADIS, Intera, etc. This would include temporary power, water, toilet facilities, refrigerator, heater and/or air conditioning.

Site Preparation.

Provide the following:

- a sturdy work table (at least 10 ft long and 3 ft wide) for the geologist, capable of supporting core lengths up to 10 ft for analysis and processing.
- a raised, rigid wooden platform slightly above the ground, adjacent to one side of the work table.
- a shelter from the rain, snow and sun for the geologist, worktable and adjacent platform. Color photographs of the fresh cores are best taken in the shade.
- a water source from a hose at the work table, to assist with core processing.
- Small deep freezer (top opening) for frozen storage of up to 20 selected 12-inch core samples
- Temporary power supply for lighting, deep freezer, and for a saw to cut the cores to fit in the core boxes
- Corrugated plastic storage boxes with lids are preferred, however wooden boxes built specifically for core storage will also be acceptable. Each box shall be designed to store not more than 10 feet of core.
- Temporary covered storage for core boxes at the site, raised off the ground and covered in Visqueen plastic sheeting or approved equal.
- Labor assistance as needed to help the geologist move cores and core boxes from the coring rig to the work bench and then to temporary storage.
- Misc. materials to assist with core analysis (red and black marker pens; rolls of plastic wrap sufficient for wrapping all of the core; tape to seal the plastic wrap; spacers in core boxes to denote lost core recovery intervals; ice chest for shipping six 12-inch cores; limestone rock saw and saw blades)

Coring Operations.

Set temporary surface casing to 50 ft or whatever greater depth is needed to penetrate through shallow alluvium at land surface. Obtain cores or drill cuttings of materials encountered to the surface casing depth. Diameter of the temporary surface casing shall be sufficient to accommodate subsequent coring, reaming, and subsequent setting of an inner casing to the base of the Del Rio clay.

Obtain HQ (2.5- inch core diameter, 3.8-inch hole diameter) continuous wireline cores from the bottom of the surface casing to the full depth of the core hole, estimated at a depth of 1,025 ft. Core barrel lengths shall not exceed 20 feet. Core runs should be 10-feet long, unless it can be shown that optimum core recovery can still be accomplished with 20-foot core runs. Shorter core barrel lengths such as 5-feet or less shall be attempted where poor core recovery is anticipated or has been experienced. The contractor is to provide an experienced core driller that can respond to variations in subsurface lithology by modifying the drilling procedures, core lengths, drilling fluid characteristics, core catchers, etc. as necessary to optimize core recovery. If a core sample is retrieved that does not meet the core recovery percentage goals for the materials being drilled, NBU expects that the driller will modify drilling procedures accordingly for the subsequent core to attempt to improve core recovery.

Contractor shall convey cores to the core table for analysis by the resident geologist.

The core hole shall be reamed to the base of the Del Rio Clay at an estimated depth of 515 ft, and a temporary casing shall be set at that depth. Diameter of the temporary casing shall be sufficient to accommodate subsequent coring below that depth.

Obtain up to three formation water quality samples at depths selected by the resident geologist. The method for obtaining a representative sample shall be proposed by the contractor and approved by the resident geologist. One of these will be at a depth between 650 and 700 ft. The other two will be at depths between 750 ft and 950 ft. Provide sample containers and convey samples to the lab. Samples will be analyzed by NBU or others for chlorides, conductivity and total dissolved solids.

The Edwards Aquifer Authority (EAA), San Antonio, will provide geophysical logs for this project, using in-house Slimline geophysical logging equipment. There will be no charge to the contractor for these services. Arrange with EAA to obtain geophysical logs for the full length of the open core hole. Contact Mark Hamilton/EAA (phone no.) to schedule logging operations. Provide a minimum of two days advance notification of each geophysical logging date. Logs shall include gamma, resistivity, fluid conductivity, spontaneous potential and neutron porosity. This will require two coring runs: one from the base of the surface casing to the base of the Del Rio Clay at about 515 ft, and one from 515 ft to the bottom of the core hole at about 1,025 ft. If unexpected, unconsolidated deposits or swelling clays are found in the interval from 515 ft to the bottom of the core hole, coring will be conducted to the full depth however geophysical logging below the problematic depth interval will be deleted.

Upon completion of coring and logging, grout the core hole from the bottom up to land surface using neat cement grout, retrieving the temporary well casings before completing grouting of the hole to land surface. The grout injection tremie pipe shall be placed initially 10 ft above the bottom of the core hole and then raised in small increments as pumped grouting proceeds, ensuring that a continuous grout seal is achieved. The bottom of the tremie pipe should remain submerged in grout throughout the grouting operations. If the core hole collapses prior to grouting, the contractor shall clear the hole to the original depth by circulating mud prior to emplacing the grout.

During grouting, gravel may be used to bridge any cavernous intervals encountered in the core hole. If the inner casing to the base of the Del Rio Clay, or the surface casing, cannot be removed due to cohesion of the clay against the outer wall of the casing, the casing may be left in place, however the top of the casing shall be cut off two feet below grade and the remaining hole filled in to land surface. The sunk cost of any buried temporary casing will be borne by the contractor. Provide a steel locator ball or other acceptable shallow-buried metal marker indicating the location of the core hole, and record the distance from two adjacent orthogonal property lines.

Upon completion of site operations, remove all debris from the site and restore it to its original condition, to the satisfaction of NBU.

Move the core boxes and deep freezer from temporary onsite storage to a secure, weather-protected location to be provided by NBU within the City limits of New Braunfels. The anticipated temporary storage location is at the NBU Service Center, 355 FM306, New Braunfels, TX 78130.

Post-Coring Analysis and Report

Based upon on-site lithologic analysis of the cores and review of the geophysical logs, the resident geologist will select up to six core sections, each 10 to 12 inches long, for lab analysis at Mineralogy, Inc., Tulsa OK. These may be frozen or unfrozen cores. The coring contractor shall package the cores in an ice chest; ship the cores to the lab, and have them analyzed for the following:

- Physical characteristics (horizontal and vertical permeability, porosity, specific gravity)
- Colored pictures of cores
- Mineralogy (X-ray diffraction, XRD)
- X-ray fluorescence (XRF)
- Cation exchange capacity, CEC
- Base exchange capacity
- Scanning electron microscopy
- Thin section petrography
- Acid soluble residue
- Core lab report

The coring contractor shall provide a PDF copy of the core lab report to NBU and to each of the consultant team members (ARCADIS, INTERA, ASR SYSTEMS). Cost of the core lab analysis shall be included within the contractor's bid price.

Payment for Coring

The Bid Sheet includes an item for Mobilization/Demobilization. This includes cost of insurance, bonds, and any other cost items not specifically listed in the "Unit Price Bid Items" listed below.

Overall core recovery efficiency in the range of 80% to 90% is expected. Overall core recovery efficiency exceeding 90 percent is probably attainable and would receive an incentive supplemental payment of 10 percent above the unit price per foot cored, as provided in the Bid Sheet. Overall core recovery efficiency less than 80 percent shall result in a reduction of the unit price per foot cored, as provided in the Bid Sheet. The reduction shall be 10 percent per 10 percent reduction in overall core recovery efficiency below 80 percent. For example, if overall core recovery efficiency is 60 percent, the unit price per foot cored would be 20% below that on the Bid Sheet. Core recovery efficiency shall be determined by the resident geologist, based upon dividing total core length recovered by total core length attempted.

The Bid Sheet includes an item for Standby Time. Approval for standby time will need to be issued by NBU. Delays due to contractor's equipment failure will not qualify for standby time approval. Delays due to bad weather or other natural causes beyond the control of the contractor will be considered for approval for an extension of project completion time, but not for standby time. Delays due to failure or delayed arrival of EAA geophysical logging equipment will be considered for approval of standby time.

The Bid Sheet includes an item for Owners Allowance. This is intended as an amount set aside by NBU as an incentive payment to the contractor if overall core recovery is greater than 90 percent. The Base Bid should be prepared based upon NBU's expected core recovery between 80 and 90 percent.

Liquidated Damages shall apply if field activities exceed 45 calendar days. The amount shall be $1,700 per day, offsetting the cost for the resident geologist time and expenses.

NEW BRAUNFELS UTILITIES

CONTINUOUS WIRELINE CORE HOLE AT AIRPORT SITE

BID SHEET

The Bid Sheet shall be attached to and shall be a part of the complete Contract Documents.

It is agreed that all field work on the **CONTINUOUS WIRELINE CORE HOLE** shall be completed within **150 calendar days** of the date specified in the written Notice to Proceed.

UNIT PRICE BID SCHEDULE					
ITEM	**DESCRIPTION**	**QUANTITY**	**UNIT**	**UNIT COST**	**EXTENSION**
1	MOBILIZATION/ DEMOBILIZATION	1	LS		
2	ROTARY DRILL HOLE FOR SURFACE CASING	50	FT		
3	FURNISH/INSTALL TEMPORARY SURFACE CASING	50	FT		
4	REAM CORE HOLE FOR INNER CASING	465	FT		
5	FURNISH/INSTALL TEMPORARY INNER CASING	515	FT		
6	CORING (50 FT TO 515 FT)	465	FT		
7	CORING (515 FT TO 1,025 FT)	510	FT		
8	CORE HOLE ABANDONMENT	1,025	FT		
9	CORE BOXES	98	EA		
10	HOTEL/ PER DIEM	45	DAYS		
11	STANDBY TIME	8	HRS		
12	OWNERS ALLOWANCE				$10,000
TOTAL					

Contractor Name: ____

Address: ____

____

Phone Number: ____

Coring Experience:

On a separate sheet provide pertinent experience during the past five years, including a brief description of at least three continuous wireline coring projects and associated equipment and field staff. Reference coring depth for each project.

References:

On a separate sheet provide at least three references with contact information.

An insurance certificate in the amount of $1 million shall be provided by the selected contractor within seven days following notification of contract award.

Submit bids to the following address:

New Braunfels Utilities

263 Main Plaza

New Braunfels, TX 78130

Attention: Michael Short, P.E., Chief Engineer for Water Services

Questions should be directed to the following address:

Mr. R. David G. Pyne, P.E.

President, ASR Systems LLC

540 NE 5th Ave

Gainesville, FL 32601

Telephone 352-336-3820 (office)

352 215 0319 (cell)

Email: dpyne@asrsystems.ws

10.2.2 Appendix B.2. Specifications for NBU ASR 6-inch monitoring well

Specifications for NBU ASR 6" Monitoring Well, September 4, 2017

INVITATION TO BID

New Braunfels Utilities (NBU) invites submittal of bids for the drilling of a 6" monitor well at one site near the New Braunfels Regional Airport, southeast of New Braunfels, Texas. This is part of the second phase of an Aquifer Storage Recovery (ASR) program to augment the City's water supply capacity to help meet peak demands and improve overall water supply reliability.

The selected site is at a parcel of land under control of NBU, near the New Braunfels Regional airport. Work at the site will include the drilling of a monitor well to an approximate depth of 1,025 ft below ground surface (bgs). Specifications for the monitoring well drilling project accompany this Invitation to Bid.

Arcadis-U.S. Inc. is directing the overall NBU ASR development program, assisted by ASR Systems LLC, Gainesville, Florida and INTERA Inc., Austin TX. For this specific work effort, INTERA Inc. will provide resident geologist observation services during drilling and completion of the well.

The project site is within the groundwater regulatory authority of the Edwards Aquifer Authority (EAA). NBU has obtained the authorizations for the work needed from EAA. All other construction-related licenses, permits and authorizations, if any, must be obtained by the selected contractor prior to initiating work.

The contractor shall provide documentation along with its bid on contractor's equipment, personnel, and experience during the past five years in performing this type of work and at these depths.

All bids must be submitted in sealed envelopes bearing on the outside: the title "NBU ASR Monitoring Well;" and the name of the bidder and its address. No bid security is required. Evidence of insurance will be required within seven days following notification by NBU of planned award of the project to the selected bidder

NBU reserves the right to reject any or all bids, to waive any informality in any bid or to re-advertise for bids. Selection will be made by NBU based upon bid price, applicable experience within the past five years, and project references.

Interested and experienced well drilling contractors are invited to submit bids for this project. Bids are due no later than **4:00 pm local time, (date)**, on the bid form provided herein. Any bid received after this date and time will not be considered. Bids shall be delivered to New Braunfels Utilities, 263 Main Plaza, New Braunfels, TX 78130. Any questions should be directed to Neil Deeds (512-425-2000) (ndeeds@intera.com).

Ian Taylor, P.E.
Chief Executive Officer
New Braunfels Utilities

BACKGROUND INFORMATION

New Braunfels Utilities, further referred to as NBU, is soliciting proposals from qualified water well drilling firms to drill and complete a six-inch monitoring well. The contractor shall comply with all laws, ordinances and codes, rules and regulations of the Local and State authorities having jurisdiction over any of the work specified herein. The location of the planned monitoring well is New Braunfels, Texas, adjacent to the New Braunfels Airport. The site is accessed via Saur Lane, a paved road, **Figure 1** shows a map of the site parcel. The bore hole site coordinates from Google Earth are: TBD. Any deviation from the site coordinates need to be approved by the client. The site for the monitoring well shall be approved by the contractor based on access and technical considerations related to the objectives of the project and the long-term monitoring objectives for the monitoring well. After testing is complete, the well shall be left in a condition that is suitable for long-term use as an monitoring well.

Prior to arrival of drilling equipment, access to the site from Saur Lane, approximately 350 feet, will be cleared by NBU along the south property line. Existing piles of fill dirt, building debris and small trees around the drilling site will be cleared and leveled by NBU to provide for drilling operations. The contractor shall take all reasonable precautions to minimize any damage to the property. NBU will also survey the property, establishing permanent markers at corners and temporary stakes every 100 feet along property boundary lines. A local permanent datum will be established at one location at the easterly corner of the property. Elevation of the permanent datum will be established later by others.

The soil cover is clay. NBU will provide gravel for the access route and drilling site to facilitate drilling operations during any wet weather. An NBU fire hydrant on Saur Lane is at the end of the site access route, approximately 200 ft from the bore hole site. NBU will provide a connection at the fire hydrant, including a control valve, flowmeter and backflow preventer. Water for drilling operations will be provided at no charge. The contractor is responsible for providing up to approximately 300 feet of hose or temporary piping to convey water from the fire hydrant to the drill site.

The project is to construct a monitoring well to an anticipated depth of up to about 1,025 feet. The target aquifer is the brackish portion of the Edwards Aquifer, which is expected to occur from a depth of about 525 to 975 feet, based on limited regional information. Geologic formations expected to be encountered during drilling are as follows:

Formation	**Top**	**Base**	**Description**
Alluvium	0	~50	very thin layer of alluvial flood plain deposits
Taylor Clay	50	100	mixture of clay, sand and marl
Austin Chalk	100	380	mostly chalk and marl
Eagle Ford Group	380	415	shale, siltstone and limestone
Buda Limestone	415	455	fine grained, hard, massive limestone
Del Rio Clay	455	525	calcareous and gypsiferous clay
Georgetown	525	575	fine to coarse grained limestone, chert nodules abundant

Edwards Group	575	975	various characters of limestone and dolomite
Walnut Clay	975	1015	marine clay formation
Upper Glen Rose	1025	?	alternating limestone, dolomite and marl

There is current uncertainty regarding depths of the formations, reflecting very limited available local data from existing wells, plus the possibility of buried faults in this area. In a separate procurement, a continuous wireline coring operation will be completed at the same site. This core information will be used by the client's geologist to better define the depths of the various formations, prior to the drilling and construction of the monitoring well.

Total drilling depth may perhaps need to extend to about 1,100 ft. Except for shallow alluvium and the Del Rio Clay, the formations encountered are expected to be capable of remaining open borehole; however, this is not certain. Casing will need to be set 10 ft below the base of the Del Rio Clay prior to drilling further into the Georgetown or below. A "Regional Dense Member (RDM)" may be encountered at a depth between approximately 650 to 700 ft. This is a thin, limestone, semi-confining layer approximately 20 ft thick. During drilling, the NBU consultant Team will have a geologist onsite to initially characterize bore hole lithology.

The water in the Edwards Aquifer is anticipated to be brackish. Any brackish water produced during drilling and well development shall be contained on site in temporary storage containers. If significant production of formation water starts to occur during drilling, a closed loop system will be implemented as to minimize groundwater production. The brackish water will eventually be discharged from the containers to an NBU sanitary sewer manhole, located approximately 2,000 feet from the drilling site on adjacent New Braunfels Airport property. However, the rate at which that disposal can occur will be dependent on the quality of the water, thus the requirement for containment in the temporary containers. The contractor will arrange for the temporary containers, and the necessary conveyance from the containers to the sanitary sewer manhole.

EQUIPMENT AND MATERIALS

The contractor shall furnish all necessary labor, equipment and materials required to perform the project, unless otherwise noted. Equipment shall be in good working condition, not subject to repeated failure that would delay progress. All materials needed for the work shall be new, and the contractor shall assume all responsibility for ordering materials. All downhole equipment and well casing shall be cleaned prior to delivery to the job site. Materials and equipment (well casings, casing shoes, grout tubing, grout, bentonite, and other materials as needed) shall be stored on site prior to starting drilling operations and in a manner that prevents damage from exposure to the elements or from any other cause. Site security for this equipment and materials is the sole responsibility of the contractor.

The contractor shall provide a temporary construction trailer at the site for shared use by the contractor's employees and also by the INTERA geologist and any authorized visitors to the site, such as NBU, Edwards Aquifer Authority, and ARCADIS. This would include temporary power, water, toilet facilities, refrigerator, heater and/or air conditioning.

DRILLING AND SAMPLING OVERVIEW

The contractor will drill and install a monitoring well to a depth of approximately 1,025 feet. Drilling and sampling will occur in three stages:

1. Ground surface to 10 ft below the base of the Del Rio Clay (~535 ft bgs),
2. Base of Del Rio Clay to the top of the RDM (~650 ft bgs) , and
3. Top of the RDM to total depth (TD) (~1025 ft bgs).

Stage 1 will consist of drilling, geophysical logging, and installing casing. Upon completion of installing the casing, the driller will grout the annulus between the outside of the casing and the bore hole from the bottom of the Del Rio Clay up to land surface using neat cement grout. The grout injection tremie pipe shall be placed initially 10 ft above the bottom of the borehole and then raised in small increments as pumped grouting proceeds, ensuring that a continuous grout seal is achieved. The bottom of the tremie pipe should remain submerged in grout throughout the grouting operations. If the bore hole collapses prior to grouting, the contractor shall clear the hole to the original depth by circulating mud prior to emplacing the grout. From the commencement of drilling, the contractor is required to provide cuttings to the client's on-site geologist every 10 linear feet of borehole completed.

During stage 2 the contractor will drill to the top of the RDM. Upon nearing the RDM, cuttings will be provided every 5 linear feet to aid identification of this unit. Upon encountering the RDM, the contractor will trip out drill string, and purge the well until the client's on-site geologist determines that a representative water quality sample can be taken. The client's on-site geologist will take water quality samples with contractor assistance. Prior to purging, the contractor will measure the water level in the well. During purging, the contractor will estimate the flow rate from the well and measure the water level under pumping conditions.

During stage 3, the contractor will drill to TD as designated by the client's on-site geologist, trip out drill string, and prepare the site and well to run a geophysical log. The contractor is not responsible for logging. After logging is complete, an inflatable packer will be placed at or below the bottom of the RDM (to be specified by client's geologist) to isolate the interval above the RDM from an interval below the RDM, with a pump below the packer. The packer should be rated for a 200 psi pressure differential, and of the type that can be left downhole and continued to operate effectively after construction is complete. An example of this type of packer is here (model 350-SD-01):

http://www.continentaldrillingsupply.com/Packers.pdf

Additionally, a piezometer will be installed below the packer. Prior to purging, the contractor will record the water level. The interval below the packer will be purged by pumping until the client's on-site geologist determines that a representative water quality sample can be taken, and the water level will be measured under pumping conditions. The client's on-site geologist will take water quality samples with contractor assistance.

The Edwards Aquifer Authority (EAA), San Antonio, will provide geophysical logs for this project, using in-house Slimline geophysical logging equipment. There will be no charge to the contractor for these services. The contractor will arrange with EAA to obtain geophysical logs for the full length of the open bore hole, which will consist of two separate logging runs. Contractor will contact Mark Hamilton/EAA at (210) 222-2204 to schedule logging operations. Contractor shall notify EAA with a tentative estimate for when logging can occur, with a minimum of 1 day notice. Logs will include gamma, resistivity, fluid conductivity, caliper, video, and sonic porosity. The two logging runs are as follows: one from the base of the surface casing to the base of the Del Rio Clay at about 525 ft, and one from 525 ft to the bottom of the bore hole at about 1,025 ft. If unexpected, unconsolidated deposits or swelling clays are found in the interval from 525 ft to the bottom of the bore hole, drilling will be conducted to the full depth, however geophysical logging below the problematic depth interval may not be completed.

DRILLING OPERATIONS

A. The contractor shall drill a minimum 24" borehole and furnish and install a minimum 20" conductor casing to a depth of 50 feet bgs.

B. Using an air or mud rotary drilling process, the contractor will drill a minimum 14" borehole and (after logging by EAA as described in the previous section) complete with 10" nominal SDR-17 PVC casing from 50 feet to approximately 535 feet below ground surface or, 10 feet into the top of the Georgetown Formation. Grouting of the casing will require grout be pumped in place using the positive displacement method with a pneumatic grout pump and construction tremie pipe initially set 10 feet above the base of the borehole. Grouting in stages will be required to control heat of hydration.

C. Using a mud-free drilling process, the contractor will drill a 6" borehole to 650 feet below ground surface or, the top of the Regional Dense Member of the Edwards Group. Any produced water must be contained stored on site in containers. If significant brackish water is produced, beyond what can be stored in containers, the contractor must utilize a close-loop system to reduce/minimize this production.

D. The contractor will then pull all of the drill string out of the hole and purge the hole as described in the previous section.

E. Using a mud-free drilling process, the contractor will then drill a 6" borehole to approximately 1,025 feet below ground surface or, clearly below the base of the Walnut Clay, as designated by the client's on-site geologist. Produced water must be handled as described in (C) above.

F. The contractor will then pull all of the drill string out of the hole, and set an inflatable packer at the base of the RDM, with a pump below the packer. The contractor will then purge the interval as described in the previous section. Purged water must be stored in containers.

G. The contractor will plug the well back up from TD to:

    a. 25' below the bottom of the RDM, or

    b. the top of the RDM (approximated to be 650 feet bgs).

   The chosen alternative will be based on the findings from the wireline coring (a separate procurement), geophysical logging, and results of the water quality sampling of the intervals above and below the RDM. Any plugging shall be with neat cement grout, except in lost circulation intervals where gravel may be utilized to bridge the interval.

   Alternative (a) will require reinstallation of the packer, and the piezometer and pump below the packer. The piping connected to the packer (should that alternative be chosen) will be secured at the wellhead. Alternative (b) will not include a packer or other equipment, since the Lower interval will be completely plugged.

SITE COMPLETION

A. The surface completion will include a 6 ft by 6 ft concrete pad, with 4 steel bollards at the corners for protection from farm equipment.
B. The wellhead will extend above the concrete pad approximately 2 feet, and be protected with a locking cap. The wellhead requires a 2” access port on the side of the riser to allow wires from downhole instrumentation to pass through.
C. Contractor will work with client’s geologist to drain the brackish water from the on-site containers to the sanitary sewer, and arrange for eventual removal of the containers from the site.
D. Upon completion of site operations, contractor will remove all debris from the site and restore it to its original condition, to the satisfaction of NBU.

SUBMITTALS

A. Prior to construction, contractor shall submit to client a schedule indicating the sequence and estimated timing of Work.
B. The contractor will keep an accurate field log of construction and testing activities.
C. Formation drill cuttings shall be made available to the project geologist.
D. The Bid Sheet includes an item for Standby Time. Approval for standby time will need to be issued by NBU. Delays due to contractor’s equipment failure will not qualify for standby time approval. Delays due to bad weather or other natural causes beyond the control of the contractor will be considered for approval for an extension of project completion time, but not for standby time. Delays due to failure or delayed arrival of EAA geophysical logging equipment will be considered for approval of standby time.
E. Liquidated Damages shall apply if field activities exceed 21 calendar days. The amount shall be $Y,YYY per day, offsetting the cost for the resident geologist time and expenses.

NEW BRAUNFELS UTILITY

MONITOR WELL

BID SHEET

The Bid Sheet shall be attached to and shall be a part of the complete Contract Documents.

It is agreed that all field work on the **MONITORING WELL DRILLING** shall be completed within **21 calendar days** of the date specified in the written Notice to Proceed.

UNIT PRICE BID SCHEDULE					
ITEM	**DESCRIPTION**	**QUANTITY**	**UNIT**	**UNIT COST**	**EXTENSION**
1	MOBILIZATION/ DEMOBILIZATION	1	LS		
2	ROTARY DRILL HOLE FOR SURFACE CASING	50	FT		
3	FURNISH/INSTALL SURFACE CASING	50	FT		
4	DRILL MINIMUM 14” BOREHOLE	485	FT		
5	FURNISH/INSTALL 10” CASING	485	FT		
6	MUD FREE CLOSE CIRCUIT DRILL 6” BOREHOLE	490	FT		
7	BACKFILL AND GROUT TO RDM	325	FT		
8	UPPER INTERVAL WELL PURGING	6	HRS		
9	LOWER INTERVAL WELL PURGING	12	HRS		
10	INFLATABLE PACKER, PIEZOMETER, AND PUMP	1	LS		
10	PRODUCED WATER HANDLING/STORAGE	1	LS		
11	STANDBY TIME	8	HRS		
TOTAL					

Contractor Name: ____

Address: ____

____

Phone Number: ____

Well Drilling and Installation Experience:

On a separate sheet provide pertinent experience during the past five years, including a brief description of at least three well drilling and installation projects and associated equipment and field staff. This experience must include use of inflatable packers to isolate borehole intervals.

References:

On a separate sheet provide at least three references with contact information.

An insurance certificate in the amount of $1 million shall be provided by the selected contractor within seven days following notification of contract award.

Submit bids to the following address:

New Braunfels Utilities

263 Main Plaza

New Braunfels, TX 78130

Attention: Michael Short, P.E., Chief Engineer for Water Services

Questions should be directed to the following address:

Neil Deeds, P.E.

INTERA Incorporated

1812 Centre Creek Drive

Austin, TX 78754

Telephone 512-425-2025 (office)

512-506-1230 (cell)

Email: ndeeds@intera.com

10.3 Appendix C. Coring report

AQUIFER STORAGE RECOVERY PROGRAM
CORING REPORT
NEW BRAUNFELS UTILITIES
NEW BRAUNFELS, TEXAS

PREPARED FOR

ASR SYSTEMS, INC.
GAINESVILLE, FLORIDA

AND

NEW BRAUNFELS UTILITIES
NEW BRAUNFELS, TEXAS

PREPARED BY

GROUNDWATER MANAGEMENT ASSOCIATES, INC.
4300 SAPPHIRE COURT, SUITE 100
GREENVILLE, NORTH CAROLINA 27834

GROUNDWATER MANAGEMENT ASSOCIATES, INC.

JUNE 28, 2018

This report has been prepared by Groundwater Management Associates, Inc., a professional corporation employing individuals licensed to practice geology in Texas.

STATE OF TEXAS
RICHARD KENT SPRUILL
GEOLOGY 3/5/19
12888
LICENSED
PROFESSIONAL GEOSCIENTIST

Richard K. Spruill, Ph.D., P.G.
Principal Hydrogeologist

NORTH CAROLINA
LICENSED
SEAL 3/5/19
1060
GEOLOGIST
JAMES K. HOLLEY

James K. Holley, P.G.
Senior Hydrogeologist

NORTH CAROLINA
LICENSED
SEAL 3-5-19
2355
GEOLOGIST
KELLEY ALAN SMITH

Kelley A. Smith, P.G.
Project Hydrogeologist

Table of Contents

1.0 INTRODUCTION

New Braunfels Utilities (NBU) in New Braunfels, Texas is developing an ASR program with the support of ASR Systems LLC (ASRS). ASRS is working as a subconsultant to ARCADIS US, Inc. ASRS requested that Groundwater Management Associates, Inc. (GMA) provide geological consulting support to the project as a subconsultant to ASRS. One specific service requested of GMA included field geological services associated with continuous wireline core drilling at a site near the New Braunfels Regional Airport. GMA has provided similar services for ASRS on other projects in the United States, and we have developed protocols and core-logging methods that are tailored to coring practices developed by ASRS.

This report, prepared by GMA, presents hydrogeologic observations and evaluations during oversight of the continuous wire-line coring near the New Braunfels Regional Airport, New Braunfels, Guadalupe County, Texas.

2.0 CORE COLLECTION AND DESCRIPTION

Preliminary interpretation of regional hydrogeologic data suggested that 1100 feet depth would be sufficient to penetrate and provide data of the entire Edwards Group. ASRS and ARCADIS developed specifications for continuous coring and monitoring well construction as a part of an Aquifer Storage Recovery (ASR) feasibility study of the selected site.

The primary drilling contractor, Kutscher Drilling (Kutscher) of San Marcos, Texas, subcontracted with Cascade Drilling (Cascade) to provided wire-line coring services and to work in cooperation with GMA to collect, describe, and store 2.5-inch diameter (HQ) cores collected from approximately 59 to 1097 feet depth below land surface (bls). Kutscher mobilized to the site on March 17, 2018, and set a 4-inch diameter outer casing to a depth of approximately 59 feet bls. Cascade setup on the 4-inch casing, and they began coring activities on March 19, 2018 and ended on April 5, 2018. Figure 1 illustrates the location of the core hole (CH-1) near the New Braunfels Regional Airport. Figure 2 is a copy of the geologist's core log prepared by GMA, which details the lithology, core description specifics, aquifer interval designations, depth intervals of core samples submitted for geochemical and geotechnical analyses, natural gamma, resistivity, and caliper logs, and core recovery percentages.

The 2.5-inch diameter "HQ" cores were collected in a core barrel, delivered to the land surface via the wire-line, and then extruded by hand into a stainless-steel half-shell tray. Cascade carefully transferred the core to the hydrogeologist's work table where the cores were measured inside the steel half-shell tray. GMA provided a hydrogeologist on site during the core sampling to document the core drilling process, to photograph core samples, to describe the lithology, color, texture and structure of sediments or rock, and to determine total and solid core recovery percentage, and the rock quality designation. The total core recovery percentage (TCR%) is the borehole core recovery percentage, and the solid core recovery percentage (SCR%) is the borehole core recovery percentage of solid, cylindrical, pieces of rock core (Deere, 1964). The rock quality designation (RQD) is the measure of rock core quality and signifies the degree of jointing or fracturing in a rock mass, measured as a percentage of the drill core in lengths of 10 cm (4 inches) or more. An RQD of greater than 75% represents good quality, while an RQD of less than 50% represents low quality

(Deere, 1964). GMA also collected and froze representative core samples for subsequent mineralogical and chemical analysis. Cores were generally clean of drilling mud, but when necessary, GMA lightly rinsed the cores prior to description. GMA utilized the Munsell Soil Color Charts (1994) for color descriptions, and sediment grain sizes were referenced to the Wentworth (1922) grain-size scale to ensure consistent description of the cores. Core descriptions were based upon the Folk (1965) Classification of sedimentary rocks. An annotated photographic record in DVD format of the core is attached to this report.

At 416.5 feet BLS, GMA noted that there may have been inconsistencies by the drilling crew in how the cores were laid out on the viewing table and in the core boxing procedure. There is a possibility that some of the core intervals above 416.5 feet BLS may have been laid out and photographed with the core bottoms and tops reversed in the viewing tray and core boxes. GMA recognized the inconsistency in core handling, and we took steps to ensure that all core photos below 416.5 ft. were oriented properly.

Because the majority of the sediments encountered in the cored section were composed of carbonate rock, core recovery percentages were excellent (94% total recovery). Intervals of lower recovery percentage were generally thought to be attributed to operational issues, such as plugging of the core barrel. Coring penetrated through the Taylor Group, Austin Group, Eagle Ford Group, Buda Limestone, Del Rio Clay, Georgetown Formation, the Person and Kainer Formations of the Edwards Group, and into the upper section of the Glen Rose Limestone. These hydrostratigraphic units are described below in section "3.0 LITHOLOGY".

The cores were carefully placed into waxed cardboard core storage boxes by Cascade. Each core box was labeled indicating the depth and orientation relative to the land surface of each core section. Once coring was completed, the core boxes were transferred by Kutscher to the New Braunfels Utilities office for long-term storage. The intention is to store the cores at this location for approximately five years, or two years after placing the ASR wells into operation, whichever is later. The cores may then be donated to an appropriate federal or state agency, or to a university. The purpose of storing the cores locally is to address any geochemical issues that may possibly arise. Typically, any such issues usually manifest during the first year of ASR operations. While none are expected at this location, it is recommended to keep the option available for further analyses of the cores.

During the coring procedures, GMA collected and froze nineteen core samples for possible geochemical and geotechnical laboratory testing. Once coring was completed, GMA reviewed geophysical logs and core drilling notes, discussed the data with ASRS and ARCADIS, and conveyed to Kutscher six core sample selections of the nineteen to be submitted for analysis. The six chosen core samples were approximately twelve inches long, were carefully labeled, and were protectively wrapped by GMA. Kutscher packed the samples in dry ice, and shipped them to Mineralogy Inc. in Tulsa, Oklahoma. The attached geologist's core log (Figure 2) indicates the depths of the six selected core samples that were submitted for analyses. Subsequently two additional core sections were shipped to Mineralogy Inc. for supplemental geotechnical analysis to determine vertical hydraulic conductivity.

3.0 LITHOLOGY

Based upon our integration of coring observations and the collected geophysical and sonic logs, GMA has developed a detailed interpretation of the hydrostratigraphy (Figure 2-Geologist's Core Log) underlying the NBU core hole site. Nine principal hydrostratigraphic units were identified. These units (from the depth of approximately 59 feet downward) include:

- The Taylor Group (Kta)
  The Taylor Group occurs from approximately 59 to 274 feet bls. The Taylor is described as a tan to gray interbedded calcareous claystone (marl) and siltstone. Marl is a calcium carbonate or lime-rich mud or mudstone which contains variable amounts of clay and aragonite. A strong petroleum odor was noted throughout the section.

- The Austin Group (Kau)
  The Austin Group occurs at depths of approximately 274 to 415 feet bls. Field core descriptions indicate that the Austin is a light gray to white, fine sandy to silty, fossiliferous limestone (intramicrite) to chalk. Evidence of bioturbation and lamination was noted throughout. The predominant fossils observed are bivalves, possibly Gryphaea. The Austin functions as a confining unit.

- The Eagle Ford Group (Kef)
  The Eagle Ford Group occurs from approximately 415 to 433 feet bls. The Eagle Ford functions as a confining unit. This unit is described as a brown laminated calcareous mudstone to fine grained sandstone. A strong petroleum odor was noted throughout the section.

- The Buda Limestone (Kb)
  The Buda Limestone unit occurs at depths of approximately 433 to 483 feet bls. At the NBU site, this confining unit is composed of light gray sandy limestone (micrite to intramicrite).

- The Del Rio Clay (Kdr)
  The Del Rio Clay occurs from approximately 483 to 532 feet bls. This is a thick confining unit composed of gray, finely laminated, fossiliferous claystone.

- The Georgetown Formation (Kg)
  The Georgetown Formation occurs from approximately 532 to 583 feet bls. This unit is a gray to white vuggy, fossiliferous limestone (micrite, intramicrite, and packed biomicrite) that functions as a confining layer in the upper part and transitions into more permeable materials with depth.

- The Person Formation of the Edwards Group
  The Person Formation occurs from approximately 583 to 734 feet bls at the site. The upper members of the Person (the "Cyclic and Marine" and "Leached and Collapsed" members) (Maclay, 1995) function collectively as an aquifer from approximately 583 to 712 feet bls. The "Cyclic and Marine" section beneath the site is described as a light gray to tan dense, porous, dolomite, dolomitic limestone, and limestone (intramicrite). Black chert was noted throughout. The "Leached and Collapsed" member is described as a light gray laminated,

bioturbated limestone (micrite to intramicrite) with interbedded gray limestone (packed biomicrite). This section is locally fractured. Based upon GMA's interpretation of the sonic log collected from the NBU core hole, we identified the following intervals that are likely to have higher porosity in the Person Formation:

Depth (feet)	Aquifer Unit
592-602	Person Formation
612-622	Person Formation
631-657	Person Formation
665-678	Person Formation
692-708	Person Formation

The basal member of the Person, the regional dense member (RDM), functions as a confining layer and is described as a white to cream, dense, laminated limestone (micrite). The RDM occurs from approximately 712 to 734 feet bls.

- The Kainer Formation of the Edwards Group.
The Kainer Formation occurs from approximately 734 to 1046 feet bls at the site. Like the Person Formation, the upper members of Kainer (the "Grainstone", "Kirschberg Evaporite", and "Dolomitic" members) (Maclay, 1995) function collectively as an aquifer. The "Grainstone" section beneath the NBU site is described as a light brown to tan bioturbated, porous, limestone (packed biomicrite to intramicrite). Black chert was noted throughout. The "Kirschberg Evaporite" member is described as an interbedded cream to tan dolomite, and gray limestone (packed biomicrite to intramicrite). The "Dolomitic" member is described as interbedded dark gray dolomite, and gray laminated, fossiliferous limestone (packed biomicrite to intramicrite). Based upon GMA's interpretation of the sonic log collected from the NBU core hole, we identified the following intervals that are likely to have higher porosity in the upper Kainer Formation:

Depth (feet)	Aquifer Unit
781-811	Kainer Formation
844-850	Kainer Formation
876-880	Kainer Formation
891-917	Kainer Formation
921-925	Kainer Formation
942-950	Kainer Formation

The basal member of the Kainer, "Basal Nodular" (sometimes referred to as the Walnut Clay), functions as a confining layer and is described as a gray to dark gray laminated dolomite, and light gray laminated, fossiliferous limestone (intramicrite). The "Basal Nodular" occurs from approximately 950 to 1046 feet bls.

- <u>The Upper section of the Glenn Rose Limestone (Kgru).</u>
  The core hole terminated at approximately 1097 feet bls in the upper section of the Glen Rose Limestone. This unit begins at a depth of approximately 1046 feet bls, and it is described as a gray, laminated, bioturbated, porous limestone (intramicrite). The upper Glen Rose functions as an aquifer.

A detailed interpretation of the hydrostratigraphy underlying the NBU core hole site can be found in Figure 2, the geologist's core log.

4.0 REPORT CERTIFICATION

This report has been prepared by Groundwater Management Associates, Inc., a professional corporation employing individuals licensed to practice geology in Texas.

Richard K. Spruill, Ph.D., P.G.
Principal Hydrogeologist

STATE OF TEXAS
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Senior Hydrogeologist

NORTH CAROLINA
LICENSED
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2355
GEOLOGIST
KELLEY ALAN SMITH
3-5-19

Kelley A. Smith, P.G.
Project Hydrogeologist

5.0 REFERENCES

Deere, D. U.; 1964, "*Technical Description of Rock Cores*", Rock Mechanics Engineering Geology, 1. pp. (16-22).

Folk, R.L.; 1965, *Petrology of Sedimentary Rocks*, Hemphill Publishing Company, Austin, TX

Maclay, R.W. 1995. *Geology and Hydrogeology of the Edwards Aquifer in the San Antonio Area, Texas.* U.S. Geological Survey Water Resources Investigations Report 95-4186, 64 pages.

FIGURES

LEGEND

NBU CORE HOLE SITE (NBU-CH-1)

PROJECT: 70210

NEW BRUANFELLS UTILITIES CORE HOLE (NBU-CH-1) SITE LOCATION

FIGURE 1	DATE 06/05/2018

0 250 500'

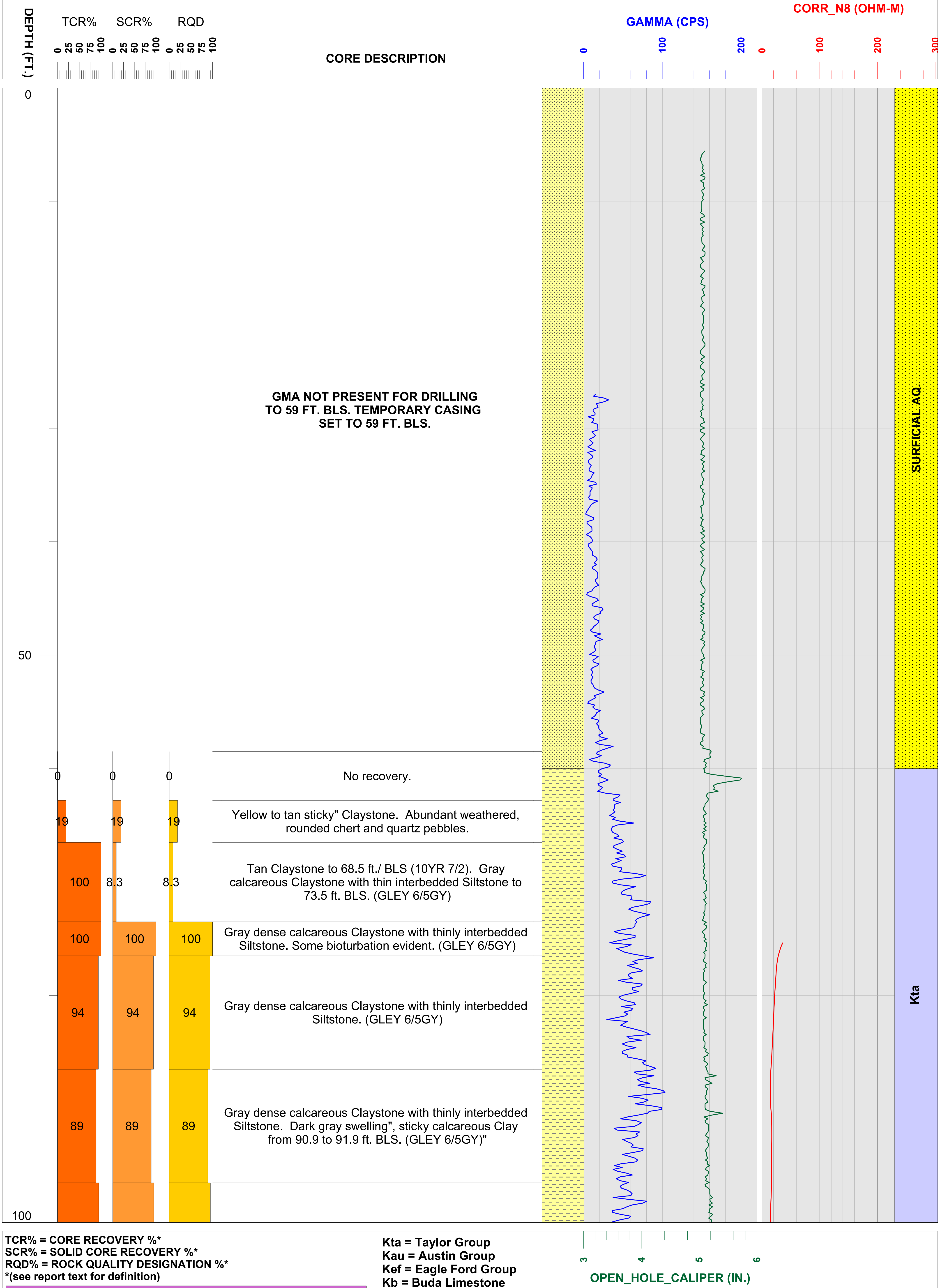
1 " = 250 '

NEW BRAUNFELS UTILITIES
NEW BRAUNFELS,
GUADALUPE COUNTY, TEXAS

GMA
GROUNDWATER MANAGEMENT ASSOCIATES, INC.

NEW BRAUNFELS, TX ASR CORE HOLE PROJECT (NBU-CH-1)

GMA Project #: 70210
NEW BRAUNFELS, GUADALUPE CO., TX
Dates Drilled: 3/20/2018 to 4/5/2018
Site Location: N 29.704500°, W 98.053611°



Depth interval	TCR%	SCR%	RQD	Core Description
	0	0	0	No recovery.
	19	19	19	Yellow to tan sticky" Claystone. Abundant weathered, rounded chert and quartz pebbles.
	100	8.3	8.3	Tan Claystone to 68.5 ft./ BLS (10YR 7/2). Gray calcareous Claystone with thin interbedded Siltstone to 73.5 ft. BLS. (GLEY 6/5GY)
	100	100	100	Gray dense calcareous Claystone with thinly interbedded Siltstone. Some bioturbation evident. (GLEY 6/5GY)
	94	94	94	Gray dense calcareous Claystone with thinly interbedded Siltstone. (GLEY 6/5GY)
	89	89	89	Gray dense calcareous Claystone with thinly interbedded Siltstone. Dark gray swelling", sticky calcareous Clay from 90.9 to 91.9 ft. BLS. (GLEY 6/5GY)"

TCR% = CORE RECOVERY %*
SCR% = SOLID CORE RECOVERY %*
RQD% = ROCK QUALITY DESIGNATION %*
***(see report text for definition)**
POROSITY & PERMEABILITY SAMPLE (FT. BLS)
VERTICAL HYDRAULIC CONDUCTIVITY SAMPLE (FT. BLS)
POROSITY, PERMEABILITY, & VERT. HYD. COND. SAMPLE (FT. BLS)
FT. BLS = FEET BELOW LAND SURFACE

Kta = Taylor Group
Kau = Austin Group
Kef = Eagle Ford Group
Kb = Buda Limestone
Kdr = Del Rio Clay
Kg = Georgetown Formation
Kgru = upper Glen Rose Limestone

CORE DESCRIPTION/CLASSIFICATION IS BASED UPON FOLK (1965).
Folk, R.L.; 1965, Petrology of Sedimentary Rocks, Hemphill

FIGURE 2.

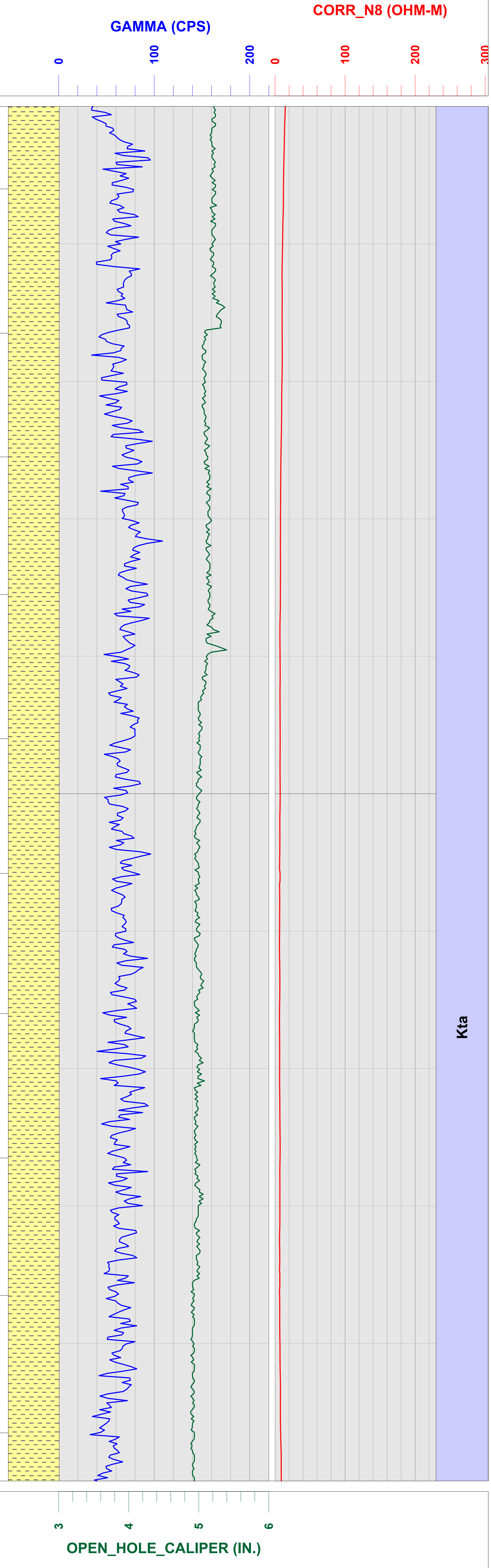
NEW BRAUNFELS, TX ASR CORE HOLE PROJECT (NBU-CH-1)

GMA

GROUNDWATER MANAGEMENT ASSOCIATES, INC.

GMA Project #: 70210
NEW BRAUNFELS, GUADALUPE CO., TX
Dates Drilled: 3/20/2018 to 4/5/2018
Site Location: N 29.704500°, W 98.053611°

DEPTH (FT.)	TCR%	SCR%	RQD	CORE DESCRIPTION
100	95	95	95	Gray dense calcareous Claystone with thinly interbedded Siltstone. (GLEY 6/5GY)
	80	80	80	Gray dense calcareous Claystone with thinly interbedded Siltstone. (GLEY 6/5GY)
	100	100	100	Gray dense calcareous Claystone with thinly interbedded Siltstone. Minor pyrite and bivalve shells. Petroleum odor. (GLEY 6/5GY)
	100	100	100	Gray dense calcareous Claystone with thinly interbedded Siltstone. Various interclasts occur. Petroleum odor. (GLEY 6/5GY)
	92	92	89	Gray dense calcareous Claystone with thinly interbedded Siltstone. Occasional interclasts from 140 to 142 ft. BLS. Petroleum odor. (GLEY 6/5GY)
150	100	100	100	Dark gray fissile calcareous Claystone with thinly interbedded Siltstone. Minor pyrite. Small section of sticky" gray Clay from 154 to 155 ft. BLS. Dominant color change near end of section from GLEY 6/5GY to GLEY 4/10GY. Petroleum odor. (GLEY 4/10GY)
	100	100	93	Dark gray dense calcareous Claystone with thinly interbedded Siltstone. Lower fissility. Petroleum odor. (GLEY 4/10GY)
	95	29	29	Dark gray dense calcareous Claystone with thinly interbedded Siltstone. Large interclasts from 162 to 164 ft. BLS. Major fracturing, possibly mechanical, occurs in the upper sections of the core. Minor pyrite. Petroleum odor. (GLEY 4/10GY)
	93	93	93	Gray dense calcareous Claystone with thinly interbedded Siltstone. Abundant interclasts and bioturbation. Color does vary between gray and dark gray. Minor calcite and pyrite. (GLEY 4/10GY)
	100	100	100	Gray and dark gray dense calcareous Claystone with thinly interbedded Siltstone. More fissile than above. Minor pyrite. Darker sections are tar-like and have strong petroleum odor. (GLEY 4/10GY)
200				Gray and dark gray dense calcareous Claystone with



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Kgru = upper Glen Rose Limestone

CORE DESCRIPTION/CLASSIFICATION IS BASED UPON FOLK (1965).
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FIGURE 2.

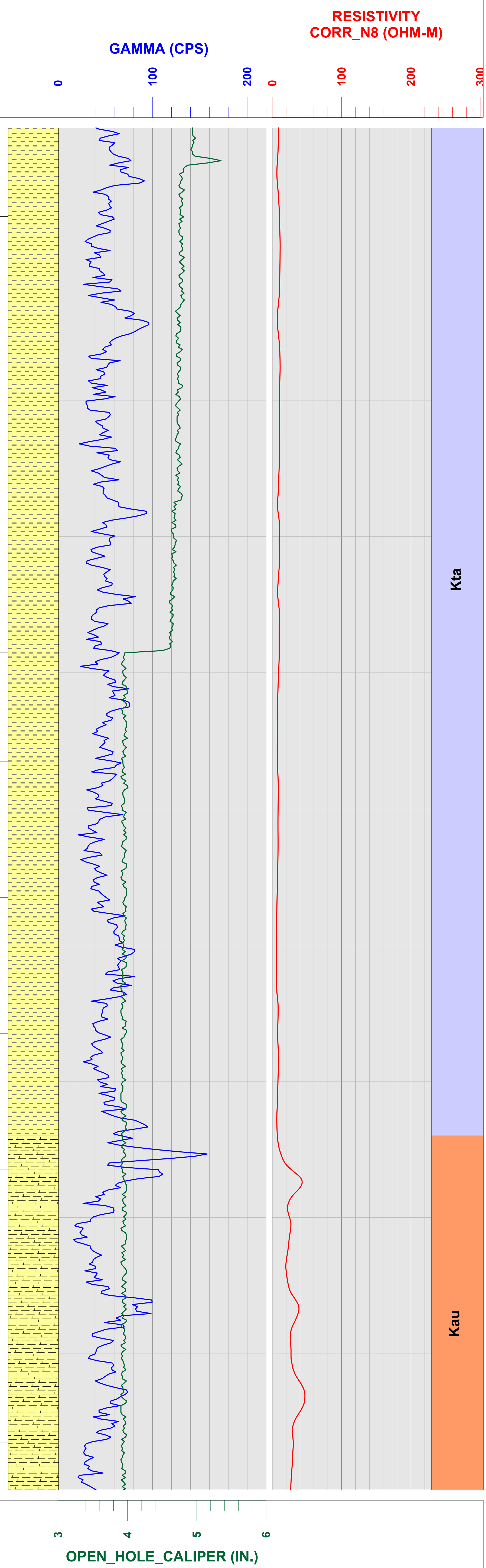
GMA
GROUNDWATER MANAGEMENT ASSOCIATES, INC.

NEW BRAUNFELS, TX ASR CORE HOLE PROJECT (NBU-CH-1)

GMA Project #: 70210
NEW BRAUNFELS, GUADALUPE CO., TX
Dates Drilled: 3/20/2018 to 4/5/2018
Site Location: N 29.704500°, W 98.053611°

DEPTH (FT.): 200 – 300

TCR%	SCR%	RQD	CORE DESCRIPTION
88	88	88	thinly interbedded Siltstone. Abundant interclasts and bioturbation. Minor pyrite and sparry calcite. Dominant color change near end of section from GLEY 4/10GY to GLEY 6/5GY. Petroleum odor. (GLEY 6/5)
94	94	94	Gray and dark gray dense calcareous Claystone with thinly interbedded Siltstone. Bioturbation and interclasts are abundant. Darker sections are tar-like and have heavy petroleum odor. Minor pyrite and sparry calcite. (GLEY 6/5GY)
95	95	95	Gray and dark gray dense calcareous Claystone with thinly interbedded Siltstone. Some bioturbation and occasional interclasts. Minor pyrite, and iron staining. Petroleum odor. (GLEY 6/5GY)
100	100	100	Gray calcareous Claystone with thinly interbedded Siltstone. Bioturbation and interclasts evident. Prominent sparry calcite zone with pyrite from 234.5 to 235.5 ft. BLS. Some calcite infilling at breaks/fractures. Minor fromboital pyrite. (GLEY 6/5GY)
0	0	0	
100	100	100	Gray and dark gray dense calcareous Claystone with thinly interbedded Siltstone. Bioturbation and interclasts common. Minor pyrite. Petroleum odor. (GLEY 6/5GY)
98	98	98	Gray and dark gray dense calcareous Claystone with thinly interbedded Siltstone. Bioturbation and interclasts common. Minor pyrite. Petroleum odor. (GLEY 6/5GY)
98	98	92	Gray and dark gray dense calcareous Claystone with thinly interbedded Siltstone. Bioturbation and interclasts common. Prominent interclasts at 263 ft. BLS. Some black coarse sand and pebbles up to 16mm observed in thin layers at 257 and 259 ft. (GLEY 6/5GY)
100	100	100	Gray and dark gray dense calcareous Claystone with thinly interbedded Siltstone. Minor pyrite and green mineral sand (glauconite?). Petroleum odor. (GLEY 6/5GY) At 274 ft. BLS, lithology changes to light gray to white slightly sandy, fossiliferous Limestone-Chalk (intramicrite). Some bioturbation. Fossils are mostly bivalves, possibly Gyphaea. (GLEY 8/10Y)
99	99	99	Light gray to white sandy, fossiliferous, Limestone-Chalk (intramicrite) from 276.5 to 279 ft. BLS. 279 to 286.5 ft. BLS is sandy biomicrite. Some bioturbation and lamination. Black and green (glauconite?) sand. Fossils are bivalves, possibly Gryphaea. (GLEY 8/10Y)
100	100	100	Light gray to white slightly sandy, fossiliferous, Limestone-Chalk (intramicrite). Some bioturbation. Black and green (glauconite?) sand. Fossils are bivalves, possibly Gryphaea. (GLEY 8/10Y)
			Light gray to white slightly sandy, fossiliferous,



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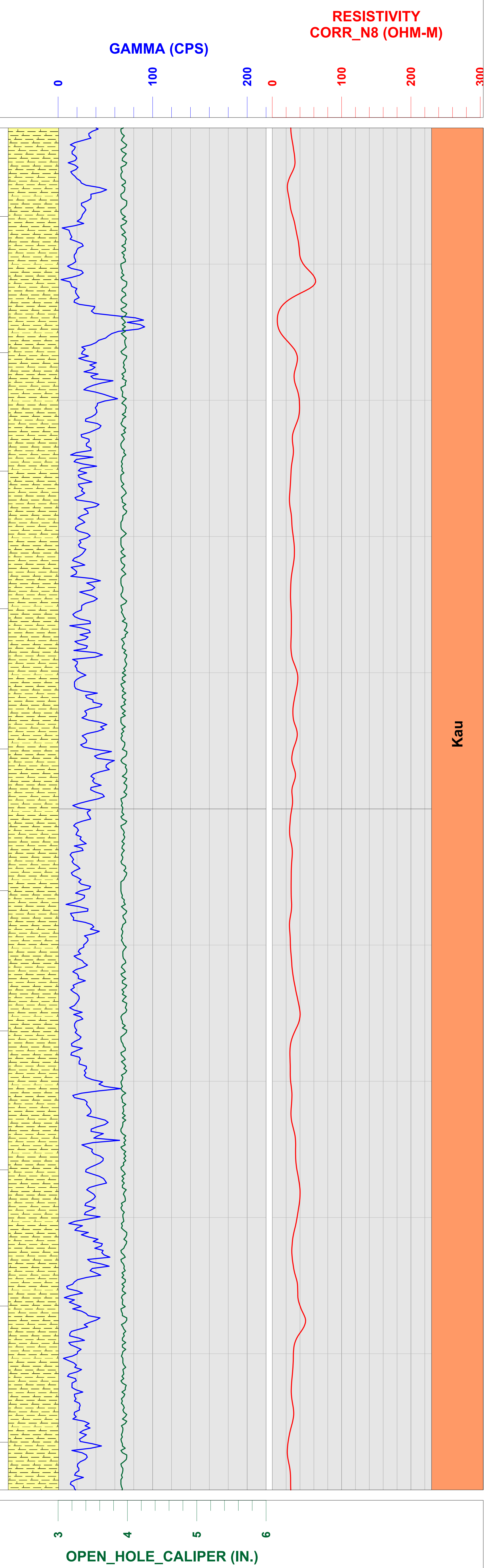
NEW BRAUNFELS, TX ASR CORE HOLE PROJECT (NBU-CH-1)

GMA Project #: 70210
NEW BRAUNFELS, GUADALUPE CO., TX
Dates Drilled: 3/20/2018 to 4/5/2018
Site Location: N 29.704500°, W 98.053611°

DEPTH (FT.)	TCR% (0 25 50 75 100)	SCR% (0 25 50 75 100)	RQD (0 25 50 75 100)	CORE DESCRIPTION
300	98	98	93	Limestone-Chalk (micrite to intramicrite). Some bioturbation and lamination. Minor calcite infilling. Black and green (glauconite?) sand. Fossils are mostly bivalves, possibly Gryphaea. (GLEY 8/10Y)
	86	86	86	Light gray to white slightly sandy, fossiliferous, Limestone-Chalk (intramicrite). Some bioturbation. Minor pyrite, and calcite infilling. Black and green (glauconite?) sand. Fossils are mostly bivalves, possibly Gryphaea. (GLEY 8/10Y). Small section of soft gray calcareous Clay (marl) from 314 to 316 ft. BLS.
	99	89	89	Light gray to white slightly sandy, Limestone-Chalk (micrite to intramicrite) . Some bioturbation and lamination. Black and green (glauconite?) sand. (GLEY 8/10Y)
	98	98	98	Light gray to white slightly sandy, Limestone-Chalk (micrite to intramicrite) . Some bioturbation and lamination. Black and green (glauconite?) sand. (GLEY 8/10Y)
	100	99	99	Light gray to white slightly sandy, Limestone-Chalk (fossiliferous micrite to intramicrite) . Some bioturbation and lamination. Black and green (glauconite?) sand. (GLEY 8/10Y)
350	99	99	99	Light gray to white slightly sandy, fossiliferous, Limestone-Chalk (micrite to intramicrite). Some bioturbation and lamination. Black and green (glauconite?) sand. Minor pyrite. Fossils are bivalves, possibly Gryphaea. (GLEY 8/10Y)
	99	99	99	Light gray to white slightly sandy, fossiliferous, Limestone-Chalk (micrite to fossiliferous micrite). Some bioturbation and lamination. Black and green (glauconite?) sand. Fossils are bivalves, possibly Gryphaea. (GLEY 8/10Y)
	99	99	96	Light gray to white slightly sandy, fossiliferous, Limestone-Chalk (intramicrite to fossiliferous micrite). Some bioturbation and lamination. Black and green (glauconite?) sand. Minor pyrite and possible ash. Fossils are bivalves, possibly Gryphaea. (GLEY 8/10Y)
	100	100	97	Light gray to white slightly sandy, fossiliferous, Limestone-Chalk (micrite to fossiliferous micrite). Some bioturbation and lamination. Black and green (glauconite?) sand. (GLEY 8/10Y and 5/10Y)
	100	100	100	Light gray to white slightly sandy, fossiliferous, Limestone-Chalk (intramicrite to fossiliferous micrite). Some bioturbation and lamination. Black and green (glauconite?) sand. Small section of brown Mud from 386.5 to 388.5 ft. BLS. (GLEY 7/10Y)
400				Light gray to white slightly sandy, fossiliferous,



TCR% = CORE RECOVERY %*
SCR% = SOLID CORE RECOVERY %*
RQD% = ROCK QUALITY DESIGNATION %*
*(see report text for definition)

POROSITY & PERMEABILITY SAMPLE (FT. BLS)

VERTICAL HYDRAULIC CONDUCTIVITY SAMPLE (FT. BLS)

POROSITY, PERMEABILITY, & VERT. HYD. COND. SAMPLE (FT. BLS)

FT. BLS = FEET BELOW LAND SURFACE

Kta = Taylor Group
Kau = Austin Group
Kef = Eagle Ford Group
Kb = Buda Limestone
Kdr = Del Rio Clay
Kg = Georgetown Formation
Kgru = upper Glen Rose Limestone

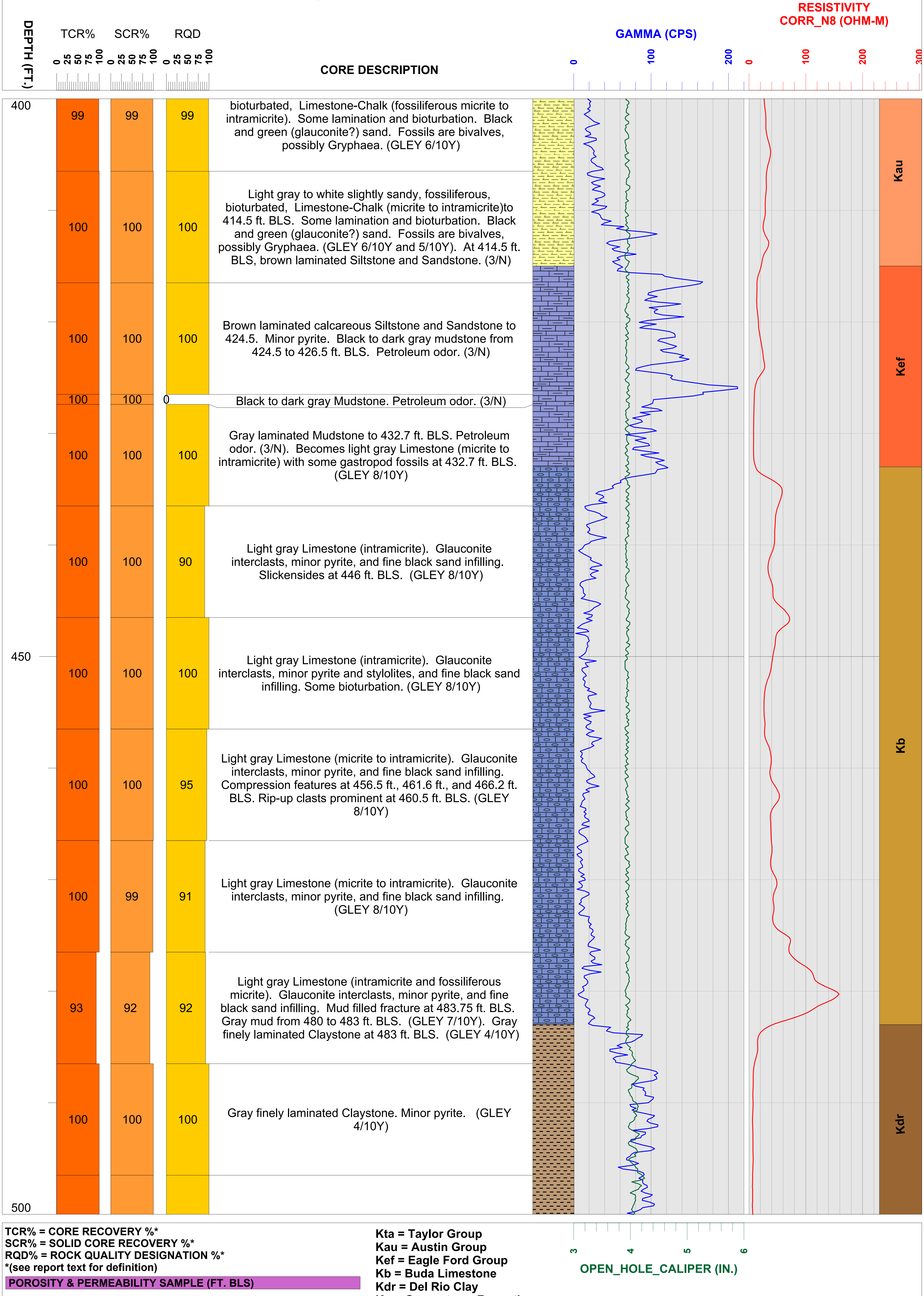
CORE DESCRIPTION/CLASSIFICATION IS BASED UPON FOLK (1965).
Folk, R.L.; 1965, Petrology of Sedimentary Rocks, Hemphill

FIGURE 2.

NEW BRAUNFELS, TX ASR CORE HOLE PROJECT (NBU-CH-1)

GMA Project #: 70210
NEW BRAUNFELS, GUADALUPE CO., TX
Dates Drilled: 3/20/2018 to 4/5/2018
Site Location: N 29.704500°, W 98.053611°

GROUNDWATER MANAGEMENT ASSOCIATES, INC.



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GMA
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GMA Project #: 70210
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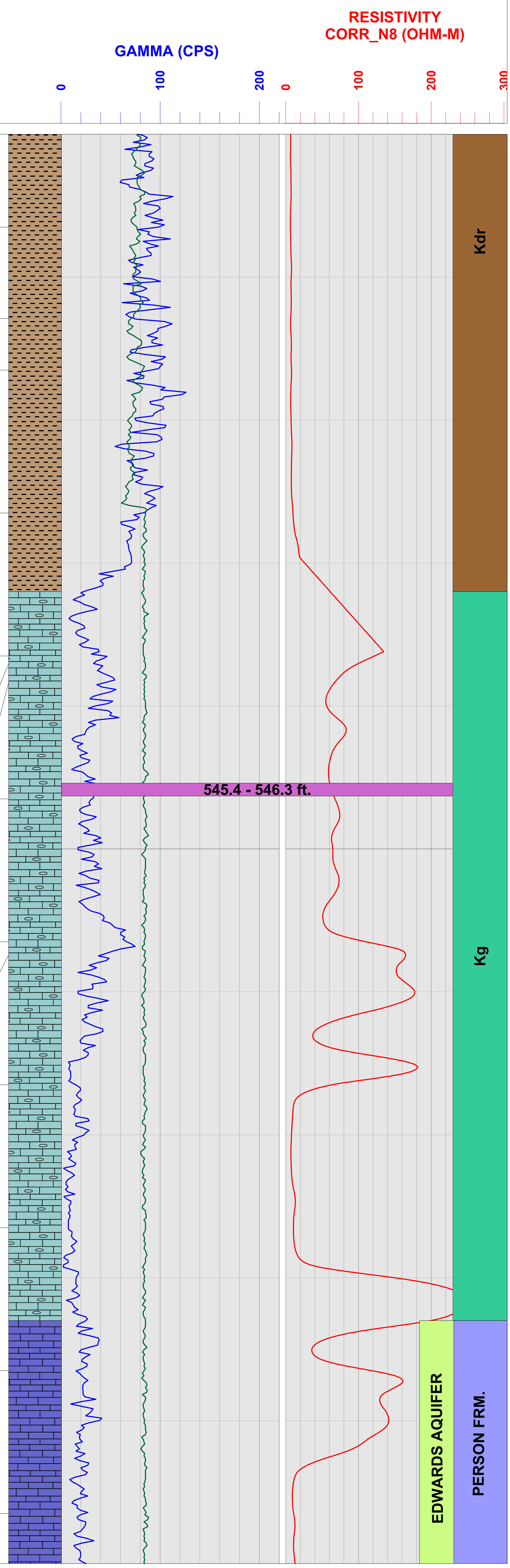
DEPTH (FT.)	TCR% (0–100)	SCR% (0–100)	RQD (0–100)	CORE DESCRIPTION
500	100	100	100	Gray finely laminated Claystone. Minor pyrite. (GLEY 4/10Y)
	82	82	82	Gray finely laminated, fossiliferous Claystone. Minor pyrite. (GLEY 4/10Y)
	100	100	100	Gray finely laminated, fossiliferous Claystone. Minor pyrite. (GLEY 4/10Y)
	98	98	98	Gray finely laminated, fossiliferous Claystone becoming more Siltstone with depth. Minor pyrite. (GLEY 4/10Y)
	100	100	91	Gray finely laminated, fossiliferous Siltstone. Minor pyrite. (GLEY 4/10Y). At 530 ft. BLS, Gray to white fossiliferous Limestone (intramicrite). Some chert and pyrite. (GLEY 8/10Y)
	100	100	100	Gray to white fossiliferous Limestone (intramicrite). Some chert and pyrite. (GLEY 8/10Y)
	100	100	100	Gray to white fossiliferous Limestone (intramicrite). Minor pyrite. (GLEY 8/10Y)
	100	100	100	Gray to white fossiliferous Limestone (intramicrite). Minor pyrite. Abundant stylolites. Slickensides at 546.3 ft. BLS. (GLEY 8/10Y)
550	93	93	82	Gray to white fossiliferous Limestone (fossiliferous micrite to intramicrite). (GLEY 8/10Y)
	100	100	100	Gray to white fossiliferous Limestone with minor black Marl zone. (GLEY 7/10Y)
	100	100	95	Gray to white vuggy, fossiliferous Limestone (intramicrite). 562 to 563.5 has higher porosity. (GLEY 7/10Y)
	100	100	100	Gray to white vuggy, fossiliferous Limestone (packed biomicrite). Chert interclasts near bottom of section. Strong sulfur odor. (GLEY 7/10Y)
	98	98	94	Gray to white vuggy, fossiliferous Limestone (pack biomicrite) to 583 ft. BLS. Some chert interclasts. Strong sulfur odor. (GLEY 7/10Y). At 583 ft. BLS, dense Limestone (intramicrite) with black chert nodules. Porous. (GLEY 6/N)
	100	100	97	Light gray to tan dense, Limestone (intramicrite) with black chert nodules, and beds of packed biomicrite. Porous. (GLEY 6/N)
600	82	80	76	Light gray to tan dense, Limestone (packed biomicrite to



3 4 5 6
OPEN_HOLE_CALIPER (IN.)

TCR% = CORE RECOVERY %*
SCR% = SOLID CORE RECOVERY %*
RQD% = ROCK QUALITY DESIGNATION %*
***(see report text for definition)**

POROSITY & PERMEABILITY SAMPLE (FT. BLS)
VERTICAL HYDRAULIC CONDUCTIVITY SAMPLE (FT. BLS)
POROSITY, PERMEABILITY, & VERT. HYD. COND. SAMPLE (FT. BLS)
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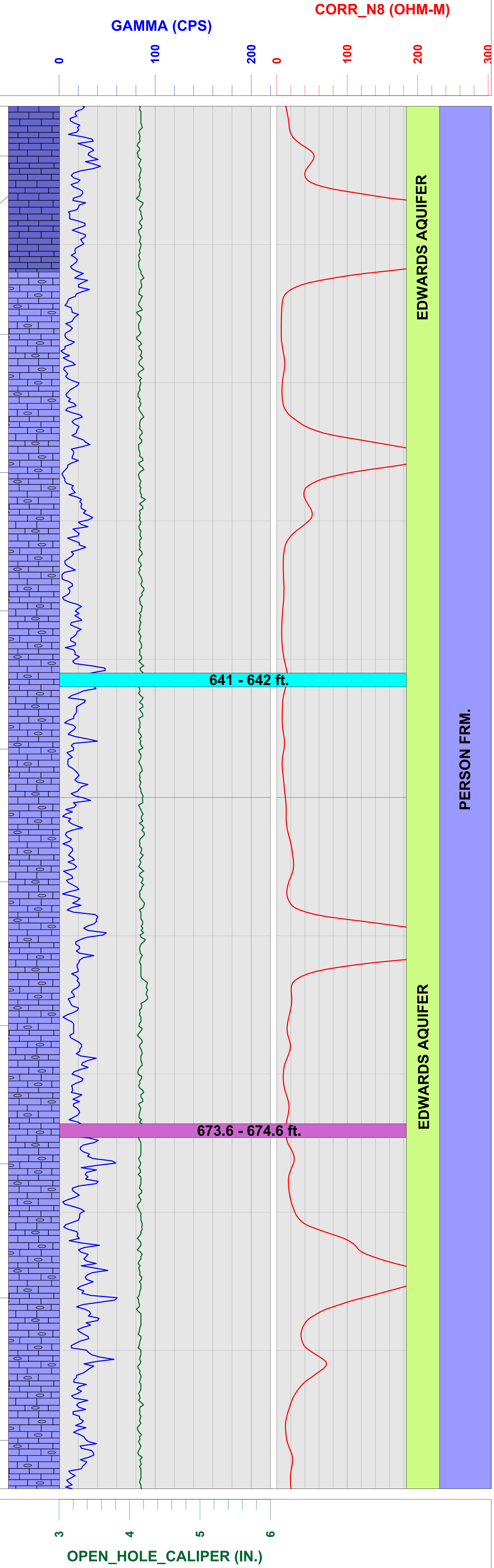
Dates Drilled: 3/20/2018 to 4/5/2018
Site Location: N 29.704500°, W 98.053611°

GROUNDWATER MANAGEMENT ASSOCIATES, INC.

DEPTH (FT.)	TCR%	SCR%	RQD	CORE DESCRIPTION
600				intramicrite) with black chert nodules and minor dolomite crystals in pore spaces. Porous. (2.5Y 5/3)
	100	100	83	Light gray to tan dense, Limestone (intramicrite) with black chert nodules and minor dolomite crystals in vuggy pore spaces. Porous. (2.5Y 5/3)
	100	96	88	White to light gray laminated Limestone (intramicrite) to 612.6 ft. BLS. (GLEY 7/10Y). Black chert nodule at 612.6 ft. BLS. Light gray to tan Limestone (packed biomicrite) to 616.5 ft. BLS. Porous. (2.5Y 5/2)
	100	100	93	Light gray to tan dense, Limestone (packed biomicrite) to 622.5 ft. BLS. Porous. (2.5Y 5/2). White to light gray laminated Limestone (intramicrite) to 626.5 ft. BLS. Occasional chert nodules. (GLEY 7/10Y)
	99	82	82	White to gray laminated vuggy Limestone (intramicrite) to 631.25. (GLEY 4/5GY). Light gray to tan friable/weathered, Limestone (packed biomicrite) to 636.5 ft. BLS. Porous. (2.5Y 5/2)
	90	90	85	Light gray to tan friable/weathered, Limestone (packed biomicrite) (2.5Y 5/2) with interbedded light gray, dense Limestone (intramicrite) (GLEY 4/5GY).
650	100	96	92	Light gray laminated, dense Limestone (micrite) (GLEY 4/5GY) with interbedded brown-gray friable/weathered packed biomicrite (dolomitic) (2.5Y 6/2). Large chert nodule at 547 ft. BLS. Some fracturing.
	96	95	91	Light gray laminated, dense, fossiliferous Limestone (intramicrite) (GLEY 4/5GY) with interbedded brown-gray friable/weathered Limestone (packed biomicrite) (dolomitic, no to weak HCL reaction) (2.5Y 6/2). Some fracturing with sparry cement.
	94	90	90	Light gray laminated, bioturbated, dense, Limestone (intramicrite) (GLEY 4/5GY) with interbedded brown-gray friable/weathered dolomitic Limestone (packed biomicrite) (2.5Y 6/2). Some fracturing.
	100	84	84	Light gray laminated, bioturbated, dense, Limestone (micrite) (GLEY 4/5GY) with minor/less interbedded brown-gray friable/weathered dolomitic Limestone (packed biomicrite). Heavily fractured.
	96	84	83	Light gray laminated, bioturbated, dense Limestone (intramicrite) (2.5Y 5/2) with interbedded gray laminated Mudstone and gray-brown friable/weathered dolomitic Limestone (packed biomicrite) (no to weak HCL reaction) (GLEY 4/5GY). Heavily fractured. Some sparry calcite infilling at fractures.
700				Light gray laminated, bioturbated, dense Limestone



TCR% = CORE RECOVERY %*
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*(see report text for definition)
POROSITY & PERMEABILITY SAMPLE (FT. BLS)
VERTICAL HYDRAULIC CONDUCTIVITY SAMPLE (FT. BLS)
POROSITY, PERMEABILITY, & VERT. HYD. COND. SAMPLE (FT. BLS)
FT. BLS = FEET BELOW LAND SURFACE

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FIGURE 2.

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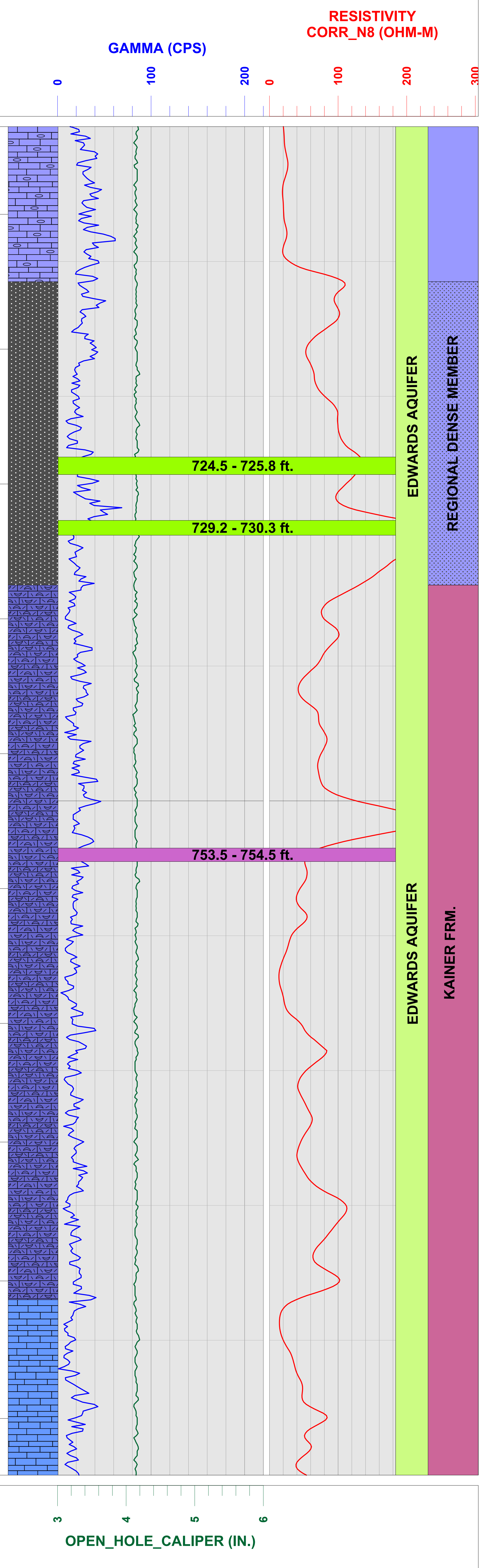
NEW BRAUNFELS, TX ASR CORE HOLE PROJECT (NBU-CH-1)

GMA Project #: 70210
NEW BRAUNFELS, GUADALUPE CO., TX
Dates Drilled: 3/20/2018 to 4/5/2018
Site Location: N 29.704500°, W 98.053611°

DEPTH (FT.): 700 – 800

TCR%	SCR%	RQD	CORE DESCRIPTION
99	99	89	(intramicrite) (2.5Y 5/2) with interbedded gray laminated dolomitic Limestone (packed biomicrite) and gray-brown friable/weathered Mudstone (no to weak HCL reaction). Vuggy porosity at 707 ft. BLS. (GLEY 4/5GY)
100	100	98	Light gray laminated, bioturbated, dense Limestone (micrite to intramicrite) (2.5Y 5/2) with interbedded gray laminated Mudstone and gray-brown friable/weathered Mudstone (no to weak HCL reaction) to 711.5 ft. BLS (GLEY 4/5GY). At 711.5 ft. BLS. (Regional Dense Member), white to cream, dense, Limestoen (micrite). (GLEY8/N)
98	98	98	White to cream, dense, laminated Limestone (micrite). Virtually no porosity. Large spar-filled fracture at 723 ft. BLS. (GLEY 8/N)
98	98	98	White to cream, dense, laminated Limestone (micrite to intramicrite) to 734 ft. BLS. (GLEY 8/N). At 734 ft. BLS, light tan Limestone (packed biomicrite). Occasional stylolites. Some porosity along bedding. (5/Y 7/2)
100	100	90	Light tan Limestone (packed biomicrite). Some porosity along bedding, vuggs, and shell molds (?). Stylolites present. Slickensides at 745 ft. BLS. (5Y 7/2)
93	86	62	Light tan Limestone (packed biomicrite to intramicrite). Porosity along bedding. Some bioturbation and fracturing. Stylolites present. (5Y 7/2)
100	100	89	Light tan Limestone (packed biomicrite to intramicrite). Porosity along bedding. Some bioturbation. Sparry calcite present in porous sections. (5Y 7/2)
98	86	82	Light tan Limestone (packed biomicrite) to 772.5 ft. BLS. Porosity along bedding. (5Y 7/2). At 772.5 ft. BLS, cream, soft, friable, chalky Limestone. (2.5Y 6/3)
97	79	77	Cream friable Limestone (packed biomicrite). Porous. Fractured. (2.5Y 6/3)
100	86	85	Cream friable Limestone (packed biomicrite) with interbedded light gray laminated Limestone (intramicrite). Porosity along bedding. Fractured. Some sparry calcite infilling and vuggy porosity. (2.5Y 6/3)



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POROSITY, PERMEABILITY, & VERT. HYD. COND. SAMPLE (FT. BLS)
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GMA Project #: 70210
NEW BRAUNFELS, GUADALUPE CO., TX
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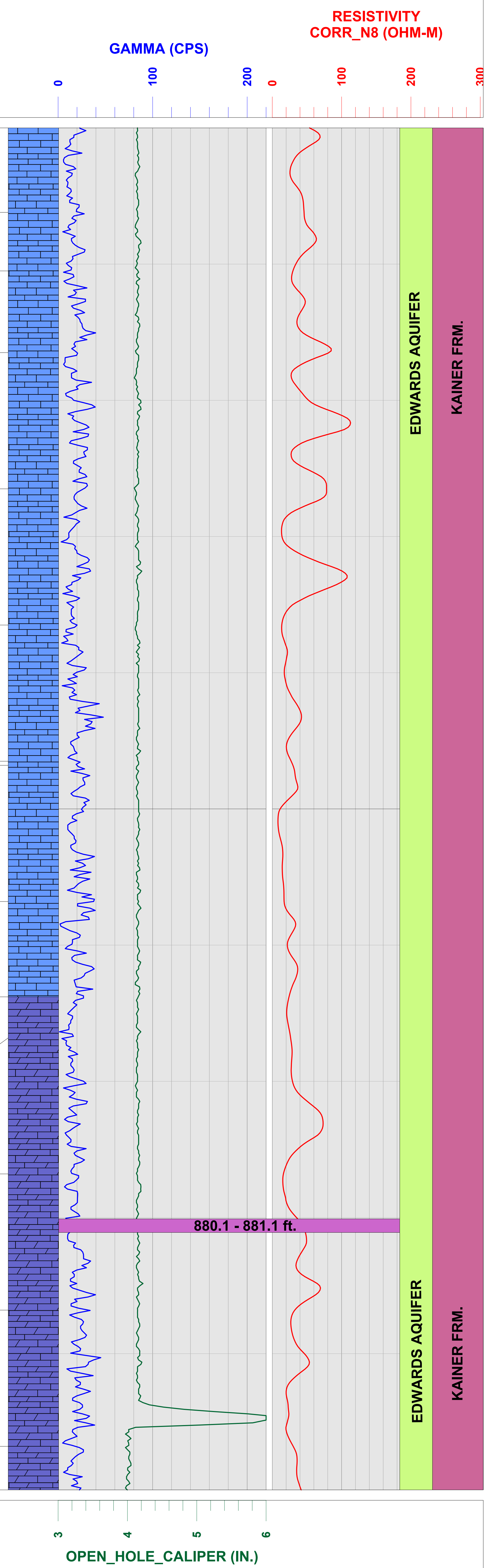
Site Location: N 29.704500°, W 98.053611°

GMA — GROUNDWATER MANAGEMENT ASSOCIATES, INC.

DEPTH (FT.)	TCR%	SCR%	RQD	CORE DESCRIPTION
800	100	90	84	Interbedded cream to tan Dolomite and gray Limestone (packed biomicrite). Some white dolomite crystal formation in vuggy pore spaces. (2.5Y 6/2)
	91	91	84	Interbedded cream to tan Dolomite and gray Limestone (packed biomicrite). Some white dolomite crystal formation in vuggy pore spaces. (2.5Y 6/2)
	100	100	90	Interbedded cream to tan Dolomite and gray Limestone intramicrite). Some white dolomite crystal formation in pore spaces and fractures. (2.5Y 5/2)
	100	97	89	Interbedded cream to tan Dolomite and gray Limestone (packed biomicrite). Some white dolomite crystal formation in pore spaces. Section is heavily fractured. (2.5Y 5/2)
	100	93	86	Interbedded cream to tan Dolomite and gray Limestone packed biomicrite). Some white dolomite crystal formation in pore spaces. Section is heavily fractured. Partial filling of fractures with sparry crystals. (2.5Y 5/2)
	100	96	93	Interbedded cream to tan Dolomite and gray Limestone (intramicrite). Some white dolomite crystal formation in pore spaces. (2.5Y 5/2)
	0	0	0	
850	100	95	95	Tan to gray porous Dolomite with some minor bioturbation. Easily broken along bedding. Thin layers of dark gray chert. Heavily fractured. Petroleum odor. (2.5Y 5/3)
	100	99	94	Interbedded cream to tan Dolomite and gray Limestone (packed biomicrite). Fossiliferous section at 861 ft. BLS. Minor bioturbation. (5Y 7/2)
	90	86	69	Interbedded dark gray Dolomite and gray, laminated, fossiliferous Limestone (packed biomicrite). Easily broken along bedding. Minor bioturbation. (5Y 7/2)
	100	91	88	Interbedded dark gray Dolomite and gray, laminated, fossiliferous Limestone (packed biomicrite). Easily broken along bedding. Minor bioturbation. Abundant sparry crystal formation. Small fault at 873 ft. BLS. (5Y 7/2)
	99	96	88	Interbedded dark gray Dolomite and gray, laminated, fossiliferous Limestone (packed biomicrite). Slightly fractured. Moldic texture with gastropod molds at 883 ft. BLS. Some chert. Minor bioturbation. (5Y 7/2 to GLEY 4/10Y)
	83	58	54	Interbedded dark gray Dolomite and gray, laminated, fossiliferous Limestone (packed biomicrite to intramicrite). Heavily fractured. Vuggy porosity on some sections. Apparent void at 893 ft. BLS. Minor bioturbation. (GLEY 4/10Y)
900				



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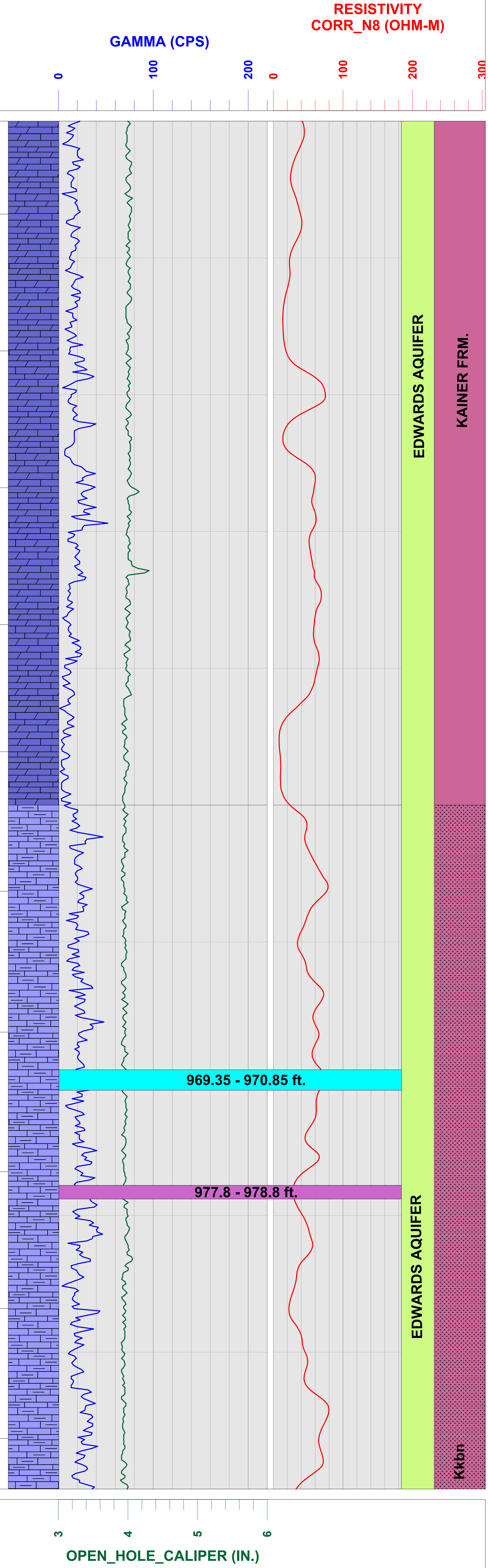
GMA GROUNDWATER MANAGEMENT ASSOCIATES, INC.

DEPTH (FT.)	TCR%	SCR%	RQD	CORE DESCRIPTION
900	100	90	90	Interbedded gray laminated Dolomite and tan, vuggy, fossiliferous Limestone (intramicrite). Color change below 898.3 ft. BLS. (2.5Y 6/2)
	100	97	97	Interbedded gray laminated Dolomite and tan, moldic, fossiliferous Limestone (intramicrite to packed biomicrite). Some stylolites. (2.5Y 6/2)
	100	97	95	Interbedded dark gray laminated Dolomite and gray fossiliferous Limestone (packed biomicrite to intramicrite). (2.5Y 6/2)
	97	87	85	Interbedded dark gray laminated Dolomite and gray, vuggy, fossiliferous Limestone (packed biomicrite to intramicrite). (2.5Y 6/2)
	98	90	88	Gray moldic fossiliferous Limestone (packed biomicrite to intramicrite) and dark brown laminated Dolomite. Limestone is friable in some sections. Some fracturing. Fossils include bivalves. (5Y 4/2)
950	100	89	89	Gray moldic fossiliferous Limestone (packed biomicrite to intramicrite) and dark brown laminated Dolomite. Limestone is friable in some sections. Some fracturing. Minor dark gray chert. Fossils include bivalves. (5Y 5/2)
	100	93	90	Gray moldic fossiliferous Limestone (intramicrite to packed biomicrite) and dark brown laminated Dolomite. Limestone is friable in some sections. Some fracturing. Easily broken along bedding. Minor dark gray chert. Stylolites present. Fossils include bivalves. (5Y 5/2)
	100	82	82	Gray moldic fossiliferous Limestone (intramicrite) and dark brown laminated Dolomite. Limestone is friable in some sections. Some fracturing. Easily broken along bedding. Minor dark gray chert. Fossils include bivalves. White to clear crystal growth (dolomite?) in pore spaces. (5Y 5/2 to GLEY 5/10Y with depth)
	100	90	88	Gray to dark gray laminated Dolomite. Large solution voids common with calcite/dolomite crystal growth. (GLEY 5/10Y)
	95	90	89	Gray to dark gray laminated Dolomite to 933 ft. BLS. White to clear sparry crystal growth in pore spaces. (GLEY 5/10Y). At 993 ft. BLS, light gray laminated Limestone (intramicrite). Large solution voids common. Some stylolites. (GLEY 7/10Y)
1000				



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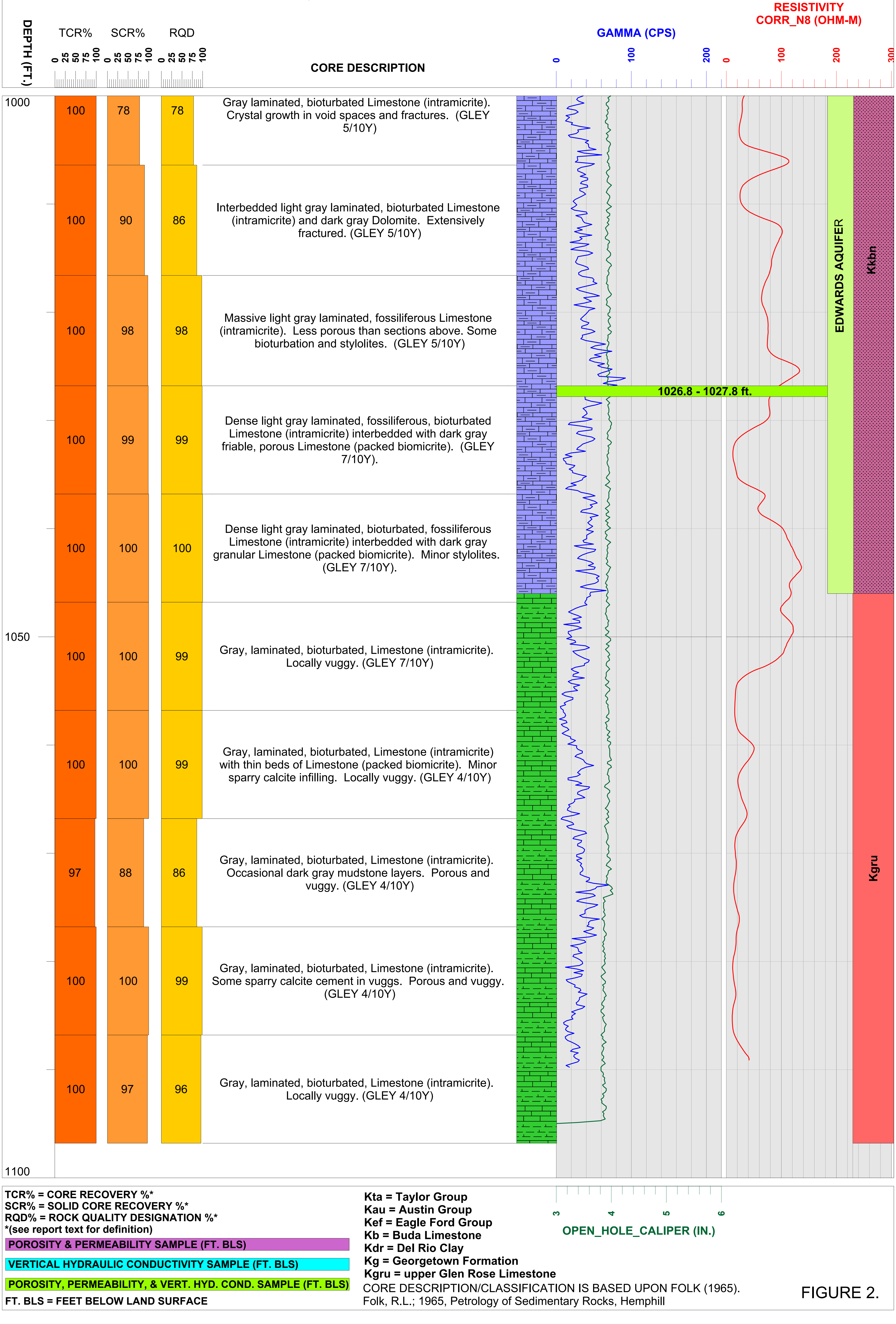

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FIGURE 2.

10.4 Appendix D. Core lab report

MINERALOGY-INC
WHERE SCIENCE GETS DOWN TO EARTH!

New Braunfels Utilities

NBU-CH-1 • Edwards Formation • ASR Evaluation

Requested by:
Christy Aylesworth
Kutscher Drilling, LTD

Mineralogy, Inc. Number 18087.r2

Date:
July 18, 2018

Submitted by:

Timothy B. Murphy

Mineralogy, Inc.
3321 East 27th Street
Tulsa, Oklahoma 74114
USA
+1 (918) 744.8284

www.mineralogy-inc.com

Table of Contents

MINERALOGY-INC
WHERE SCIENCE GETS DOWN TO EARTH!

Table of Contents

Appendix I
Thin Section and SEM Images

Depth	MI#	Petrographic Summary	Thin Section Petrography	Scanning Electron Microscopy
545.4 - 546.3	18087-01	•	•	•
673.6 - 674.6	18087-02	•	•	•
724.8 - 725.8	18087-03	•	•	•
729.2 - 730.3	18087-04	•	•	•
753.5 - 754.5	18087-05	•	•	•
880.1 - 881.1	18087-06	•	•	•
977.8 - 978.8	18087-07	•	•	•
1026.8 - 1027.8	18087-08	•	•	•

CONDITIONS AND QUALIFICATIONS

Mineralogy, Inc. will endeavor to provide accurate and reliable laboratory measurements of the samples provided by the client. The results of any x-ray diffraction, petrographic or core analysis test are necessarily influenced by the condition and selection of the samples to be analyzed. It should be recognized that geological samples are commonly heterogeneous and lack uniform properties. Mineralogical, geochemical and/or petrographic data obtained for a specific sample provides compositional data pertinent to that specific sampling location. Such "site-specific data" may fail to provide adequate characterization of the range of compositional variability possible within a given project area, thus the "projection" of these laboratory findings and values to adjoining, "untested" areas of the formation or project area is inherently risky, and exceeds the scope of the laboratory work request. Hence, Mineralogy, Inc. shall not assume any liability risk or responsibility for any loss or potential failure associated with the application of "site or sample-specific laboratory data" to "untested" areas of the formation or project area. Unless otherwise directed, the samples selected for analysis will be chosen to reflect a visually representative portion of the bulk sample submitted for analysis. Where provided, the interpretation of x-ray diffraction, petrographic or core analysis results constitutes the best geological judgment of Mineralogy, Inc., and is subject to the sampling limitations described above, and the detection limits inherent to semi-quantitative and/or qualitative mineralogical and microscopic analysis. Mineralogy, Inc. assumes no responsibility nor offers any guarantee of the productivity, suitability or performance of any oil or gas well, hydrocarbon recovery process, dimension stone, and/or ore material based upon the data or conclusions presented in this report.

Introduction

A total of 8 core intervals from the Edwards formation have been evaluated as part of an ASR investigation for the New Braunfels Utilities CH-1 Well. The core intervals include porous and consolidated limestone and dolomite intervals that exhibit locally significant amounts of secondary moldic dissolution porosity as well as intercrystalline micro and macroporosity. The purpose of the core investigation is to assess the mineralogy, geochemistry, and petrophysical properties for each of the aquifer intervals from this site. Test methods utilized to evaluate the core intervals include: x-ray diffraction mineralogical analysis (XRD), x-ray fluorescence analysis (XRF), cation exchange capacity analysis (CEC), thin section petrographic analysis, scanning electron microscopy analysis, routine porosity and permeability analysis, and vertical hydraulic conductivity analysis. The inventory provided in the table of contents provides a summary of the sample depths, laboratory IDs, and test methods utilized for specific aquifer intervals from the sample suite.

Summary

The principle findings of the laboratory analysis performed for these aquifer intervals are summarized as follows:

- The results of the x-ray diffraction mineralogical analysis (XRD; Table I) are indicative of a relatively straightforward mineral composition that is dominated by either calcite and/or dolomite. Minor mineral components contained in the suite include localized concentrations of celestite, quartz, pyrite, and clay-matrix minerals. The clay-matrix suite includes traces of kaolinite, illite/mica, mixed-layered illite/smectite, and/or traces of montmorillonite. Locally significant amounts of organic matter are incorporated within the dolomite and limestone intervals evaluated in this study.
- The results of the x-ray fluorescence chemical analysis (XRF) are summarized in Table II. The XRF data set compliments and supports the XRD investigation for these samples. The elemental chemistry is dominated by calcium oxide and magnesium oxide, coupled with subordinate amounts of silicon, aluminum, strontium, potassium, and iron. Minor to trace amounts of sulphur, chlorine, sodium, titanium, phosphorous, barium, and manganese are also locally present in these samples. The elemental chemistries reported for these samples are consistent with a mineral assemblage dominated by calcite and dolomite.
- The results of the cation exchange capacity (CEC) analysis are summarized in Table III. Cumulative CEC values for these limestone and dolomite intervals range between ~ 27.7 - 43.3 meq/100 grams of sediment. The hierarchy of cation exchange capacity is dominated by calcium (22.2 - 27.8 meq/100 g), followed by magnesium (0.567 - 19.1 meq/100 g), sodium (0.197 - 0.591 meq/100 g), and potassium (BPQL - 0.656 meq/100 g).

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- The results of the acid insoluble residue analysis are summarized in Table IV. Acid insoluble residues within these limestone intervals range between 0.88-26.24%. The insoluble residues are locally dominated by clay matrix minerals, strontium sulfate, detrital silt and sand grains, and/or organic matter.
- The results of the gas permeability, helium porosity, and grain density analysis are summarized in Table V. Efforts were made to sub-sample each of the core intervals for both horizontal and vertical core plug orientations. Contrasts in the limestone and dolomite fabric properties limited our ability to acquire suitable core plug specimens for selected vertical and horizontal core plug orientations within the sample suite. Table V provides a summary of routine core analysis results for each of the 8 core intervals included in the study. The core analysis data set shows a significant degree of variability with respect to gas permeability as well as porosity and grain density values. Selected aquifer intervals within this sample suite are characterized as relatively dense and well-cemented, with limited amounts of storage capacity. Pore volumes range from a low of ~ 5.9% to a maximum of 34.9%. Gas permeability values are likewise quite variable and range from a minimum value of 0.00106 to a maximum permeability of 660 mD. Several of the most porous dolomite and limestone lithotypes within the sample suite are characterized as locally fractured with visible cracks and discontinuities locally present within the core plug specimens provided for analysis. Grain density values likewise exhibit a significant degree of variability within this sample suite with values that range from a low of 2.69 grams/cc to a maximum value of 2.86 grams/cc. The grain density values are consistent with limestone and dolomite samples that are locally supplemented with high specific gravity sulfate cement (i.e., celestite).
- Table VI provides a summary of the vertical, full diameter, hydraulic conductivity analysis performed for selected intervals from the aquifer system. City water from Midland, TX was utilized in the analysis and vertical permeabilities were observed to range from a low of 0.0005 mD to a maximum of 0.5625 mD. Core lengths for these samples range from 10.9 cm to a maximum of 35.7 cm.
- The results of the thin section petrographic analysis and SEM evaluation for these core intervals are provided in Appendix I. The thin section and SEM summaries are supplemented with annotated figure plates that offer representative photomicrographs of the mineralogy, micro texture, and pore system properties for each of these intervals. Four of the eight intervals from the suite are classified as fossiliferous limestones, with the remaining 4 specimens specified as very fine to finely crystalline dolomite specimens. The dolomite-rich fabrics within this aquifer system tend to offer the best storage capacity and permeability characteristics for the aquifer intervals examined. The dolomitic aquifer intervals are typically microcrystalline to finely crystalline, subhedral to euhedral and locally burrow-mottled. All of the dolomite fabrics exhibit modest to significant volumes of intercrystalline macro and micro pore space. In addition to the intercrystalline porosity, locally significant amounts of skel-moldic dissolution porosity are present owing to the leaching of calcareous skeletal grains contained within the original parent limestone material.
- The limestone intervals contained within this sample suite are typically densely crystallized and exhibit matrix materials that are microcrystalline, locally

microporous, and relatively impermeable. The limestone core materials typically contains scattered skel-moldic dissolution voids, however, the secondary moldic pores are relatively isolated within the plane of the thin section and do not appear to contribute appreciably to the transmissivity within these intervals. Minor amounts of authigenic pore-filling celestite cement are locally present within sample 6 from depth 880.1 - 881.1 ft. The strontium sulfate in this sample is irregularly distributed and is expressed unevenly within both the horizontal and vertical core plug samples prepared for this interval.

- Scattered traces of clay-matrix minerals are locally present in association with the dolomite and limestone samples from this suite. The clay-matrix components include minor to trace amounts of kaolinite as well as accessory volumes of illite, mixed-layered illite/smectite, and scattered traces of montmorillonite.

Conclusions

From the perspective of overall storage capacity and transmissivity, the dolomite-rich aquifer intervals [including core depths 673.6 to 674.6 ft. (18087-02), 753.5 - 754.5 ft. (18087-05), and 977.8 - 978.8 ft. (18087-07)], represent the most attractive and effective storage intervals for this aquifer system. The two limestone intervals from core depth 545.4 - 546.3 ft. (18087-01), and 724.8 - 725.8 ft. (18087-03), are characterized by modest to relatively small volumes of residual intercrystalline macro and microporosity (6.5 - 9.5%). These limestone intervals are also densely interlocked and relatively impermeable, with gas permeability values that are limited to < 0.111 mD. The vertical gas permeability for these intervals are likewise very small and range from 0.0425 - 0.0436 mD.

The dolomite-rich lithotypes contained in this aquifer system are likely to perform well as aquifer storage and recovery units within this aquifer system. These intervals are characterized by minimal volumes of clay-matrix minerals and typically exhibit cohesively stable rock frameworks with locally excellent transmissivity values. Modest amounts of organic matter coupled with microcrystalline pyrite are locally present within the dolomite and limestone intervals of this aquifer system. The organic matter is locally present as minute lath-shaped particulates that are locally weakly attached in the pore system and potentially mobile with the injection and/or production of pore waters. The organic materials are likely to contribute to some degree of turbidity within the produced waters from this aquifer system. Selected limestone aquifer intervals from this well will likely perform as effective permeability barriers capable of compartmentalizing the storage of water within this system. The limestone core intervals examined in this study typically exhibit limited amounts of effective macroporosity and are characterized by pore systems that are dominated by intercrystalline micropores, with isolated and locally poorly preserved dissolution macroporosity.

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X-ray Diffraction Mineralogical Analysis

Table I.1

Depth (ft.)	545.4 - 546.3	673.6 - 674.6	724.8 - 725.8	729.2 - 730.3
Lab ID	18087-01	18087-02	18087-03	18087-04
Mineral Constituents	Relative Abundance (%)			
Quartz	1.5	<0.5	1.5	0.2
Calcite	97	0.5	92	99.6
Dolomite		99.5	5	
Celestite ($SrSO_4$)				
Pyrite	0.5		0.5	
Kaolinite	0.5	<0.5	1	0.2
Illite/Mica	0.5		<0.5	
Montmorillonite				
Mixed-Layered Illite/Smectite	<0.5		<0.5	
TOTAL	100	100	100	100

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X-ray Diffraction Mineralogical Analysis

Table I.2

Depth (ft.)	753.5 - 754.5	880.1 - 881.1	977.8 - 978.8	1026.8 - 1027.8
Lab ID	18087-05	18087-06	18087-07	18087-08
Mineral Constituents	Relative Abundance (%)			
Quartz		2	<0.5	1
Calcite	100	11	2	47.5
Dolomite		66	98	51
Celestite ($SrSO_4$)		21		
Pyrite				
Kaolinite				0.5
Illite/Mica				<0.5
Montmorillonite				
Mixed-Layered Illite/Smectite				
TOTAL	100	100	100	100

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X-ray Fluorescence Analysis

Table II.1

Sample ID	545.4 - 546.3	673.6 - 674.6	724.8 - 725.8	729.2 - 730.3
M.I. Sample ID	18087-01	18087-02	18087-03	18087-04
Chemical Formula	Concentration (Mass %)			
Na2O	0.1012	0.1308	ND	ND
MgO	0.5579	27.0887	2.1502	0.3878
Al2O3	2.5574	0.6888	2.4496	0.1578
SiO2	7.4607	1.3559	8.3066	0.3547
P2O5	0.1151	0.0803	0.0959	0.0776
S	0.3055	0.3572	0.3204	0.0573
Cl	0.0219	0.0917	0.0187	0.0176
K2O	0.3603	0.0834	0.2976	0.041
CaO	86.3369	69.134	84.5896	98.6151
TiO2	0.1351	ND	0.0831	ND
MnO	0.1414	ND	0.0069	0.01
Fe2O3	1.2879	0.2972	1.0298	0.074
Sr	0.0762	0.0609	0.0807	0.0569
BaO	0.0712	0.0851	0.0766	0.0542

ND = Not Detected

X-ray Fluorescence Analysis

Table II.2

Sample ID	753.5 - 754.5	880.1 - 881.1	977.8 - 978.8	1026.8 - 1027.8
M.I. Sample ID	18087-05	18087-06	18087-07	18087-08
Chemical Formula	Concentration (Mass %)			
Na2O	ND	ND	0.0879	0.0777
MgO	0.4167	11.8574	26.5828	13.9638
Al2O3	0.0293	0.089	0.3776	2.7381
SiO2	0.098	3.1045	1.2153	5.8147
P2O5	0.0678	0.0445	0.0748	0.0781
S	0.0779	4.965	0.2433	0.3433
Cl	0.03	0.0283	0.0472	0.0445
K2O	0.0434	0.0825	0.0796	0.2306
CaO	98.9607	44.9312	70.5379	75.1573
TiO2	ND	0.0165	ND	0.0811
MnO	ND	ND	ND	0.0253
Fe2O3	0.0421	0.1231	0.2194	0.7802
Sr	0.054	22.7398	0.0828	0.0558
BaO	0.0535	0.4338	0.0719	0.0856

ND = Not Detected

Cation Exchange Capacity

Table III

	Calcium		Magnesium		Potassium		Sodium		
	Results	PQL**	Results	PQL**	Results	PQL**	Results	PQL**	Cumulative
Sample ID	(meg/100g)		(meg/100g)		(meg/100g)		(meg/100g)		CEC
545.4 - 546.3 ft. MI# 18087-01	26.2	0.100	0.692	0.100	0.497	0.100	0.350	0.010	27.739
673.6 - 674.6 ft. MI# 18087-02	22.2	0.100	18.9	0.100	BPQL	0.100	0.591	0.100	41.691
724.8 - 725.8 ft. MI# 18087-03	27.6	0.100	1.93	0.100	0.656	0.100	0.369	0.010	30.555
729.2 - 730.3 ft. MI# 18087-04	27.8	0.100	0.642	0.100	0.020	0.010	0.197	0.010	28.659
753.5 - 754.5 ft. MI# 18087-05	27.8	0.100	0.567	0.100	0.026	0.010	0.394	0.010	28.787
880.1 - 881.1 ft. MI# 18087-06	24.9	0.100	15.1	0.100	BPQL	0.100	0.460	0.010	40.46
977.8 - 978.8 ft. MI# 18087-07	23.8	0.100	19.1	0.100	BPQL	0.100	0.419	0.010	43.32
1026.8 - 1027.8 ft. MI# 18087-08	27.7	0.100	4.04	0.100	0.169	0.100	0.401	0.010	32.31

Method Reference: 40 CFR 136, 261, Method for Chemical Analysis of Water and Waste EPA-600/4-79-020 March 1983
CEC Method Reference: Method of Soil Analysis, Chemical and Microbiological Properties, 2nd Ed.; American Society of Agronomy, linc.
Soil Science Society of America, Inc. page 160.
**CEC analysis provided by Accurate Laboratories & Training Center; Stillwater, OK*
***PQL= Practical Quantitation Limit*

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Acid Insoluble Residue Analysis

Table IV

Depth (ft.)	Lab ID	Acid Insoluble Residue (%)
545.4 - 546.3	18087-01	0.90
673.6 - 674.6	18087-02	4.21
724.8 - 725.8	18087-03	10.84
729.2 - 730.3	18087-04	1.20
753.5 - 754.5	18087-05	0.88
880.1 - 881.1	18087-06	26.24
977.8 - 978.8	18087-07	2.55
1026.8 - 1027.8	18087-08	10.06

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Porosity & Permeability

Table V

Lab ID	Core Depth (ft.)	Plug Orientation	N_2 Gas Permeability (md)	Helium Porosity (%)	Grain Density (g/cm^3)
18087-01	545.4-546.3’	H	0.111	9.5	2.72
18087-01V	545.4-546.3’	V	0.0436	NA	NA
18087-02	673.6-674.6’	H	310	34.9	2.83
18087-03	724.8-725.8’	H	0.0425	6.5	2.70
18087-04	729.2-730.3’	H	NA	11.1	2.69
18087-04V	729.2-730.3’	V	135*	NA	NA
18087-05	753.5-754.5’	H	201	24.1	2.69
18087-06	880.1-881.1’	H	0.00106	3.4	2.63
18087-06V	880.1-881.1’	V	86.6*	NA	NA
18087-07	977.8-978.8’	H	660*	25.4	2.83
18087-08	1026.8-1027.8’	H	3.21*	10.0	2.72

** Fracture present*

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Vertical Hydraulic Conductivity

Table VI

Lab ID	Core Depth (ft.)	Length (cm)	Hydraulic Conductivity (Kw) (md)
18136-05	641.4 - 642.0’	10.89	0.0005
18136-01	724.8-725.8’	13.04	0.0028
18136-02	729.2-730.3’	16.92	0.0109
18136-04	969.35-970.85’	35.72	0.5625
18136-03	1026.8-1027.8’	22.01	0.0180

Vertical, full diameter liquid permeability measurements were performed by SCAL Laboratories in Midland, TX. Water from the City of Midland, TX was utilized in the liquid permeability analysis for these samples.

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NBU-CH-1
Core Depth: 545.4-546.3”
18087-01

This core sample is classified as a ***skeletal lime wackstone***. Some characteristics of the sedimentary fabric and reservoir quality for this interval are noted as follows:

- The rock fabric is matrix-supported, and exhibits a densely-crystallized groundmass of microcrystalline calcite with a mean crystal diameter of ~1.5-2 μm. The groundmass is microporous and includes modest amounts of poorly interconnected intercrystalline microporosity.
- Allochems (carbonate grains) include minute calcispheres, pelagic forams, bryozoan fronds, echinoderm plates and spines, mollusk shell fragments, and undifferentiated skeletal debris. A few of the mollusk shell fragments locally exceed 12 mm in particle length.
- The SEM images illustrate the isolated character of the macropores within this core interval. The densely-crystallized microcrystalline calcite groundmass supports the skeletal fragments & moldic voids of the limestone framework, but also contributes to the isolation of the skel-moldic pores.
- The pore system includes intercrystalline microporosity, and scattered skel-moldic macropores. The macropores are small (~10-30 μm) and locally contain crystals of pore filling dolomite &/or calcite spar cement +/- traces of authigenic kaolinite clay.
- The pore volume for this limestone is 9.5%, with a (horizontal) gas permeability of 0.111 md, and a vertical permeability of 0.0436 md. This limestone interval should serve as an effective permeability barrier within the aquifer system.

The following image tags are used to help identify selected features on the thin section & SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

Sample ID	Magnification
18087-01A	16X
18087-01B	16X (XN)
18087-01C	100X
18087-01D	200X
18087-01E	200X
18087-01F	200X (XN)
18087-01G	100X

Mineralogical data for this limestone sample are summarized below:

Mineral Constituents	Concentration (%)
Quartz	1.5
Calcite	97
Pyrite	0.5
Kaolinite	0.5
Illite/Mica	0.5
Mixed-Layered Illite/Smectite	<0.5

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545.4 - 546.3 ft.; MI#18087-01 - Macro

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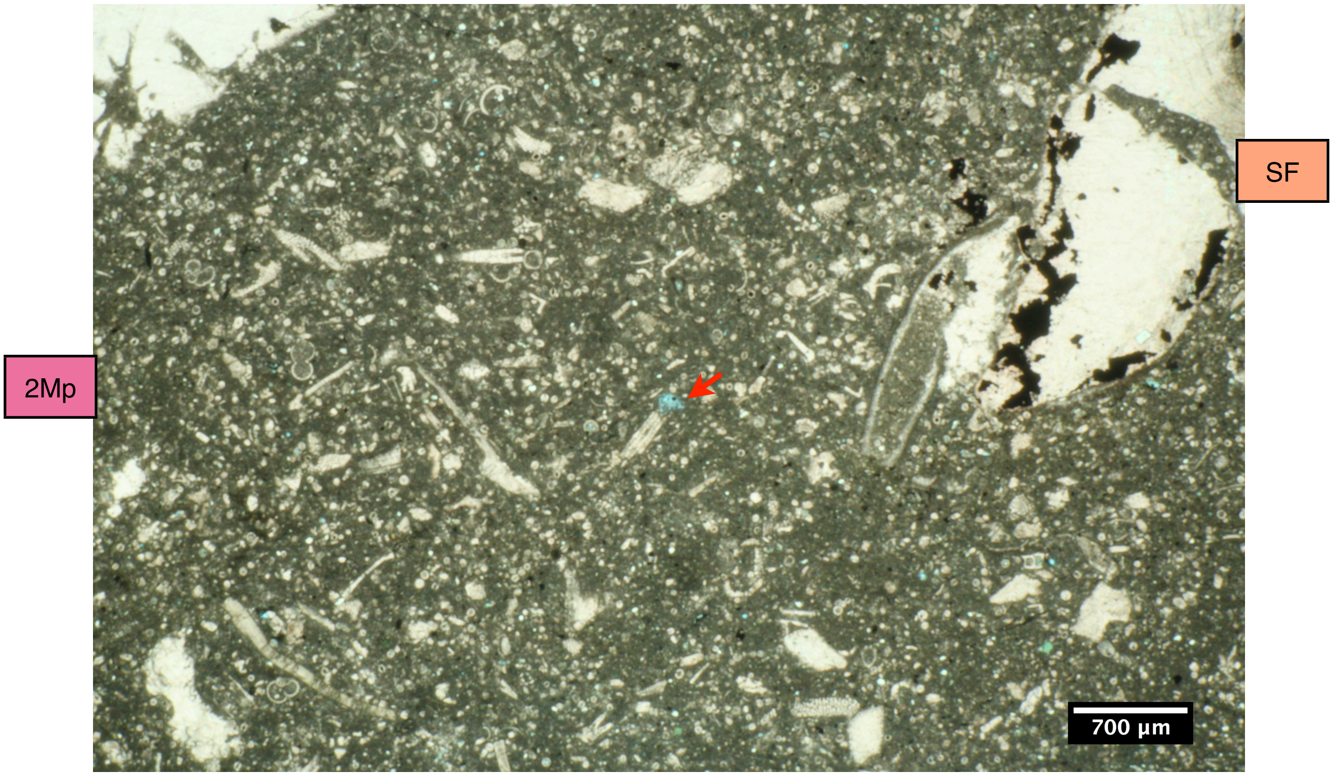
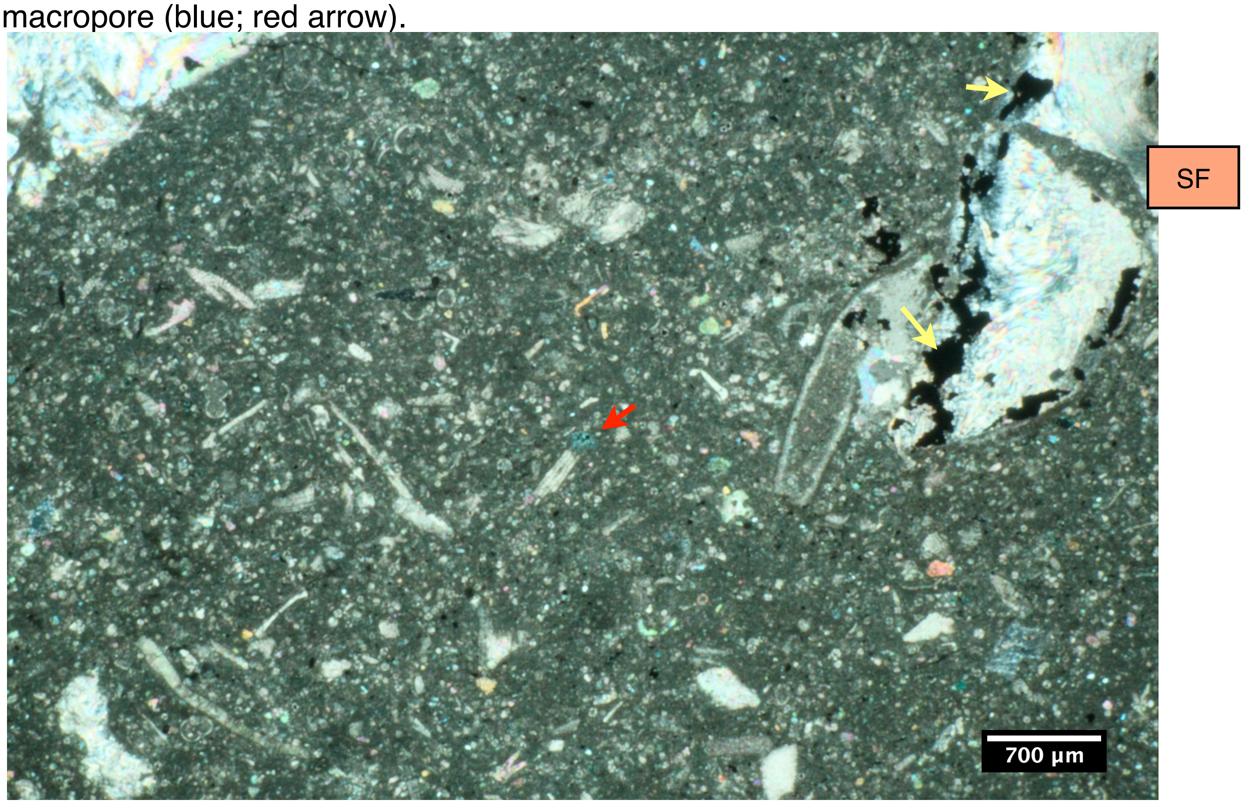
545.4 - 546.3 ft.; MI#18087-01; TS 1A - 1F



1A. A large, poorly preserved mollusk shell fragment (SF) and an isolated dissolution macropore (blue; red arrow).



1B. As in Figure 1A, with cross polarized light. Note the pyrite (black; yellow arrows) cement that is crystallized peripheral to the mollusk shell fragment.

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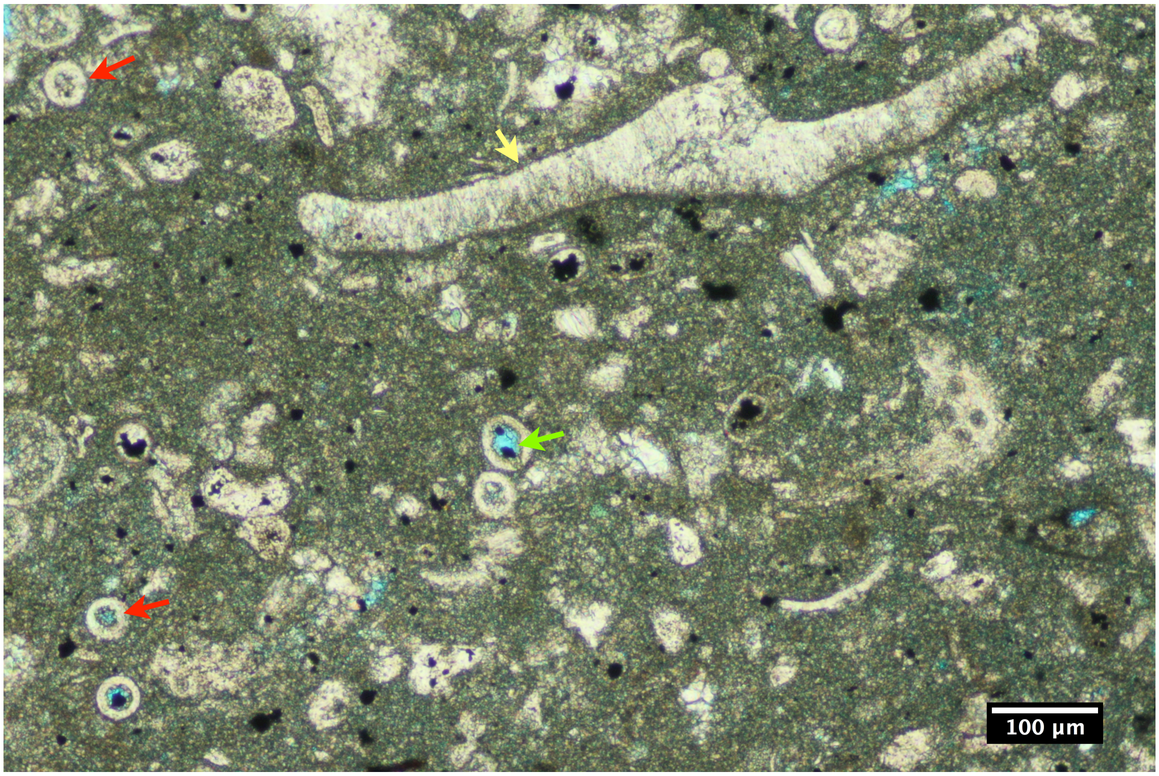
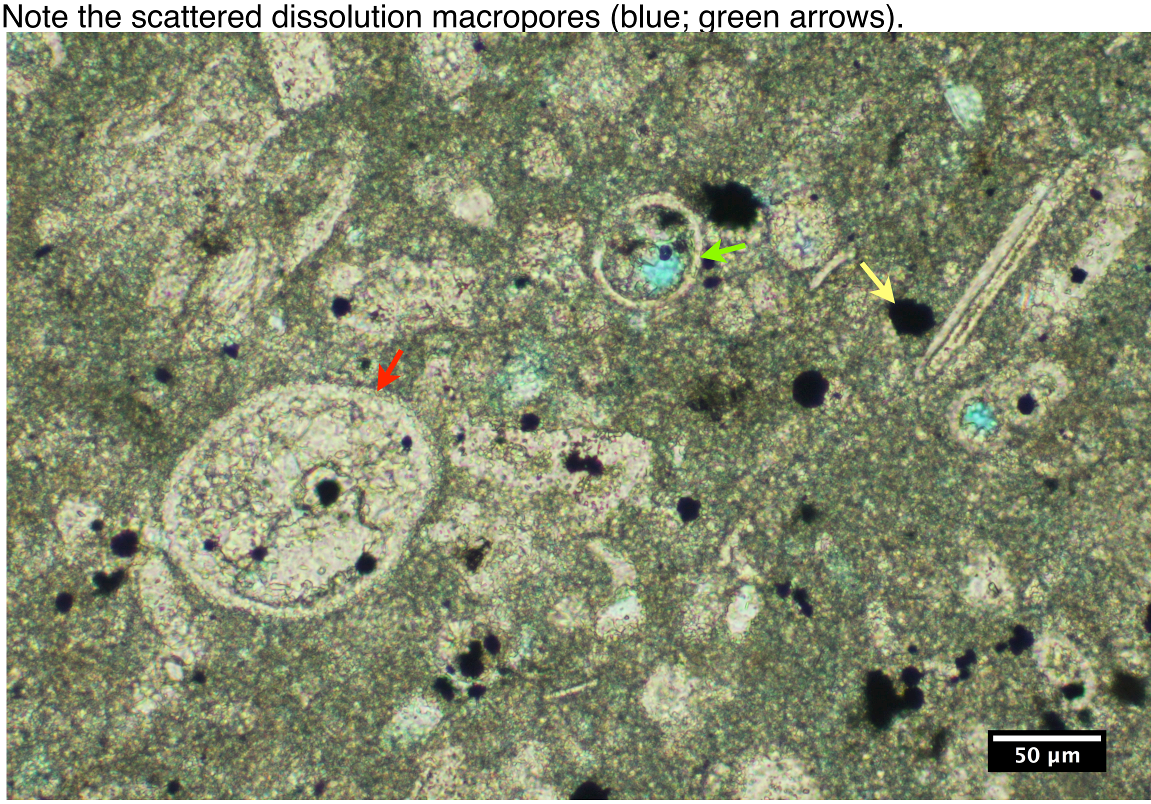
545.4 - 546.3 ft.; MI#18087-01



1C. Calcispheres (red arrows) and a mollusk shell fragment (yellow arrows; SF). Note the scattered dissolution macropores (blue; green arrows).



2Mp

1D. Pyrite cement (black; yellow arrows) is present as an irregularly distributed accessory cement.

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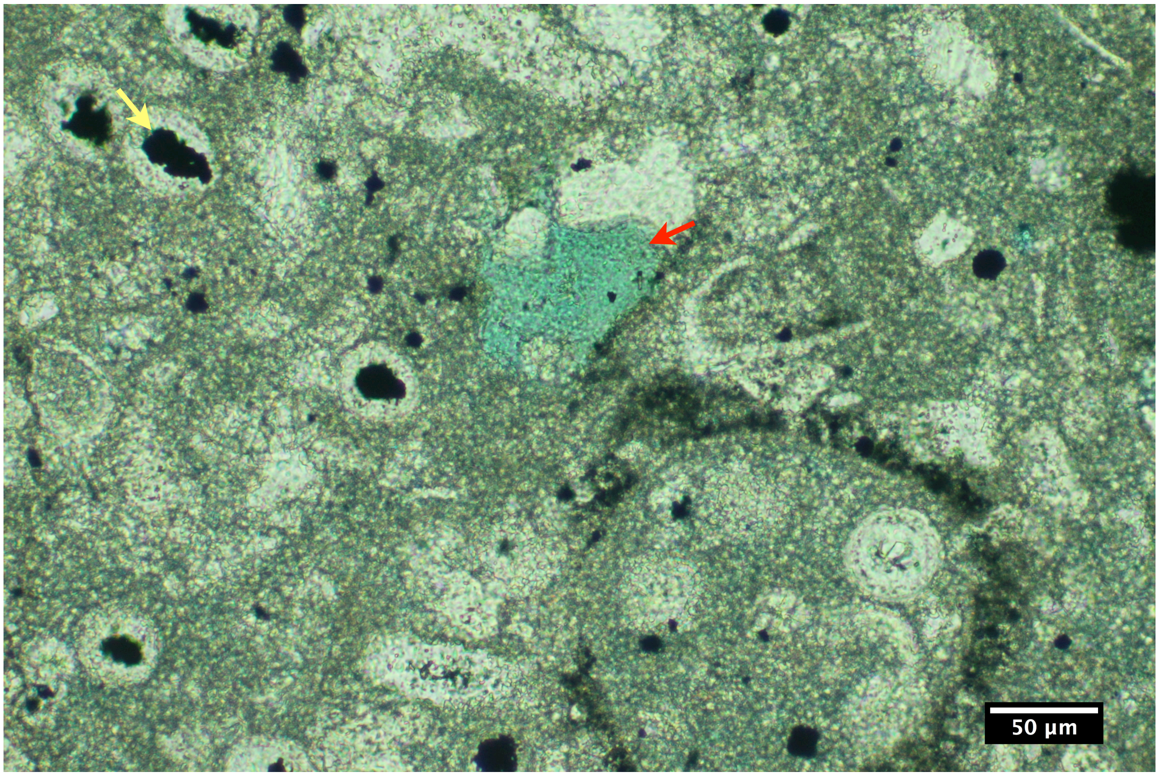
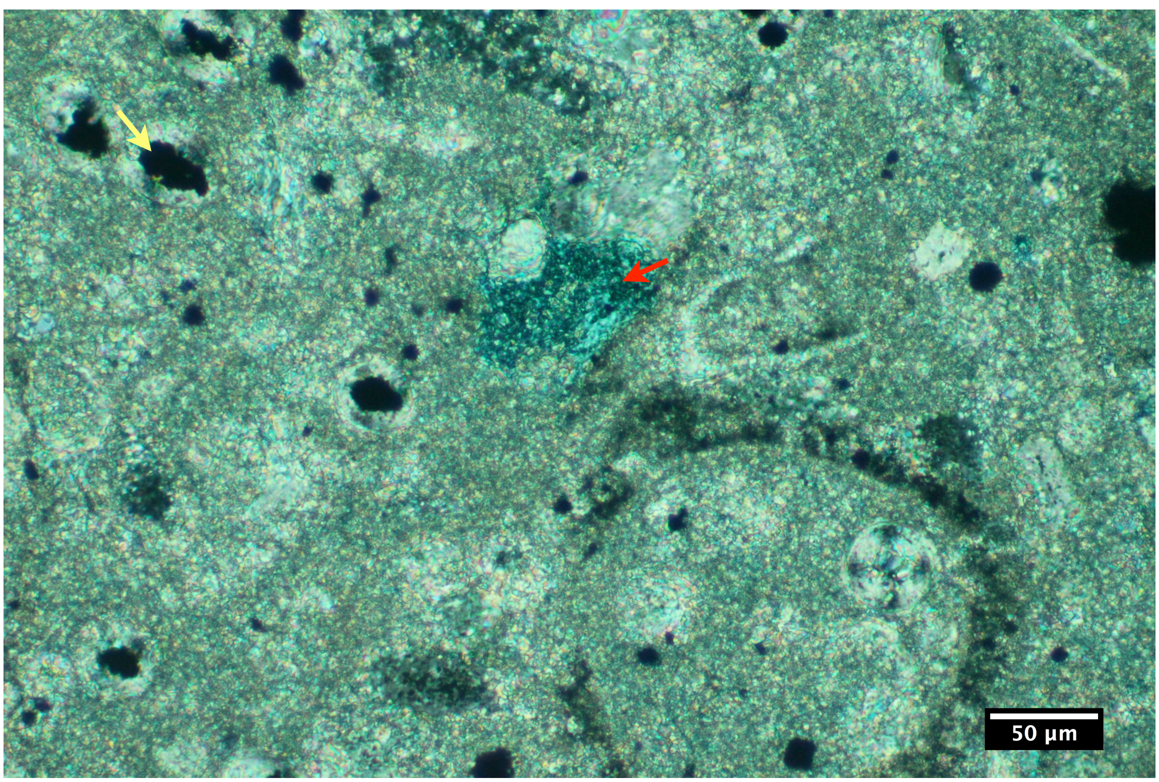
545.4 - 546.3 ft.; MI#18087-01



1E. Skel-moldic pore filled with microporous kaolinite clay (red arrows).



1F. As in Figure 1E, with cross polarized light. Note the pyrite cement (black; yellow arrows).

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545.4 - 546.3 ft. - MI#18087-01 - SEM

Summary: The SEM images illustrate the isolated character of the macropores within this core interval. The densely-crystallized microcrystalline calcite groundmass supports the skeletal fragments & moldic voids of the limestone framework, but also contributes to the isolation of the skel-moldic pores. The pore system includes intercrystalline microporosity, and scattered skel-moldic macropores. The macropores are small (~10-30 μm) and locally contain crystals of pore filling dolomite &/or calcite spar cement +/- traces of authigenic kaolinite clay.

The following image tags are used to identify selected features on the SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

18087-01 Photo Index: (bookmarks)

Sample ID	Magnification
18087-01A	150X
18087-01B	400X
18087-01C	1500X
18087-01D	6000X
18087-01E	300X
18087-01F	1300X
18087-01G	5000X

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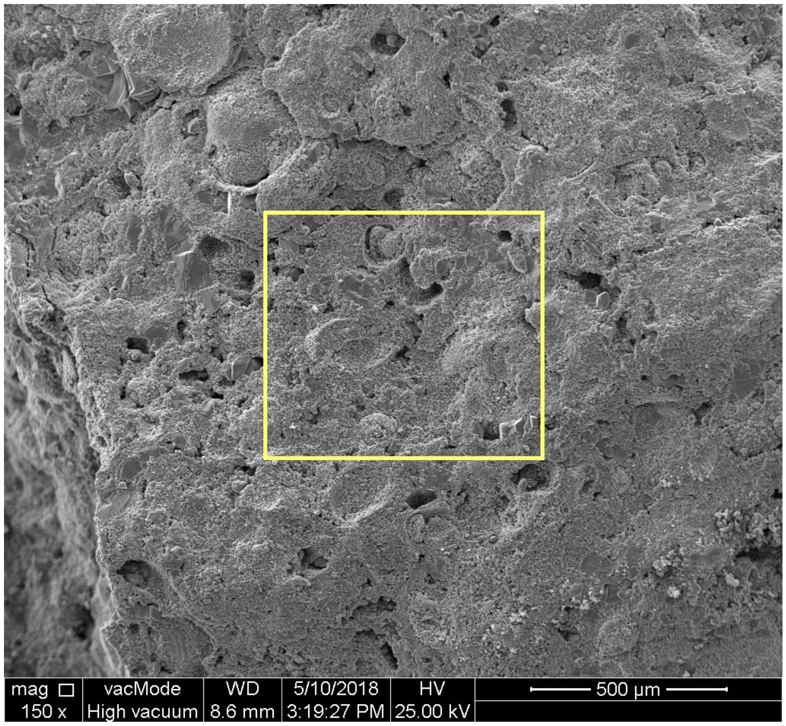
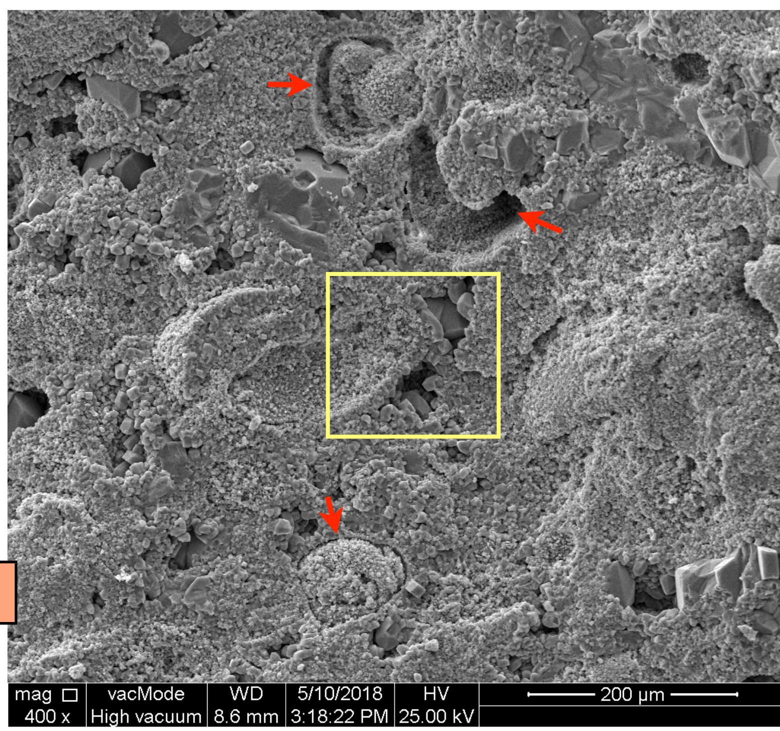
18087-01A 150X



18087-01B 400X



2Mp

SF

[18087-01 Photo Index]

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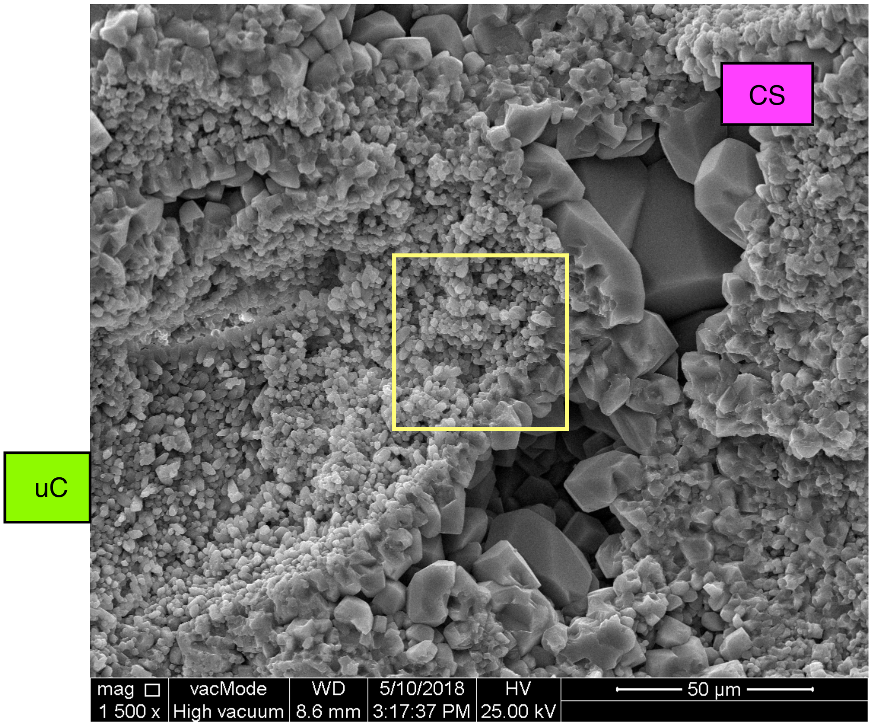
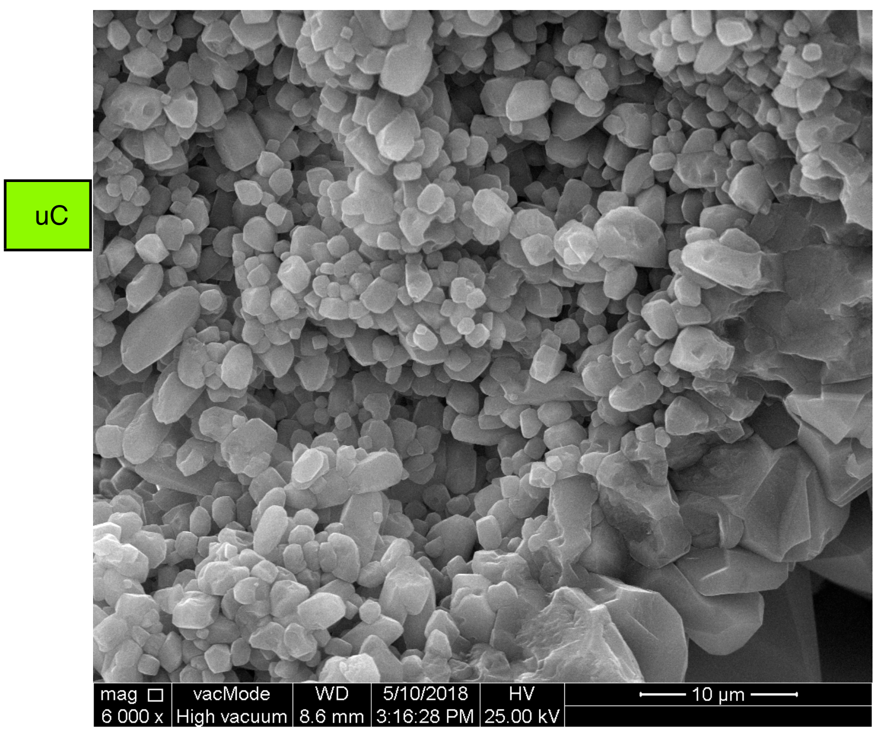
18087-01C 1500X





18087-01 Photo Index

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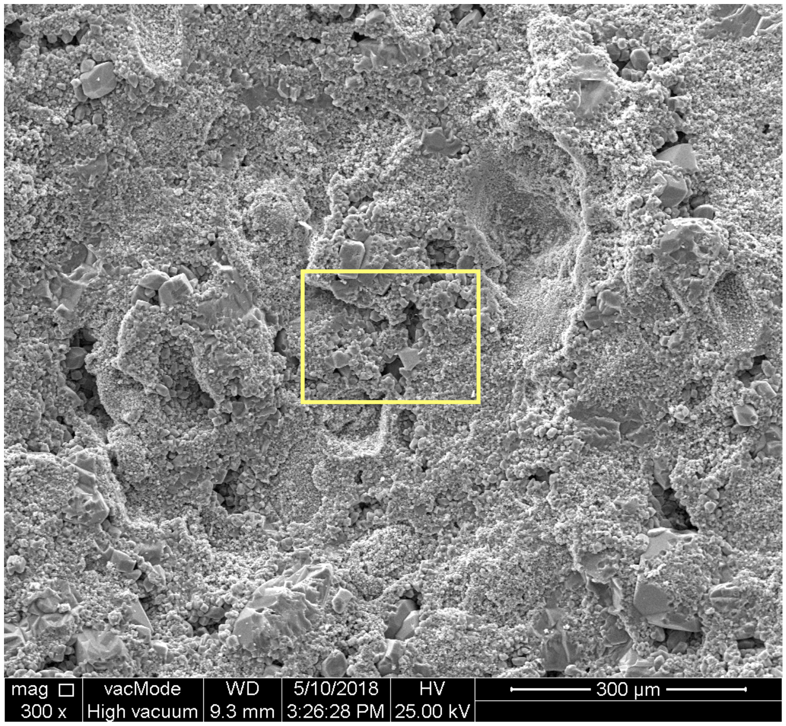
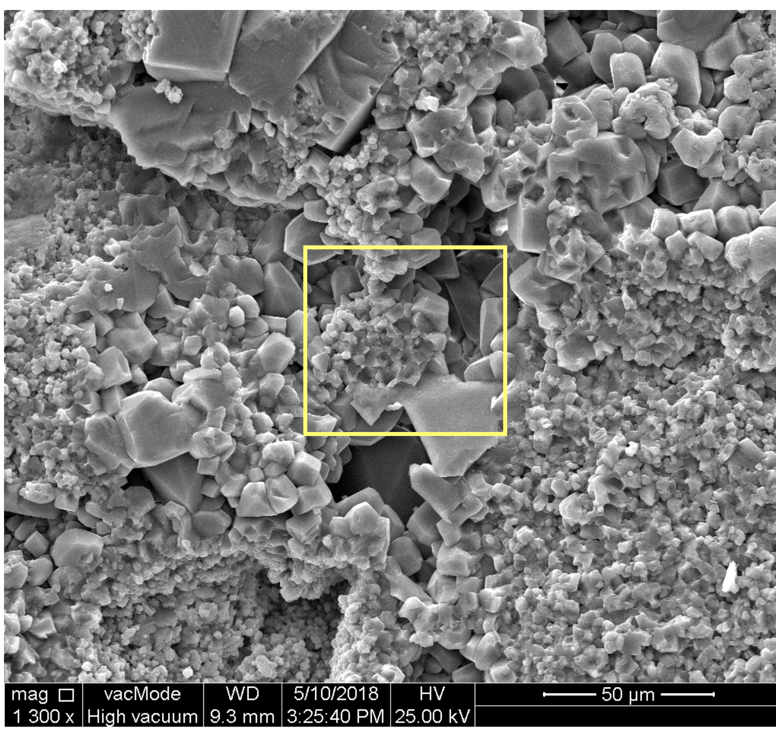
18087-01E 300X



18087-01F 1300X



Bp

[18087-01 Photo Index]

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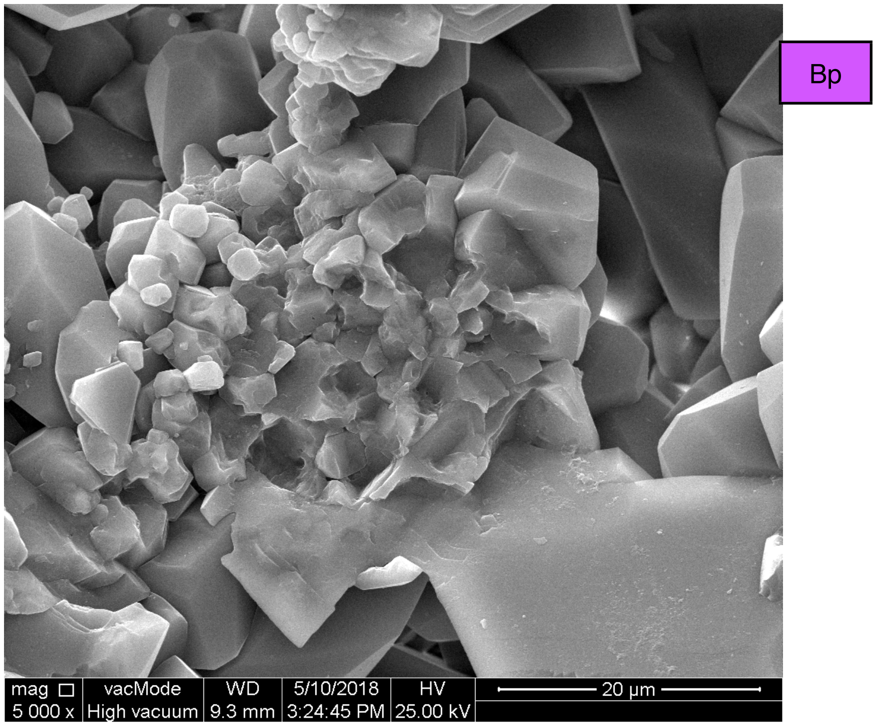
18087-01G 5000X



18087-01 Photo Index

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NBU-CH-1
Core Depth: 673.6-674.6”
18087-02

This core sample is classified as a porous, microcrystalline ***dolomite***. Some characteristics of the sedimentary fabric and reservoir quality for this interval are noted as follows:

- The mean crystal diameter is ~1-1.5 μm (microcrystalline) and the crystals are subhedral to euhedral and moderately packed.
- Dolomite accounts for ~ 99.5% of the mineral mass within this interval. Residual calcite cement is estimated to account for ~0.5% of the bulk volume. Traces of quartz, silt, and kaolinite matrix material are present as accessory mineral phases as identified in the XRD analysis.
- Scattered traces of organic matter are locally present as irregular lath-like particles that are commingled with the dolomite crystals within the groundmass.
- The sedimentary fabric is weakly-laminated and burrow-mottled. The fabric incorporates large amounts of residual intercrystalline macro and microporosity, with a pore volume of 34.9%. The intercrystalline voids are widely distributed and well-interconnected throughout the sample framework, with a measured gas permeability value of 310 md. The measured gas permeability includes flow associated with the intercrystalline pathways of the groundmass, as well as locally discontinuous cracks that are scattered within the thin section fabric. The micro-cracks and fabric irregularities are typically oriented sub-parallel to the bedding plane fabric. It is likely that overburden stress within the in situ aquifer will reduce the influence of these features with respect to fluid transmissivity.

The following image tags are used to help identify selected features on the thin section & SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

Sample ID	Magnification
18087-02A	32X
18087-02B	100X
18087-02C	200X
18087-02D	500X

Mineralogical data for this limestone sample are summarized below:

Mineral Constituents	Concentration (%)
Quartz	<0.5
Calcite	0.5
Dolomite	99.5
Kaolinite	<0.5

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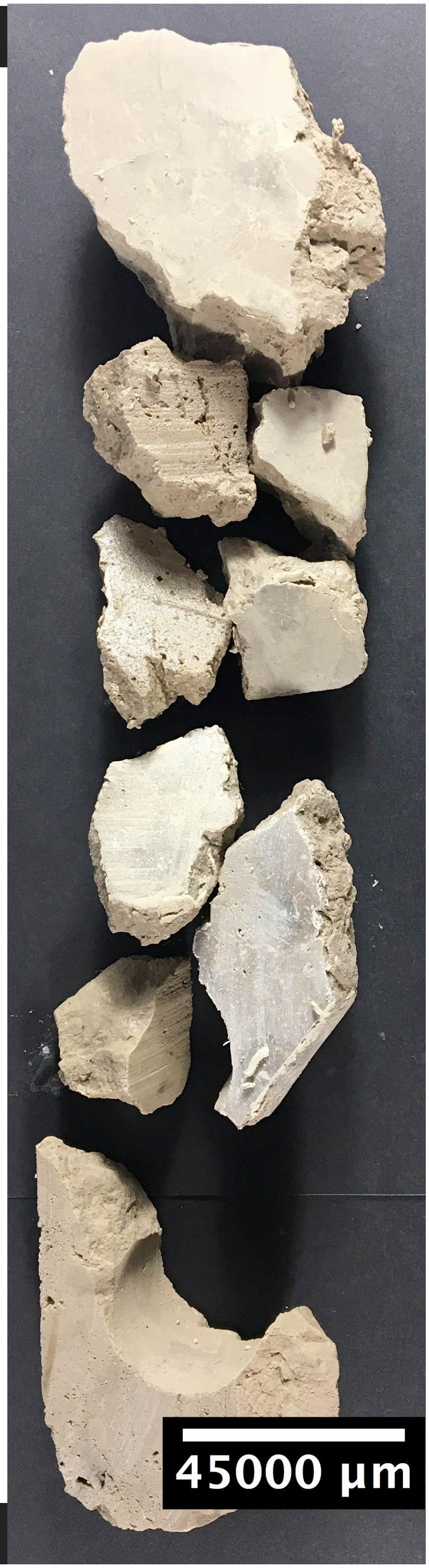
673.6 - 674.6 ft.; MI#18087-02 - Macro

673.6’



674.6’

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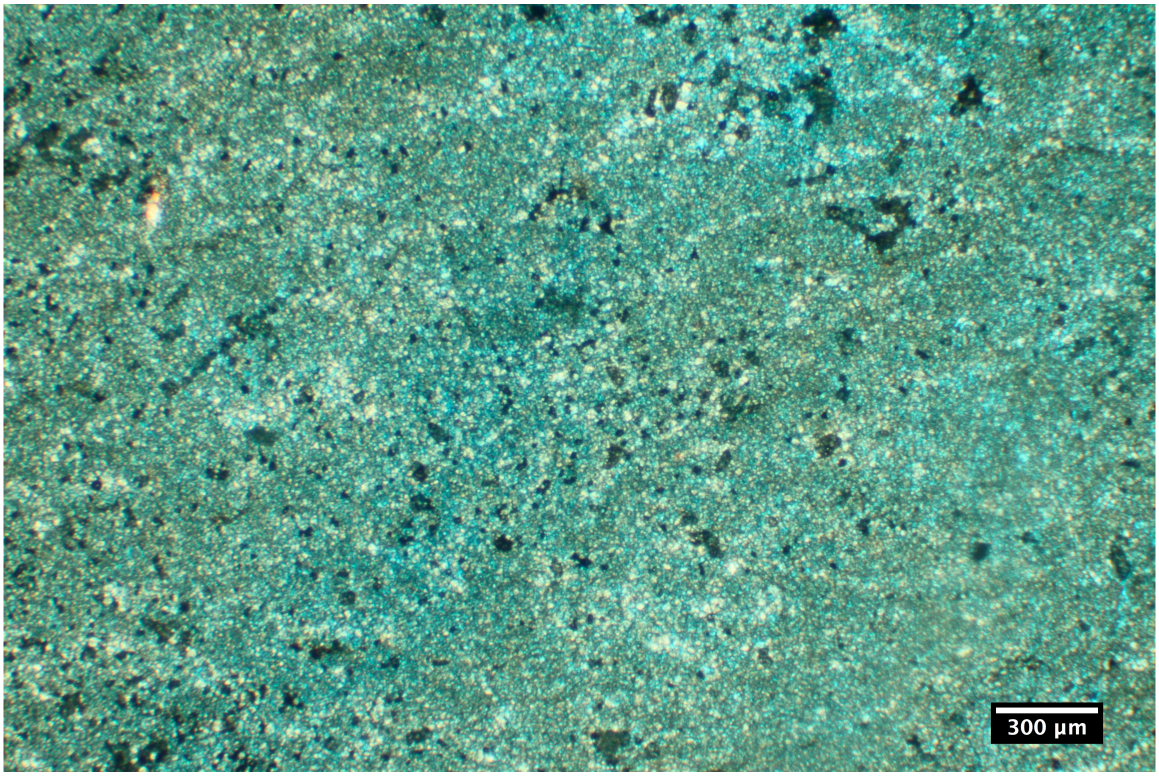
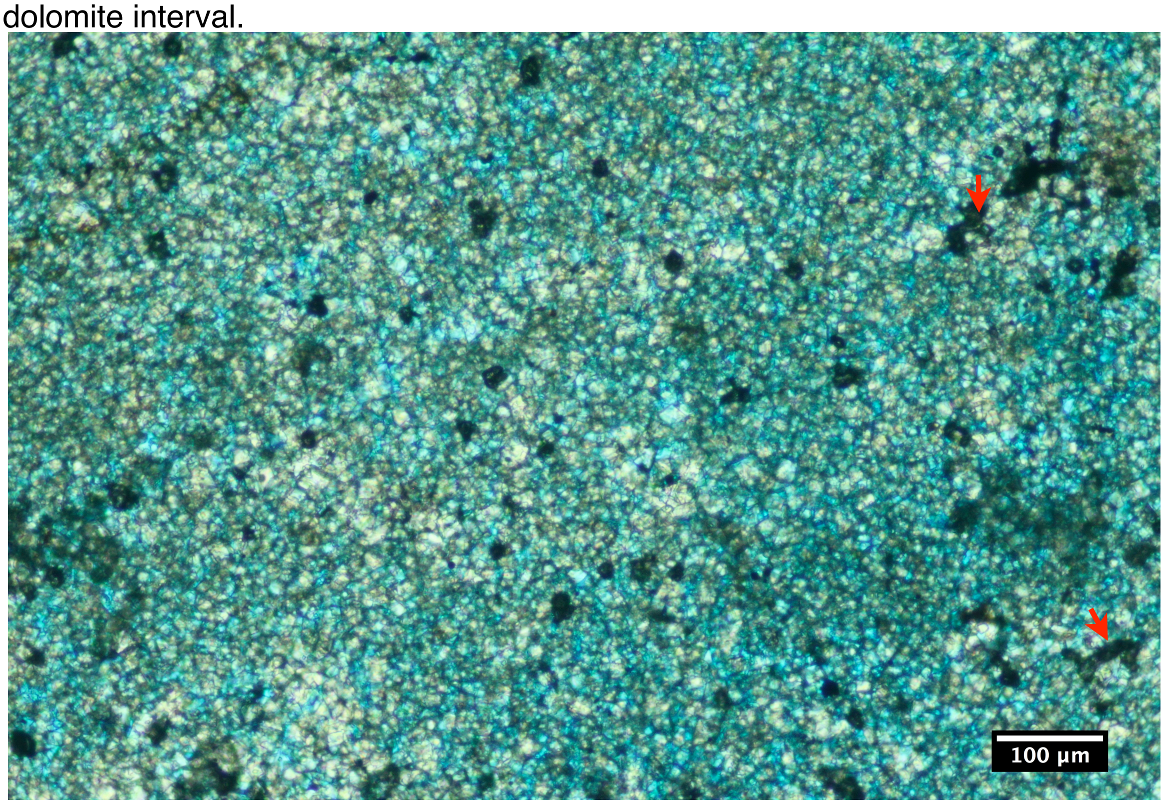
673.6 - 674.6 ft.; MI#18087-02



2A. Intercrystalline porosity accounts for nearly 35% of the bulk volume in this dolomite interval.



2B. The dolomite groundmass is burrow mottled and includes scattered particles of amorphous organic matter (red arrows) that are locally co-mingled with the microcrystalline dolomite cement.

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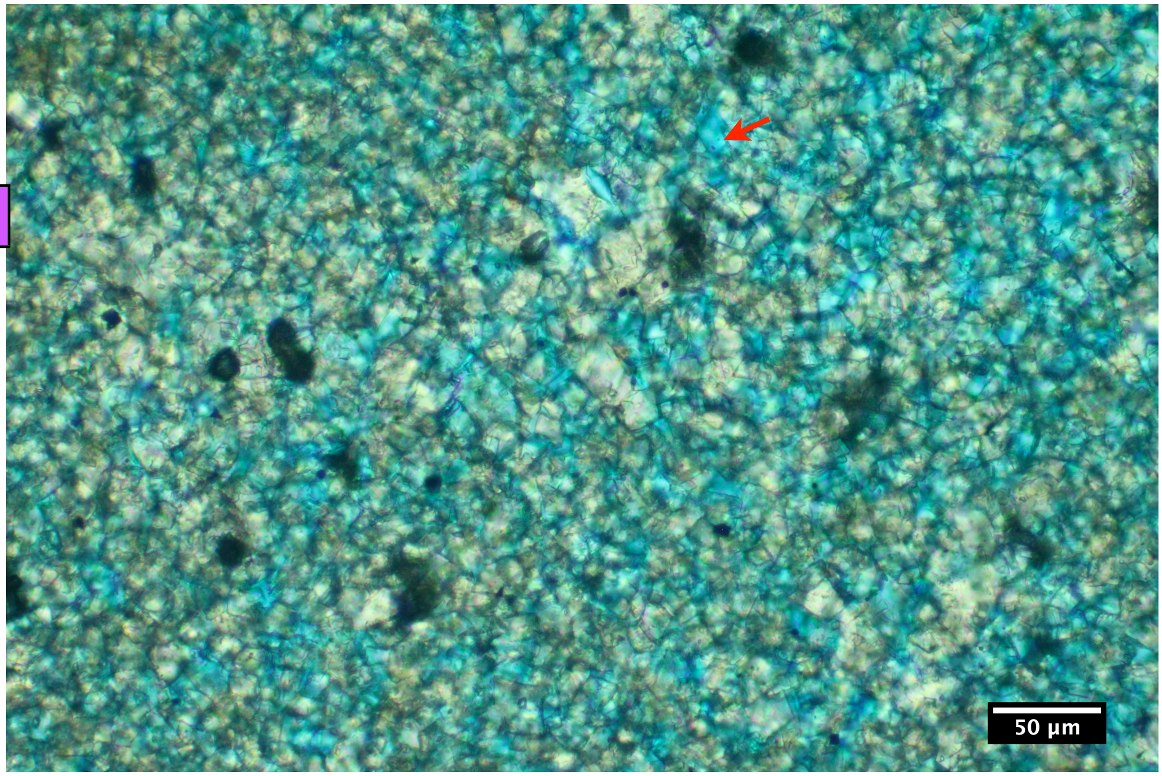
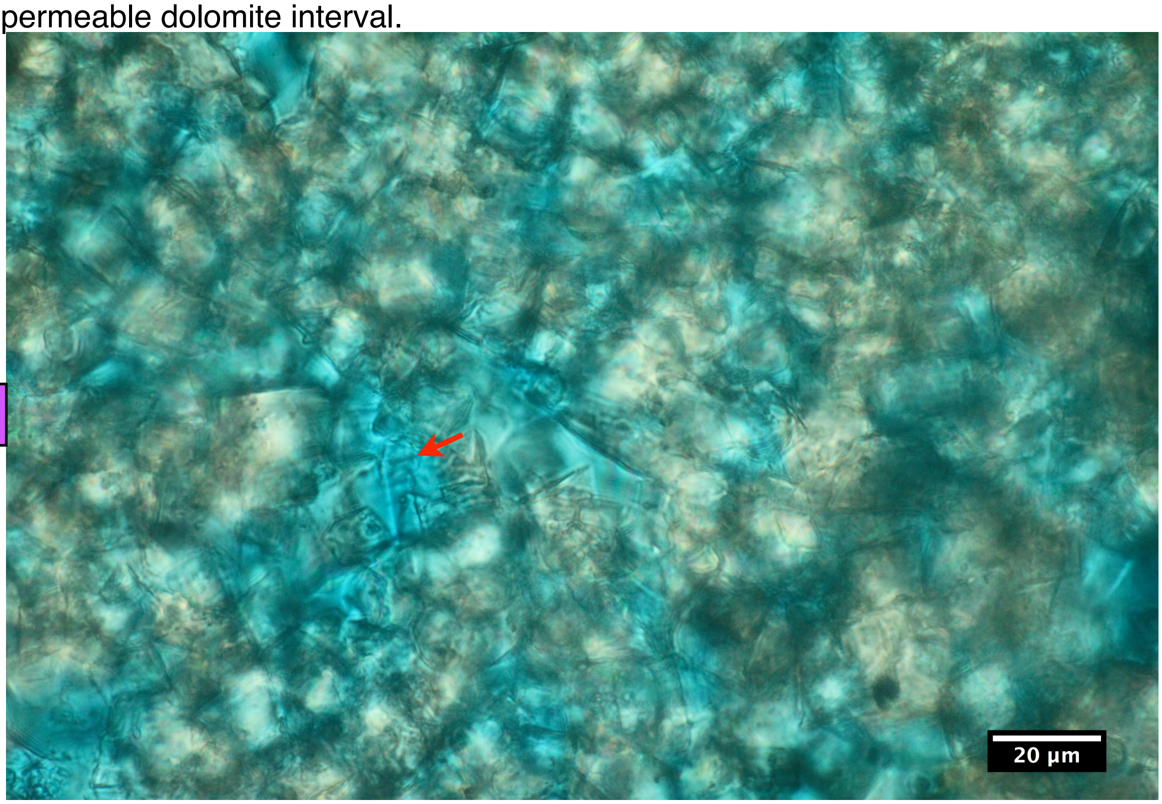
673.6 - 674.6 ft.; MI#18087-02

Bp



2C. Detailed views of the microcrystalline groundmass within this porous & permeable dolomite interval.

Bp



2D. Ubiquitous intercrystalline macro & microporosity (red arrows).

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673.6 - 674.6 ft. - MI#18087-02 - SEM

Summary: The SEM sample prepared for this interval is comprised of microcrystalline to very finely crystalline, euhedral to subhedral dolomite that is porous and locally permeable. The sedimentary fabric is weakly-laminated and burrow-mottled. The fabric incorporates large amounts of residual intercrystalline macro and microporosity, with a pore volume of 34.9%. The intercrystalline voids are widely distributed and well-interconnected throughout the sample framework, with a measured gas permeability value of 310 md. The measured gas permeability includes flow associated with the intercrystalline pathways of the groundmass, as well as locally discontinuous cracks that are scattered within the thin section fabric. The micro-cracks and fabric irregularities are typically oriented sub-parallel to the bedding plane fabric. It is likely that overburden stress within the in situ aquifer will reduce the influence of these features with respect to fluid transmissivity.

The following image tags are used to identify selected features on the SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

18087-02 Photo Index: (bookmarks)

Sample ID	Magnification
18087-02A	400X
18087-02B	800X
18087-02C	3000X
18087-02D	200X
18087-02E	1500X
18087-02F	6000X

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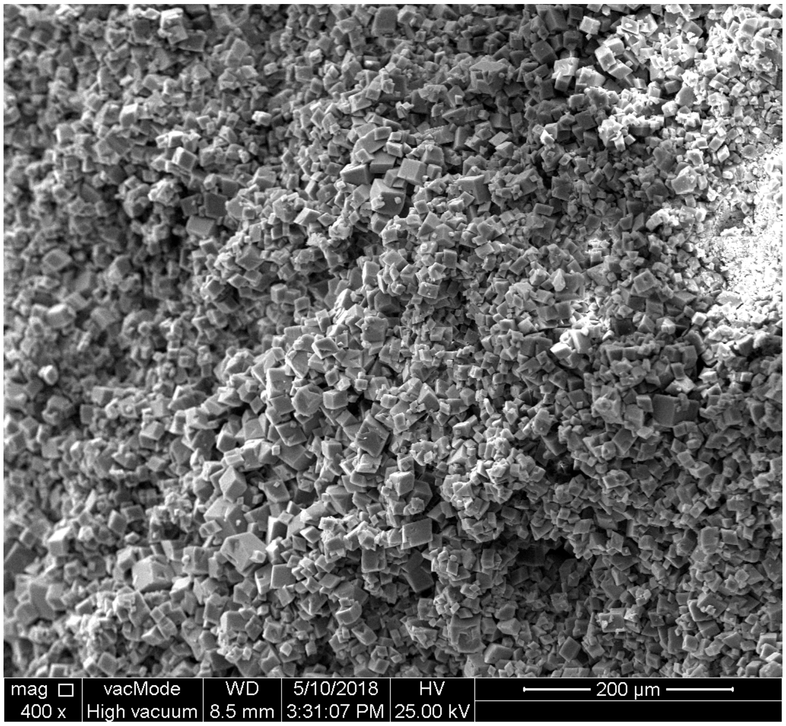
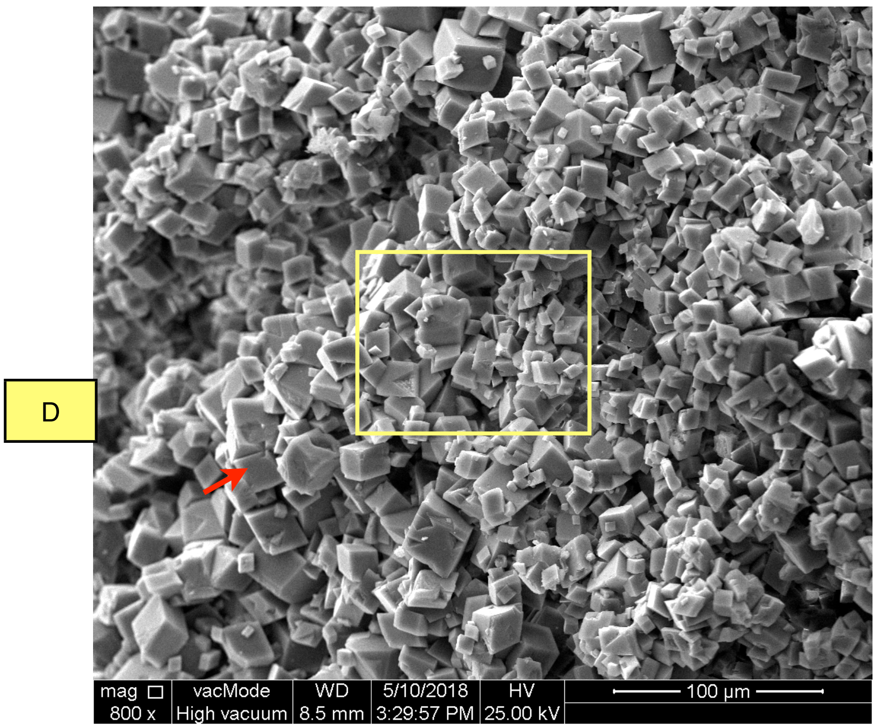
18087-02A 400X



18087-02B 800X



18087-02 Photo Index

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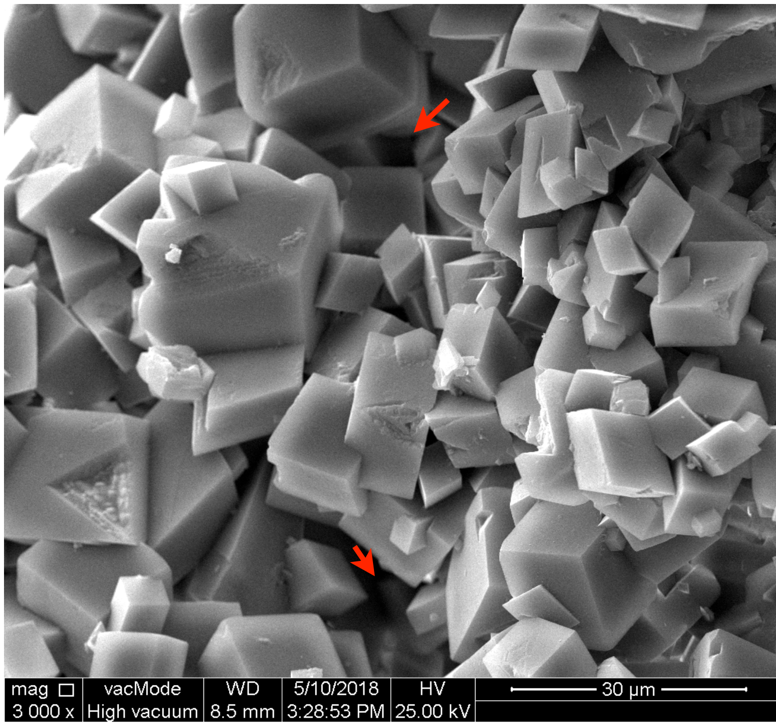
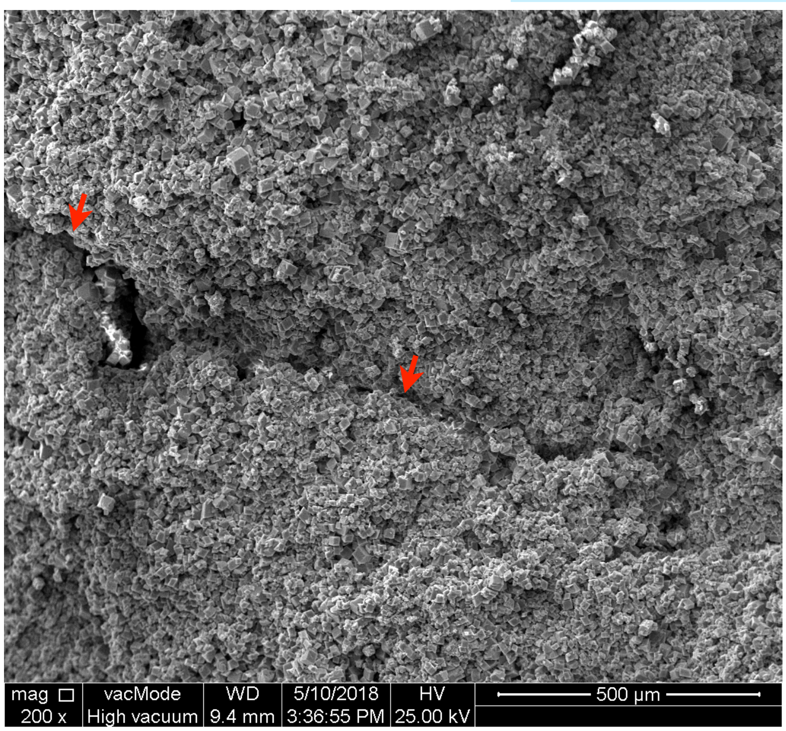
18087-02C 3000X



Bp

18087-02D 200X

Discontinuous micro-cracks (red arrows) are locally present



18087-02 Photo Index

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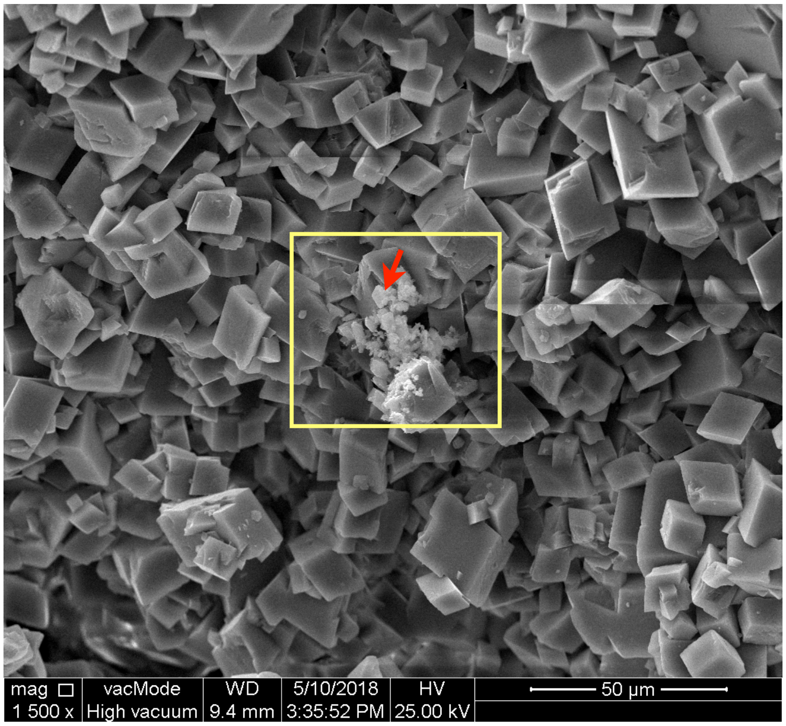
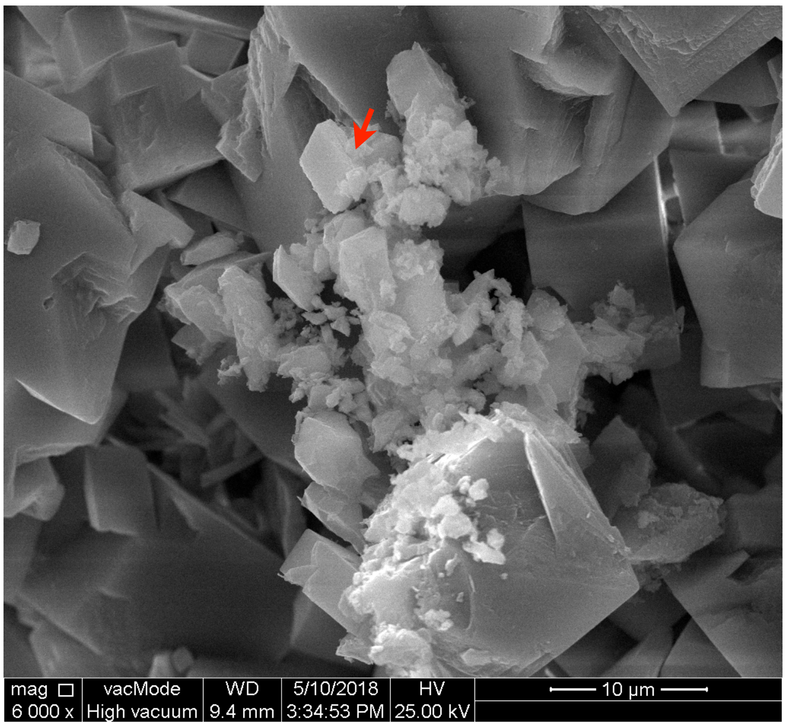
18087-02E 1500X



Possible traces of celestite ($SrSO_4$; red arrows)

18087-02F 6000X



18087-02 Photo Index

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NBU-CH-1
Core Depth: 724.8 - 725.8 ft
18087-03

This core sample is classified as a dolomitic, echinoderm-mollusk ***lime wackstone***. Some characteristics of the sedimentary fabric and reservoir quality for this interval are noted as follows:

- The mean crystal diameter of the groundmass constituents is ~1-2 μm (microcrystalline) and the crystals are subhedral to anhedral and moderately packed.
- The sedimentary fabric is matrix-supported, parallel-bedded, burrow-mottled, and densely interlocked. The limestone is fossiliferous with scattered poorly preserved skeletal fragments concentrated in sub-parallel bands.
- Calcareous skeletal fragments include echinoderm plates and spines, finely divided mollusk shell fragment material, bryozoan fronds, foram tests, calcispheres, and undifferentiated skeletal fragments. The elongated skeletal grains are commonly oriented sub-parallel to the bedding plane of the limestone.
- A few irregular concentrations of calcite spar cement are scattered within the limestone fabric and are interpreted as possible steinkerns. Steinkerns are sediment-filled growth chambers associated with skeletal fragments. These features are somewhat anomalous due to the subsequent dissolution of the original shell wall materials.
- The limestone contains small to moderate volumes (6.5%) of intercrystalline microporosity and skel-moldic dissolution void space. The horizontal gas permeability is 0.0425 md, attesting to the lack of interconnectivity between the scattered macropores in this specimen. The pore system is very poorly interconnected and this interval should comprise a effective permeability barrier within the aquifer system.

The following image tags are used to help identify selected features on the thin section & SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

Sample ID	Magnification
18087-03A	16X
18087-03B	32X
18087-03C	100X
18087-03D	200X

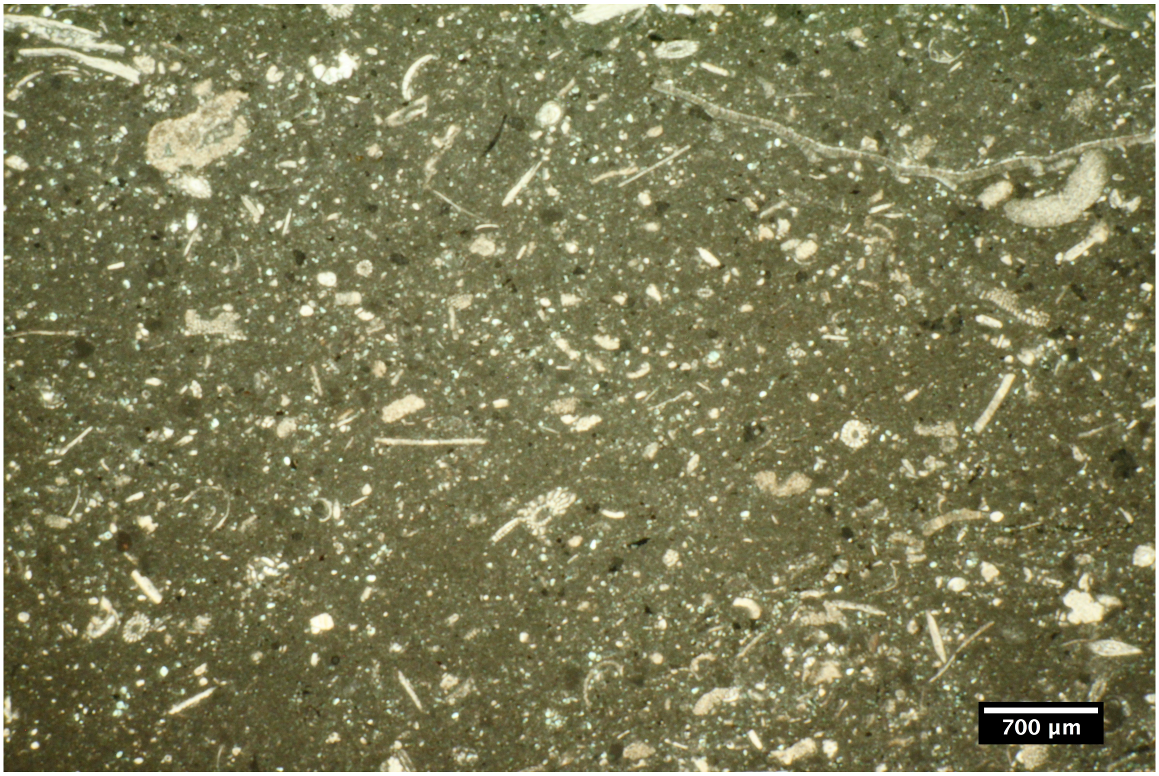
Mineralogical data for this limestone sample are summarized below:

Mineral Constituents	Concentration (%)
Quartz	1.5
Calcite	92
Dolomite	5
Pyrite	0.5
Kaolinite	1
Illite/Mica	<0.5
Mixed-Layered Illite/Smectite	<0.5

Table of Contents

724.8 - 725.8 ft.; MI#18087-03 - Macro

724.8 - 725.8 ft.; MI#18087-03



3A. The sedimentary fabric is matrix-supported, parallel-bedded, burrow-mottled, densely interlocked, and fossiliferous.

3B. An elongated bryozoan frond (red arrow) + echinoderm plates & spines (yellow arrows).

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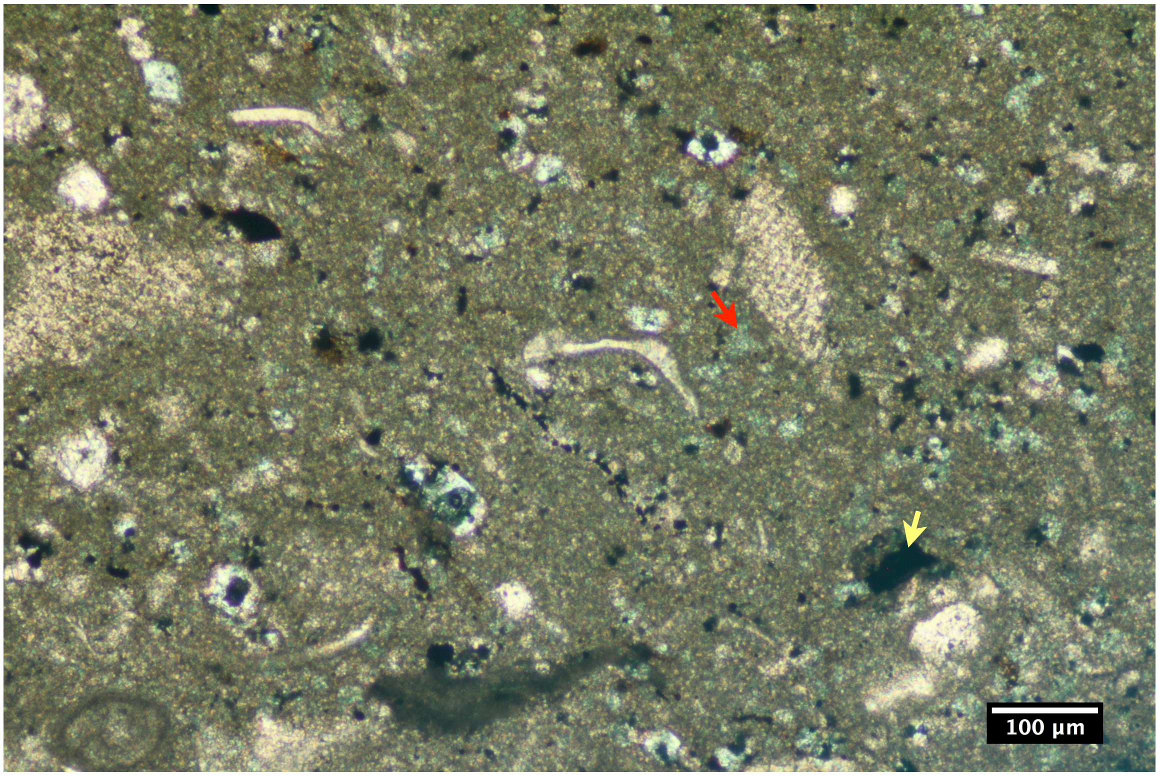
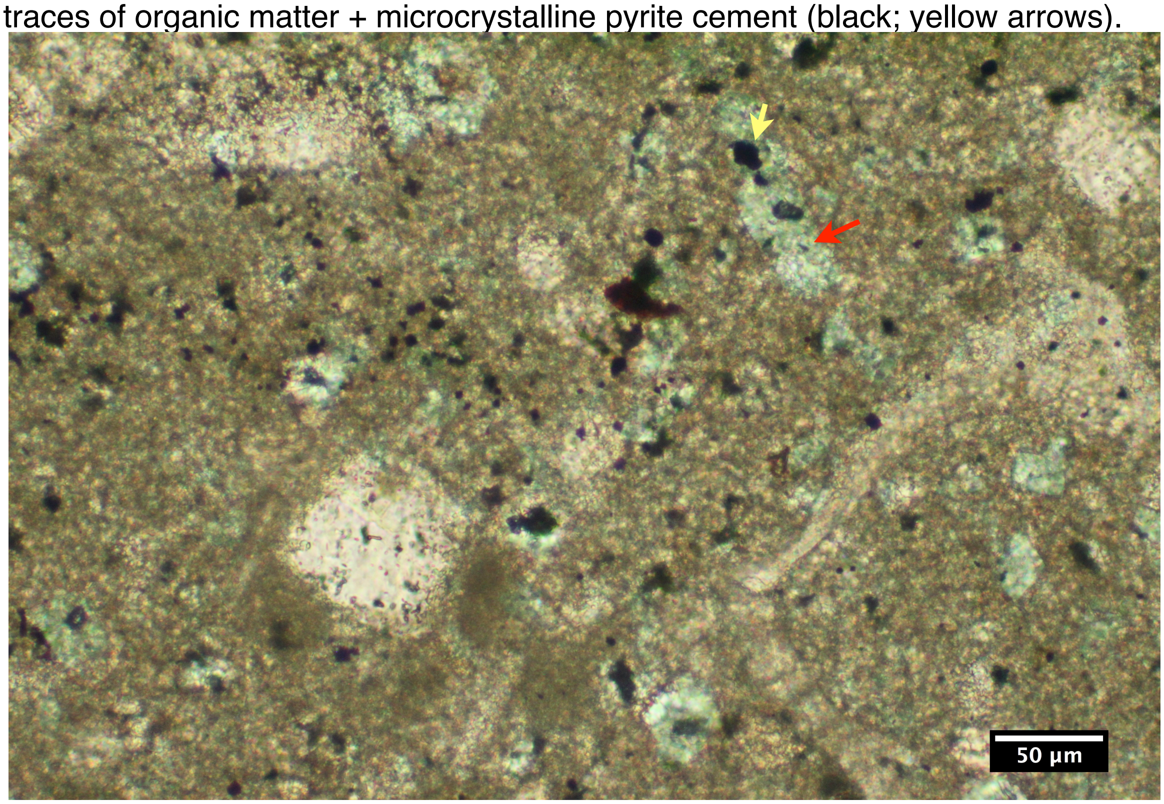
724.8 - 725.8 ft.; MI#18087-03



3C. The groundmass is locally microporous (blue-green; red arrows). Note the traces of organic matter + microcrystalline pyrite cement (black; yellow arrows).



3D. The void system is very poorly interconnected and comprises less than 7% of the limestone bulk volume.

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724.8 - 725.8 ft. - MI#18087-03 - SEM

Summary: The SEM specimen prepared for this core interval is described as non-porous, densely crystallized, skeletal lime wackstone. SEM analysis reveals that the fabric is densely interlocked and characterized by a mostly xenotopic crystals of microcrystalline calcite that generally range in size between 0.5-2 μm. Inter-crystalline microporosity is present throughout the groundmass of the sample, however, macropores are typically limited to a few scattered dissolution macropores attributed to leached calcareous skeletal fragments. The SEM sample fabric locally contains patches of coarsely-crystalline calcite spar which are tentatively attributed to the steinkerns identified within the thin section sample prepared for this interval. The pore system is very poorly interconnected and this interval should comprise a effective permeability barrier within the aquifer system.

The following image tags are used to identify selected features on the SEM images:

Igneous rock fragment	IgRF
Pore filling matrix	PFM
Authigenic clay matrix	AM
Intergranular porosity	Bp
Secondary moldic porosity	2Mp
Secondary intragranular porosity	2Wp
Feldspar	F

18087-03 Photo Index: (bookmarks)

Sample ID	Magnification
18087-03A	400X
18087-03B	800X
18087-03C	6000X
18087-03D	800X
18087-03E	1500X
18087-03F	6000X

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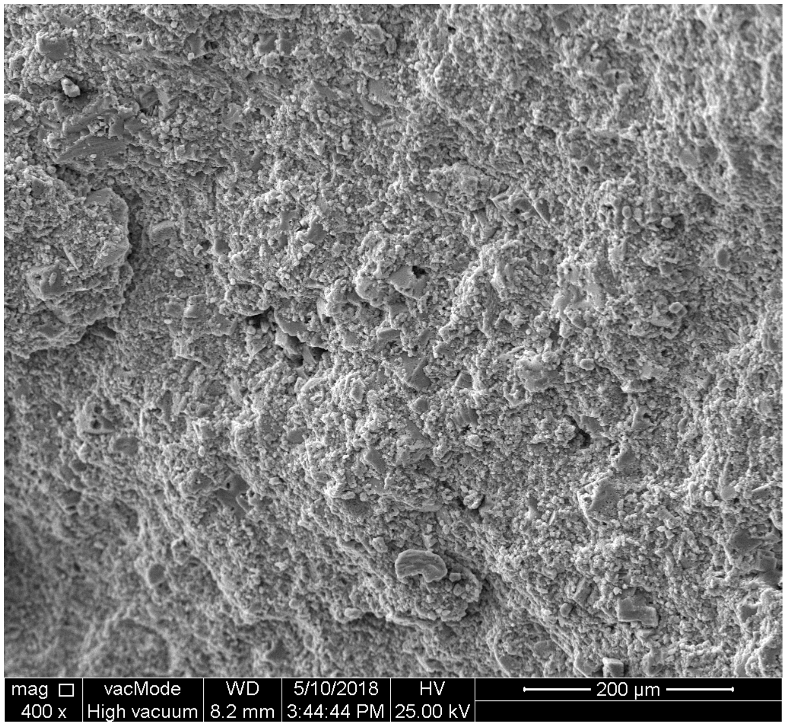
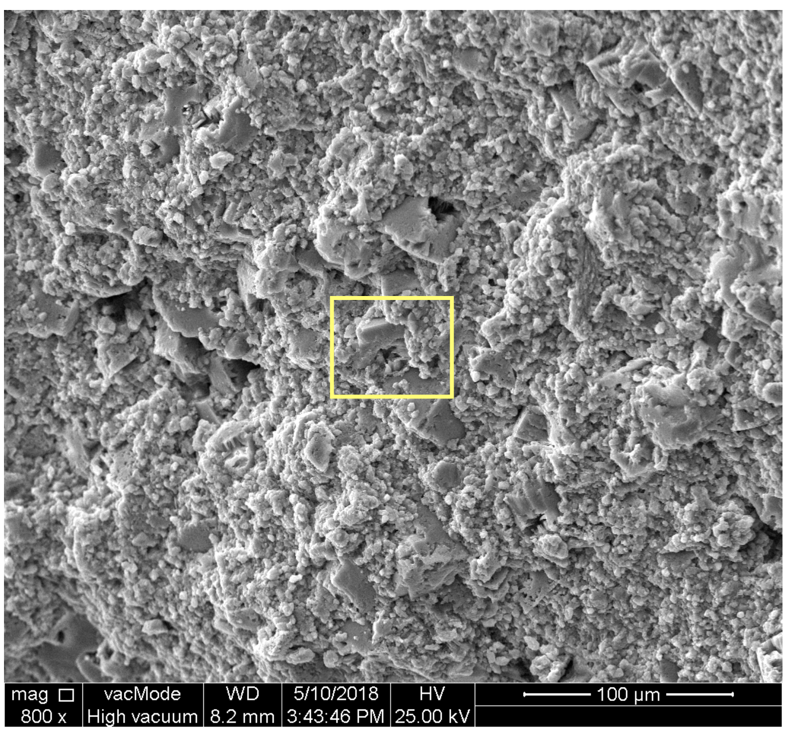
18087-03A 400X



18087-03B 800X



18087-03 Photo Index

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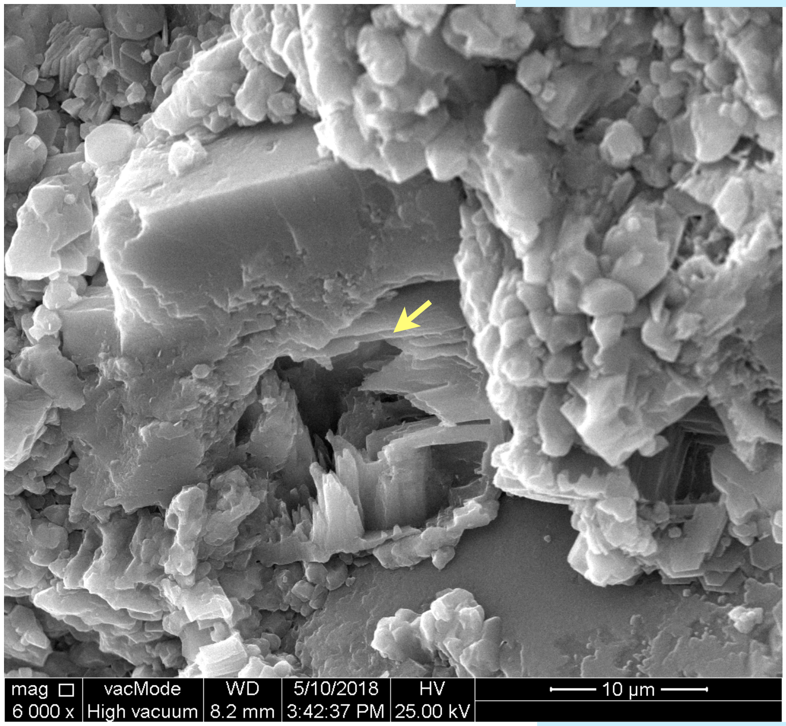
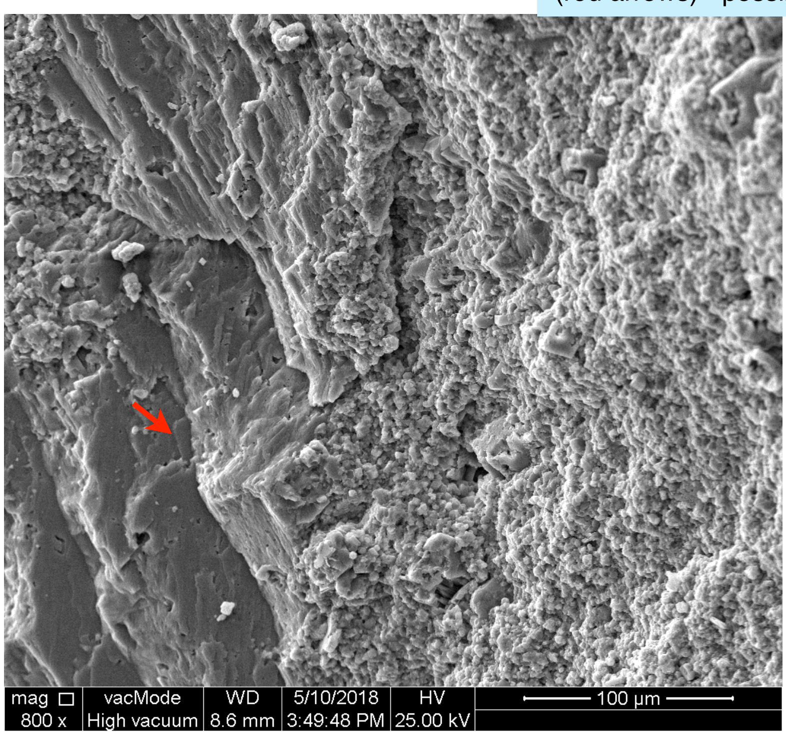
18087-03C 6000X

The corroded crystal margin of this calcite crystal (yellow arrows) are suggestive of intracrystalline dissolution porosity



18087-03D 800X

Anomalous concentration of coarsely crystalline calcite spar (red arrows) - possible steinkern



18087-03 Photo Index

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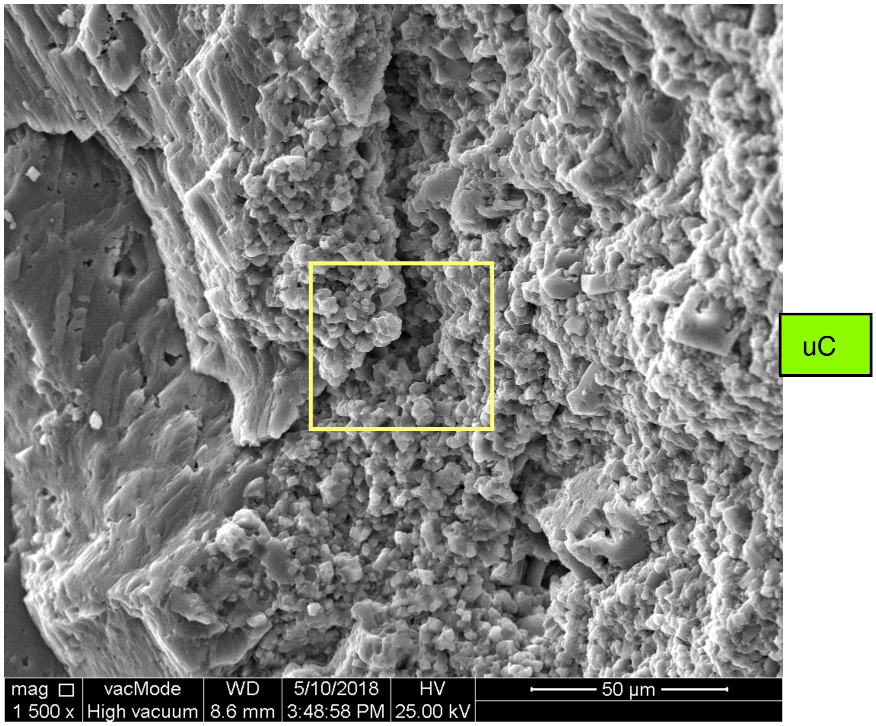
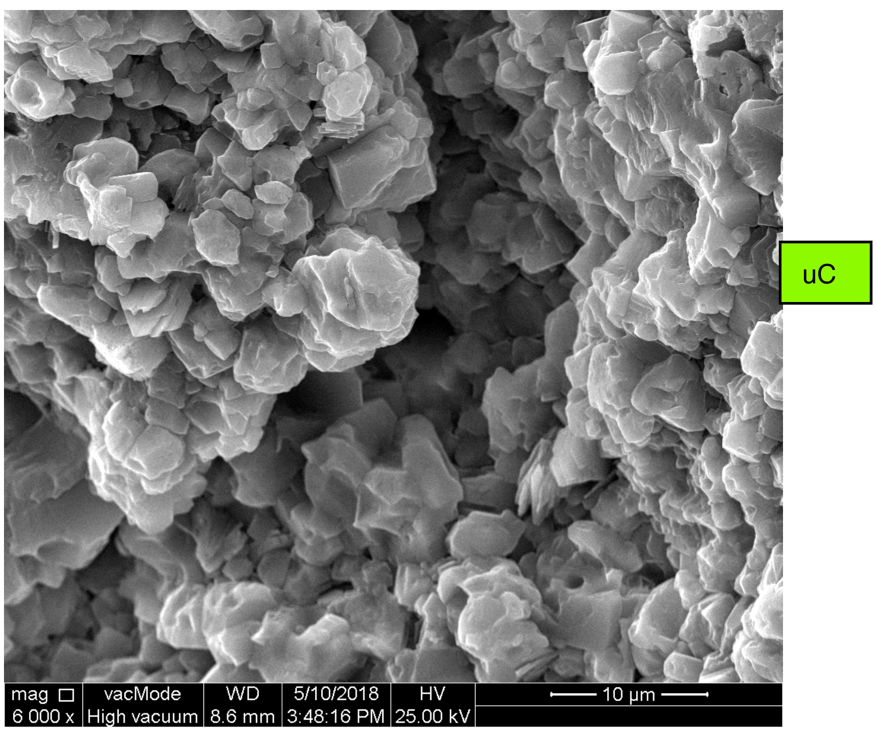
18087-03E 1500X



18087-03F 6000X



18087-03 Photo Index

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NBU-CH-1
Core Depth: 729.2 - 730.3 ft
18087-04

This core sample is classified as a foram-algae ***lime grainstone***. Some characteristics of the sedimentary fabric and reservoir quality for this interval are noted as follows:

- The mean crystal diameter of the calcite spar cement is ~25-35 μm (finely crystalline) and the cement crystals are typically subhedral to euhedral. The foram & algae-rich skeletal grains are commonly fine to medium sand-sized, moderately sorted & packed, and comprised of microcrystalline calcite with a mean crystal diameter of <2 um.
- The sedimentary fabric is grain-supported, cross-bedded, fractured, and moderately porous. The limestone is moderately packed with common point to point and elongated intergranular contacts..
- Calcareous skeletal fragments include common to abundant foram tests and calcareous algae plates, with minor amounts of mollusk shell fragments, bryozoan fronds, calcispheres and echinoderm plates and spines.
- The pore network consists of skel-moldic macropores moderate amounts of inter-crystalline macro and microporosity. Most of the skel-moldic dissolution porosity occurs as intraparticle voids (growth chambers) within selected foram tests. The macropores are generally weakly-interconnected due to the wide-spread presence of pore filling calcite spar cement.
- The limestone contains moderate amounts (11.1%) of total void space. The horizontal gas permeability measurement is not available for this interval due to the fracture density within the macro core interval. The vertical core plug sample contains an (un-separated) micro-crack, and exhibits a measured gas permeability of 135 md.

The following image tags are used to help identify selected features on the thin section & SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

Sample ID	Magnification
18087-04A	32X
18087-04B	100X
18087-04C	100X
18087-04D	200X

Mineralogical data for this limestone sample are summarized below:

Mineral Constituents	Concentration (%)
Quartz	0.2
Calcite	99.6
Kaolinite	0.2

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729.2 - 730.3 ft.; MI#18087-04 - Macro

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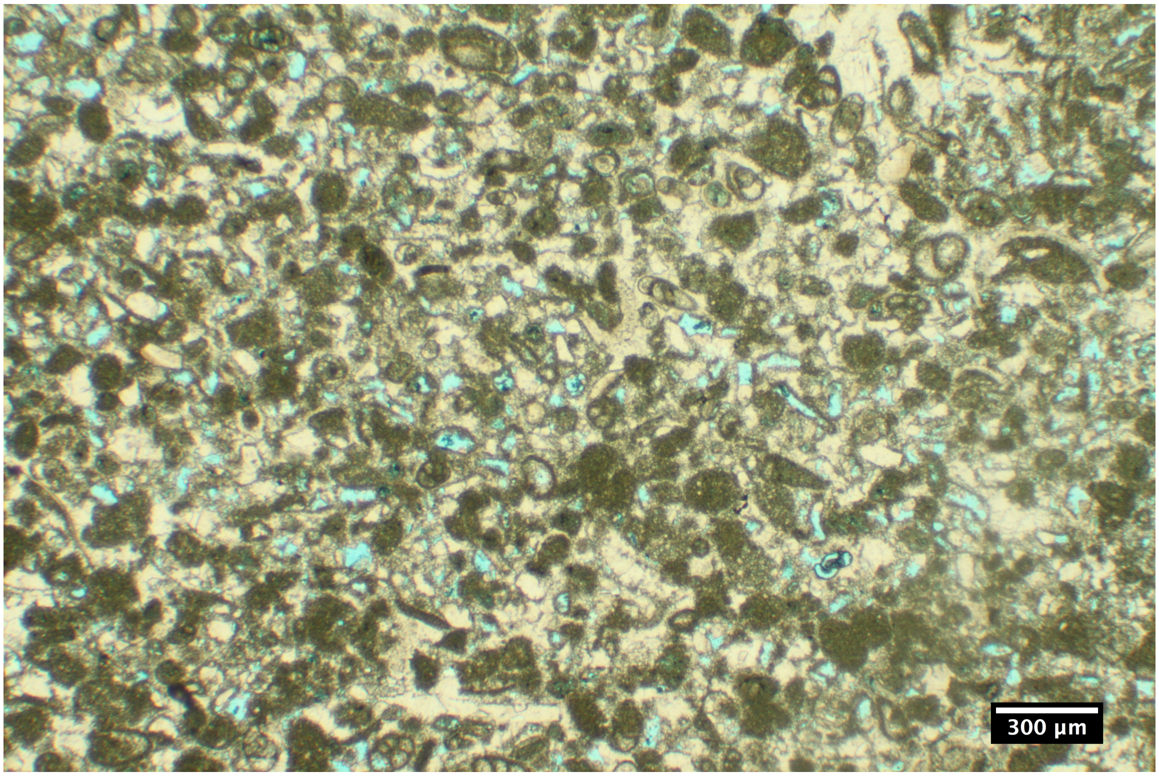
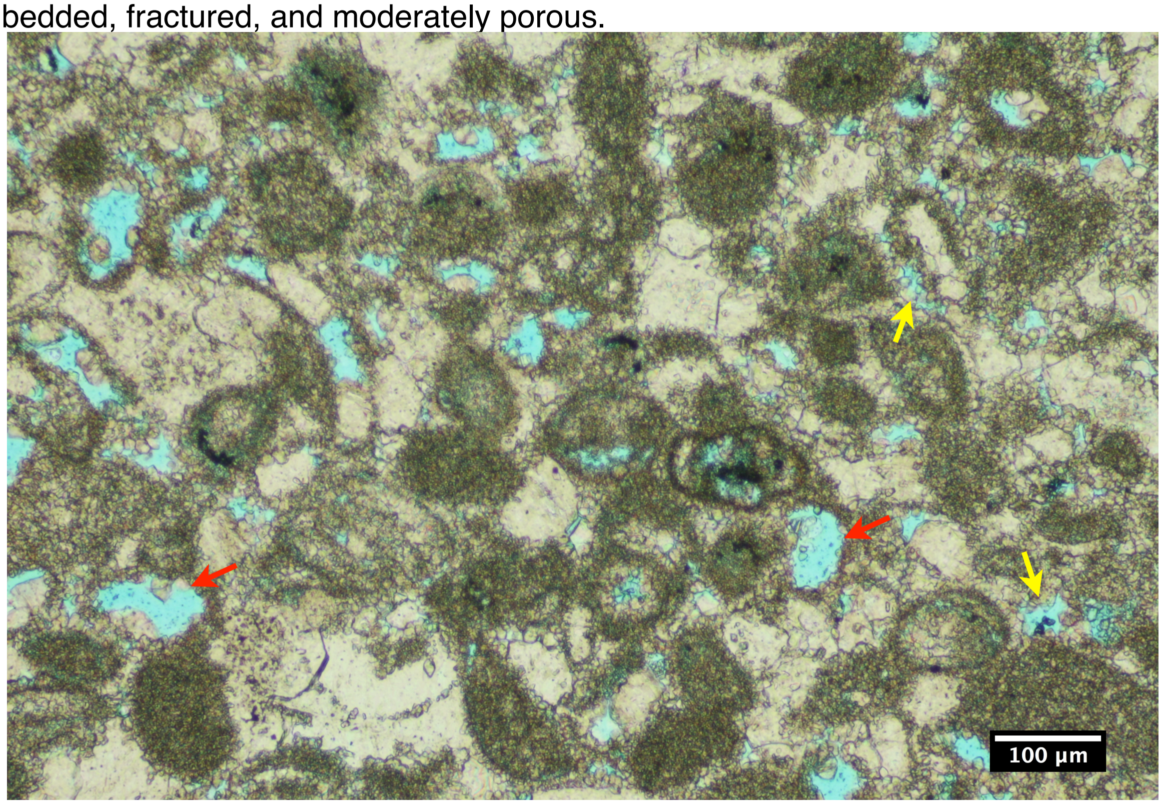
729.2 - 730.3 ft.; MI#18087-04



4A. The sedimentary fabric of this limestone interval is grain-supported, cross-bedded, fractured, and moderately porous.



4B. The pore network consists of skel-moldic macropores (red arrows) + moderate amounts of intercrystalline macro and microporosity (yellow arrows).

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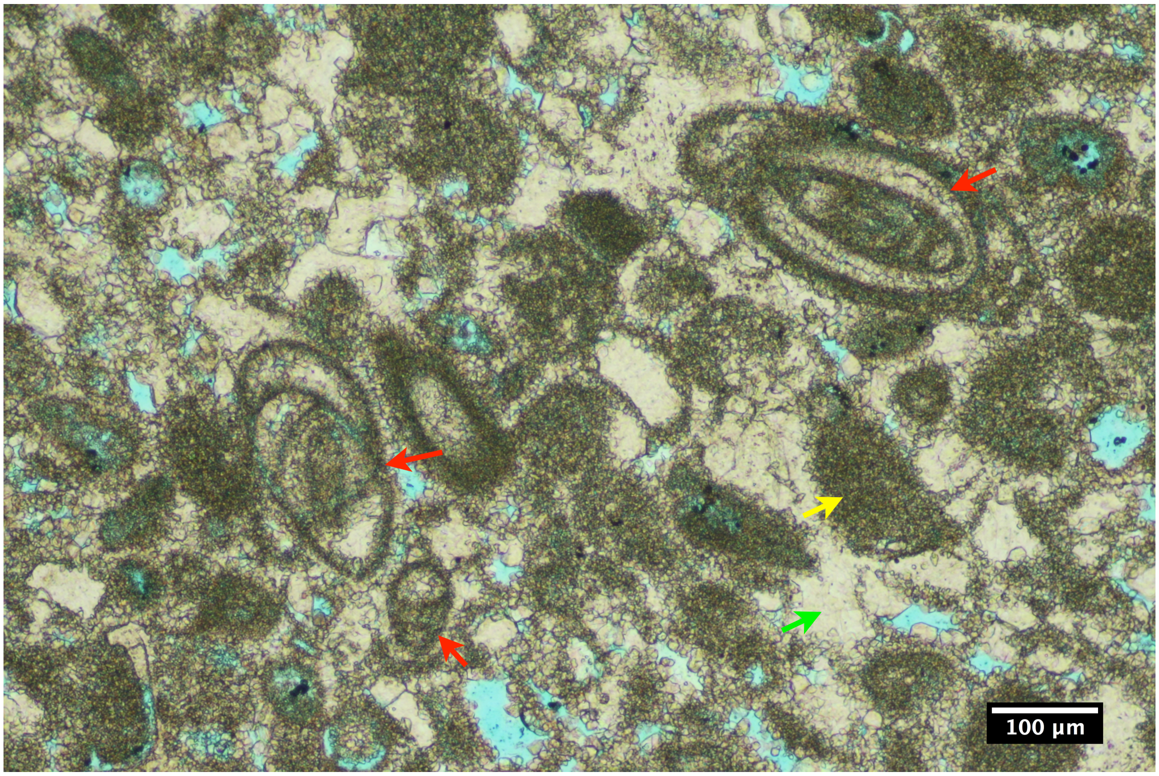
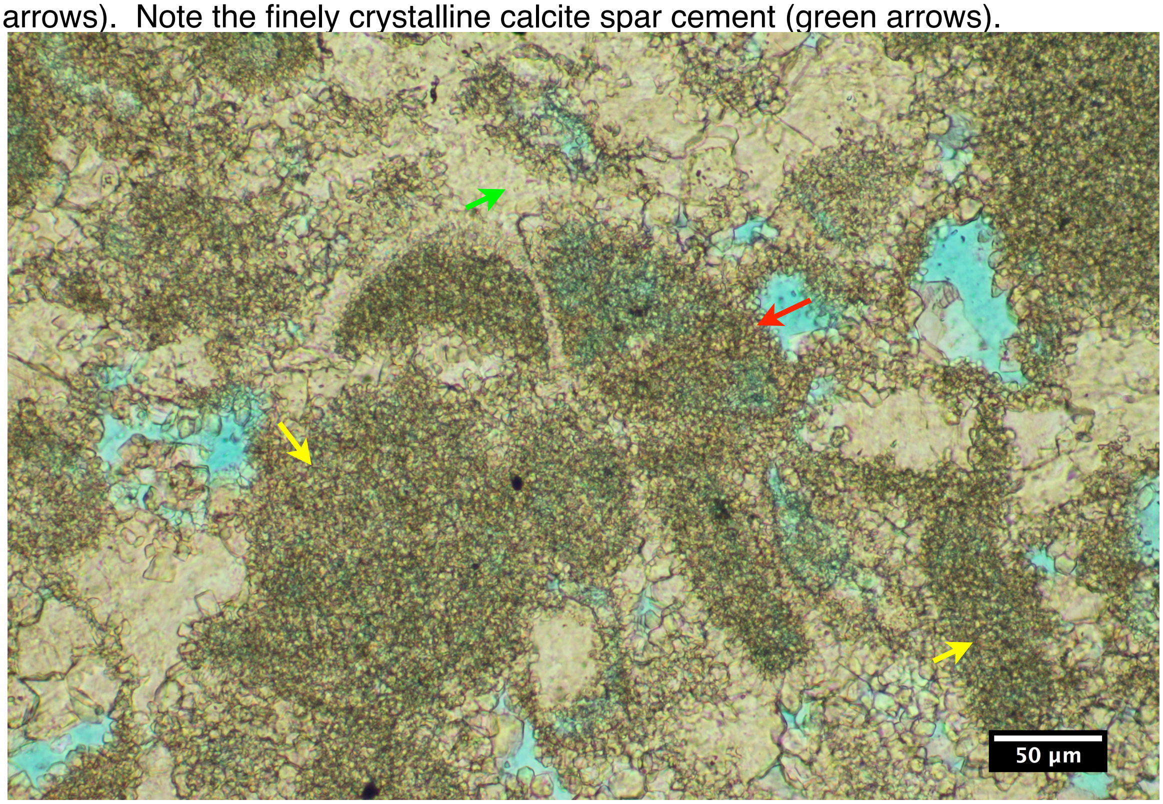
729.2 - 730.3 ft.; MI#18087-04



4C. Allochems include common foram tests (red arrows) + algae plates (yellow arrows). Note the finely crystalline calcite spar cement (green arrows).



4D. Calcareous algae plates (yellow arrows) comprised of microcrystalline calcite.

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729.2 - 730.3 ft. - MI#18087-04 - SEM

Summary: This core sample is classified as a foram-algae lime grainstone. The mean crystal diameter of the calcite spar cement is ~25-35 μm (finely crystalline) and the cement crystals are typically subhedral to euhedral. The foram & algae-rich skeletal grains are commonly fine to medium sand-sized, moderately sorted & packed, and comprised of microcrystalline calcite with a mean crystal diameter of <2 um. The pore network consists of skel-moldic macropores moderate amounts of inter-crystalline macro and microporosity. Most of the skel-moldic dissolution porosity occurs as intraparticle voids (growth chambers) within selected foram tests. The macropores are generally weakly-interconnected due to the wide-spread presence of pore filling calcite spar cement. The limestone contains moderate amounts (11.1%) of total void space. The horizontal gas permeability measurement is not available for this interval due to the fracture density within the macro core interval. The vertical core plug sample contains an (un-separated) micro-crack, and exhibits a measured gas permeability of 135 md.

The following image tags are used to identify selected features on the SEM images:

Igneous rock fragment	IgRF
Pore filling matrix	PFM
Authigenic clay matrix	AM
Intergranular porosity	Bp
Secondary moldic porosity	2Mp
Secondary intragranular porosity	2Wp
Feldspar	F

18087-04 Photo Index: (bookmarks)

Sample ID	Magnification
18087-04A	200X
18087-04B	400X
18087-04C	1500X
18087-04D	6000X
18087-04E	200X
18087-04F	800X
18087-04G	3000X

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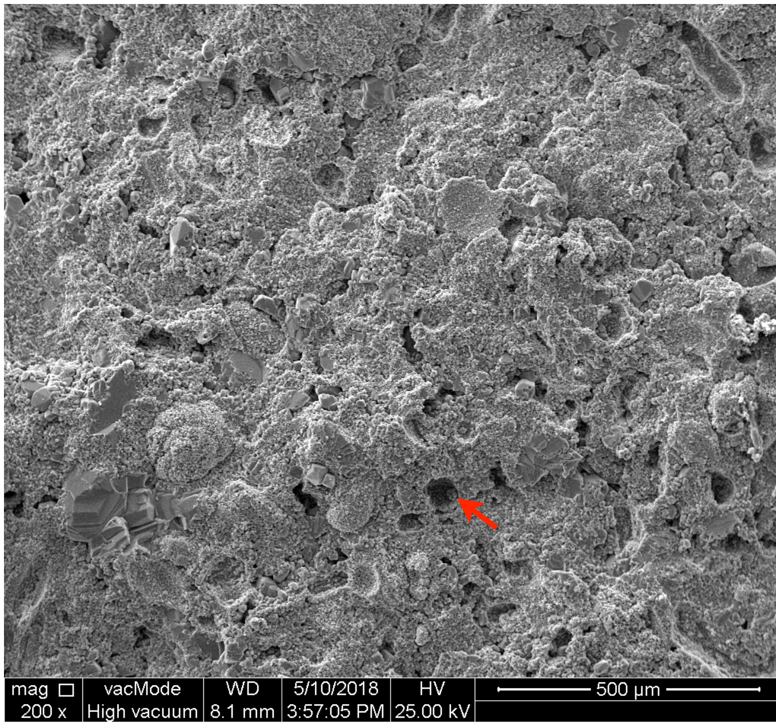
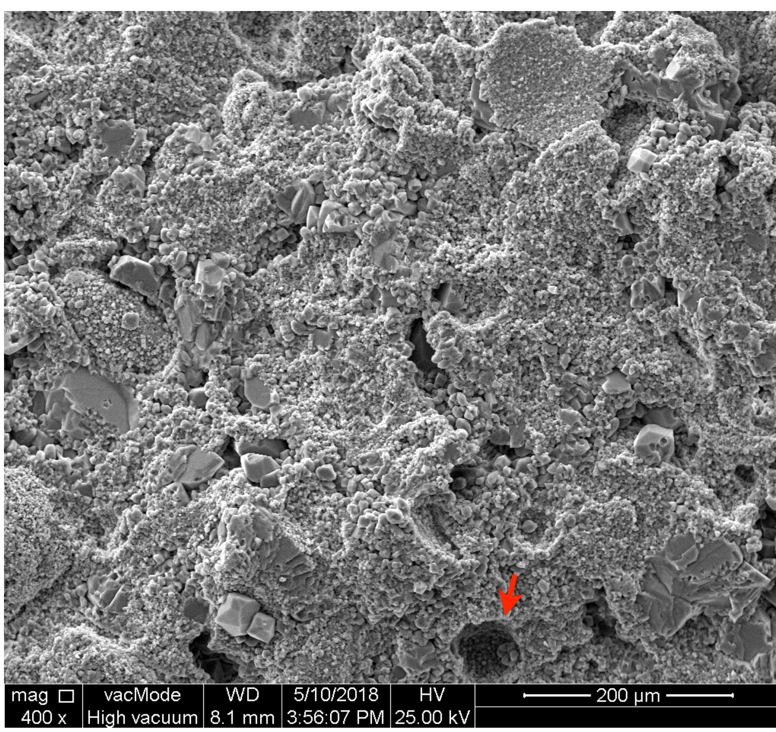
18087-04A 200X



2Mp

18087-04B 400X



2Mp

18087-04 Photo Index

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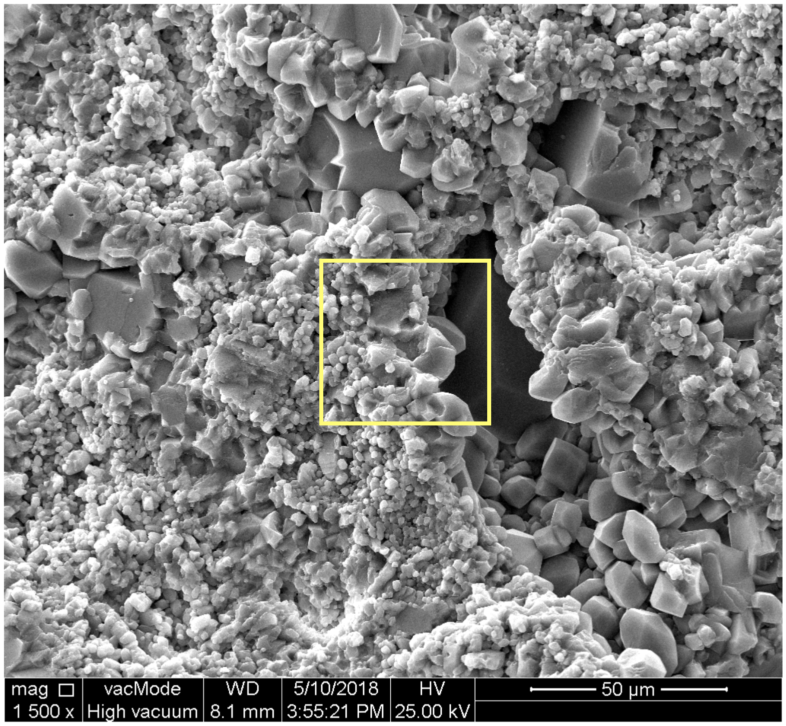
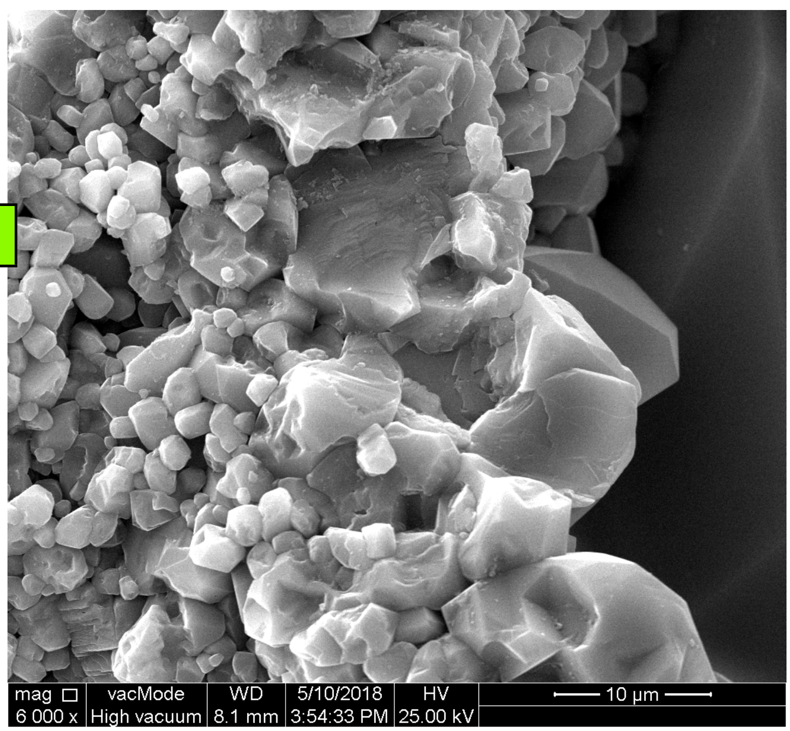
18087-04C 1500X



18087-04D 6000X

uC



18087-04 Photo Index

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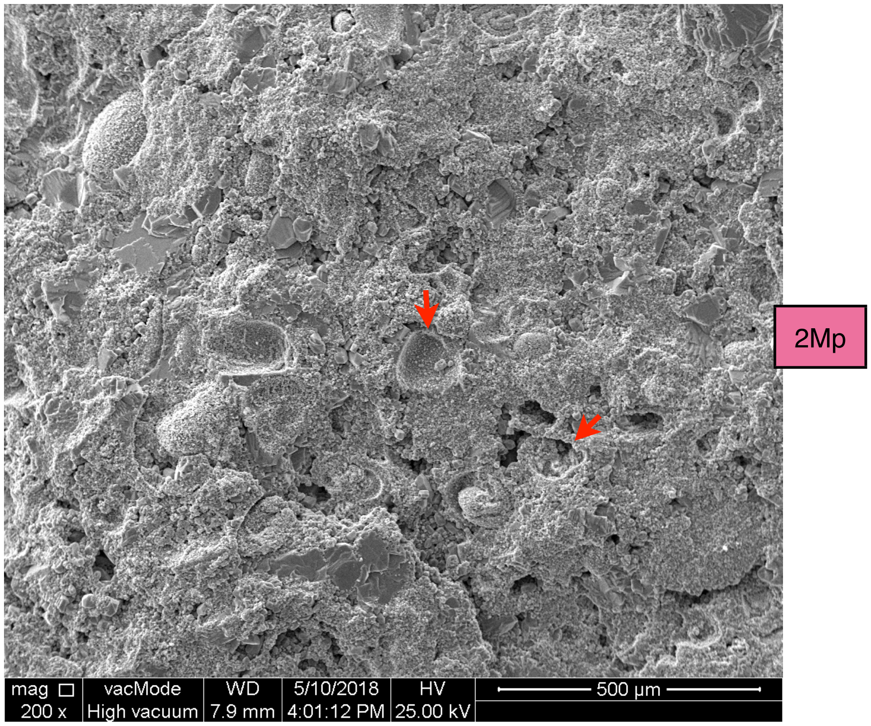
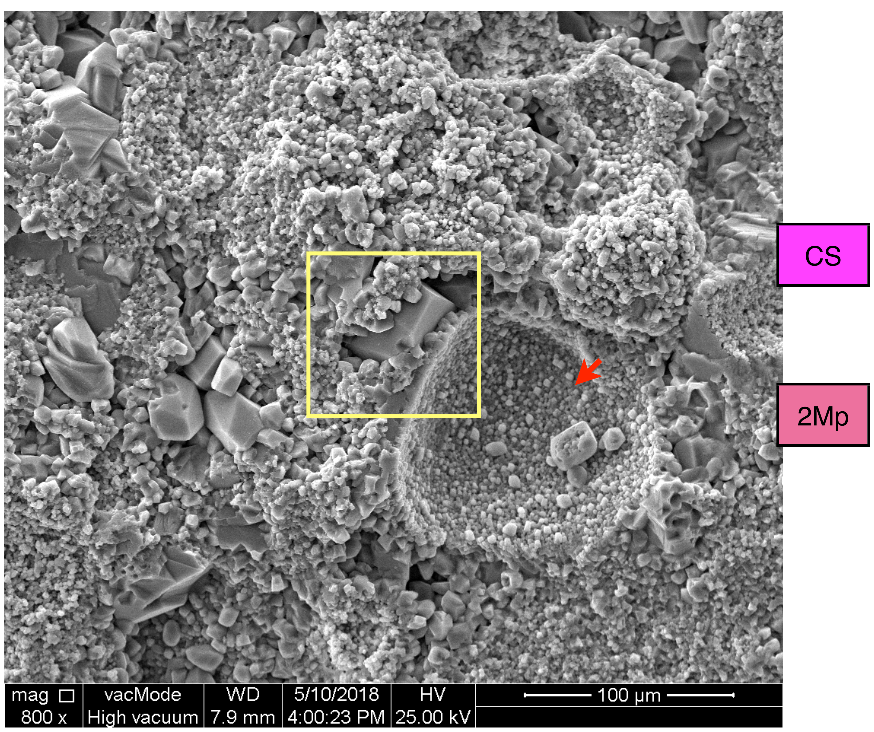
18087-04E 200X



18087-04F 800X



[18087-04 Photo Index](#)

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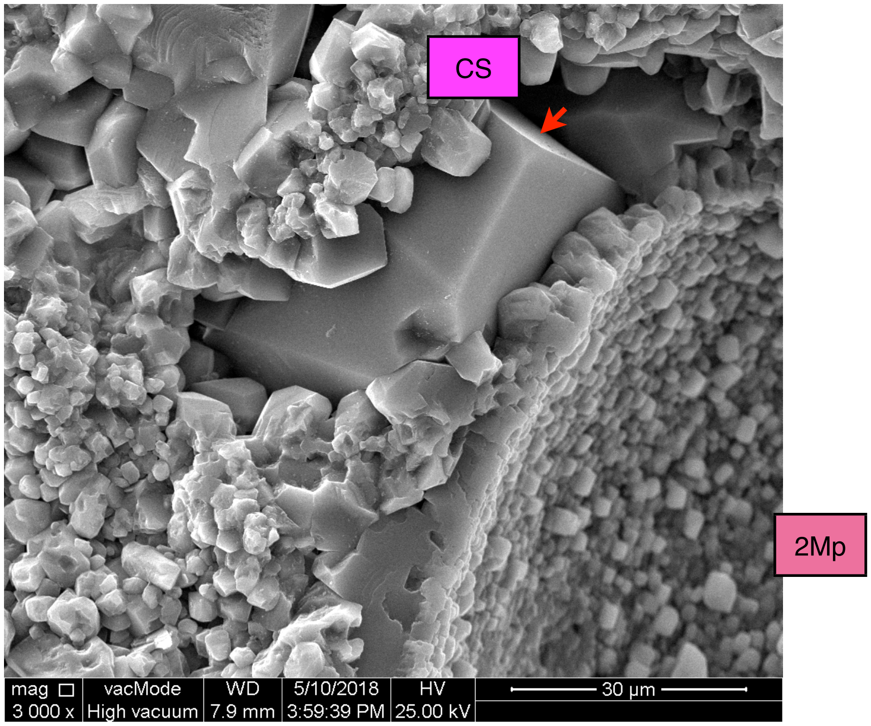
18087-04G 3000X



18087-04 Photo Index

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NBU-CH-1
Core Depth: 753.5-754.5 ft
18087-05

This core sample is described as a grain-supported, burrow-mottled, foram-rich ***lime packstone***. Some characteristics of the sedimentary fabric and reservoir quality for this interval are noted as follows:

- The core sample is comprised of microcrystalline to finely crystalline calcite. Nearly all of the carbonate grains (especially forams, algae plates and pisoliths) are comprised of microcrystalline calcite with a mean crysal diameter of ~ 1-2 um. Scattered concentrations of pore-filling, fine to medium crystalline calcite spar cement are also locally present.
- The sample fabric is massive to sub-parallel bedded, moderately packed and moderately porous.
- Framework grains include foram tests, pisoliths, and mollusk shell fragments. The foram tests and pisoliths are composed of microcrystalline and microporous calcite. Several of the foram tests exhibit growth chambers that have been infilled with fine to medium crystalline calcite spar cement. The pisoliths are representative of a accretionary sedimentary grains that formed from the concentric lamination of lime-mud.
- The pore volume of this limestone sample is dominated by inter-particle macroporosity coupled with modest amounts of intra-particle dissolution porosity, skel-moldic porosity, and intercrystalline microporosity. The void volume accounts for 24.1% of the bulk volume based on the helium porosity analysis (see Table V). The horizontal air-permeability for this limestone sample is measured at 201 md, reflecting the relatively well-interconnected nature of the macropore space within this limestone framework.

The following image tags are used to help identify selected features on the thin section & SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

Sample ID	Magnification
18087-05A	16X
18087-05B	32X
18087-05C	100X
18087-05D	100X
18087-05E	200X
18087-05F	200X

Mineralogical data for this limestone sample are summarized below:

Mineral Constituents	Concentration (%)
Calcite	100

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753.5 - 754.5 ft.; MI#18087-05 - Macro

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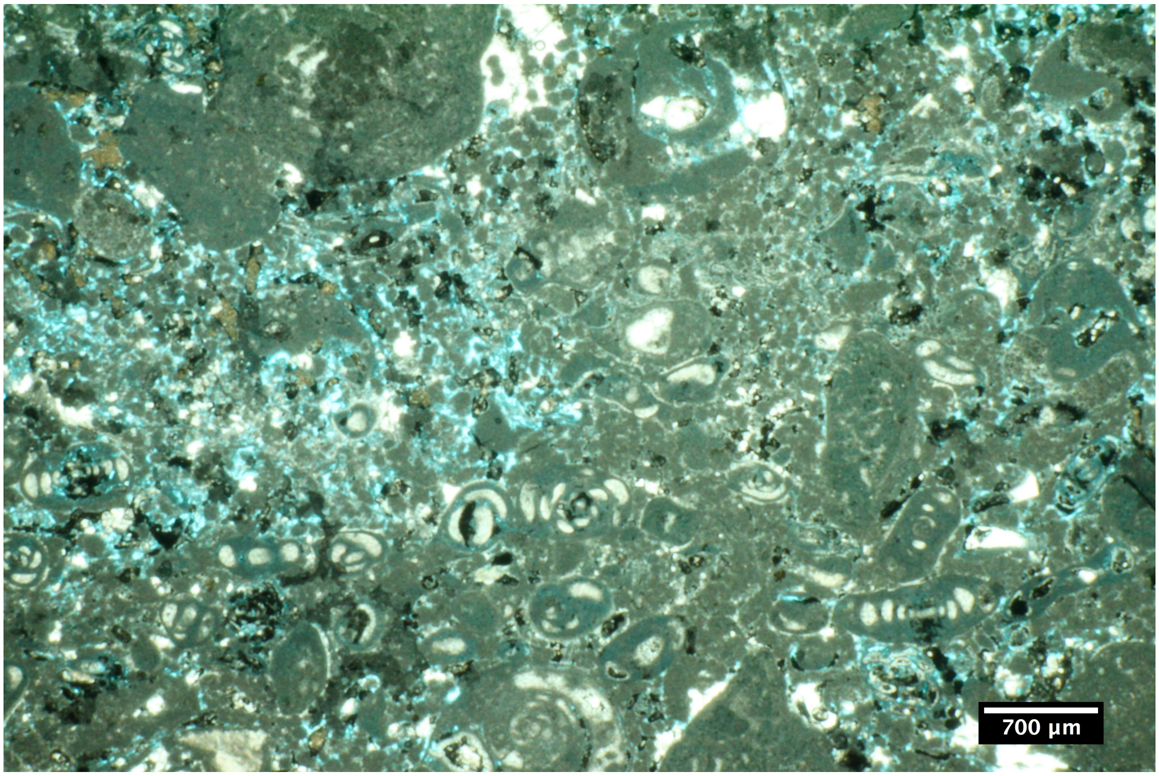
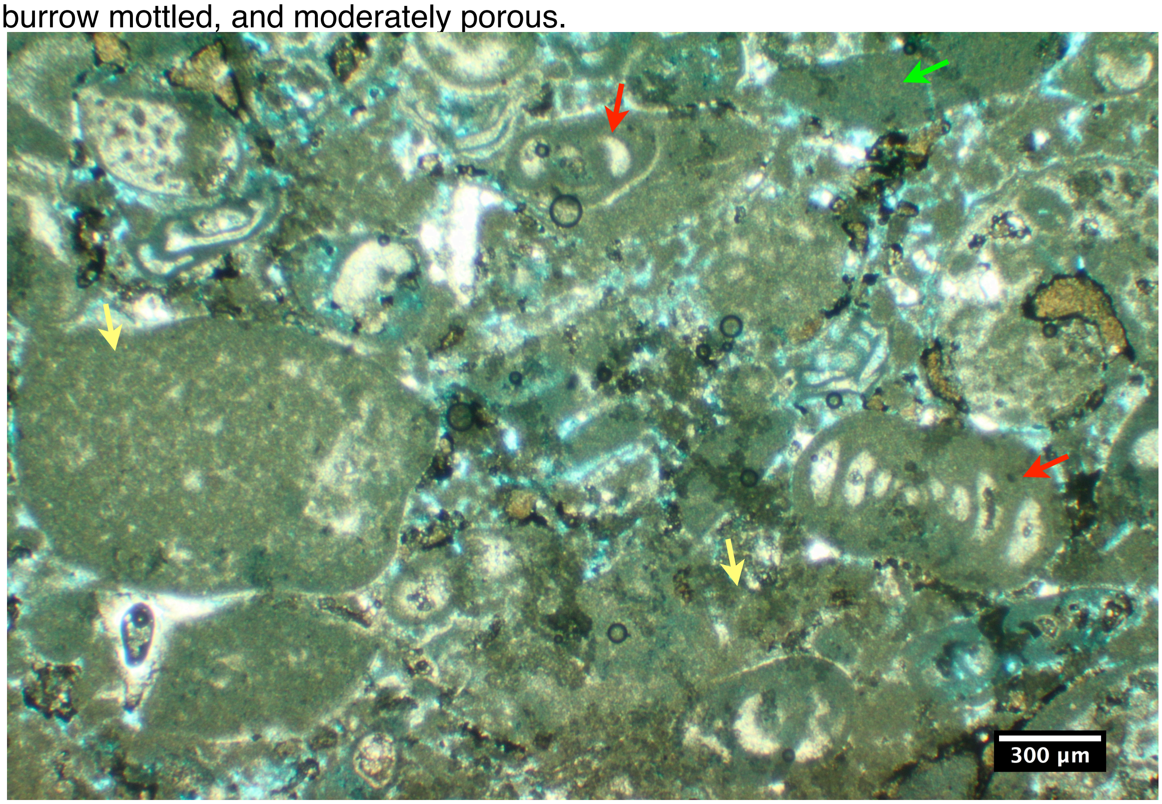
753.5 - 754.5 ft.; MI#18087-05



5A. The sample fabric is massive to sub-parallel bedded, moderately packed, burrow mottled, and moderately porous.



5B. Allochems include foram tests (red arrows), algae plates (green arrows), & pisoliths (yellow arrows).

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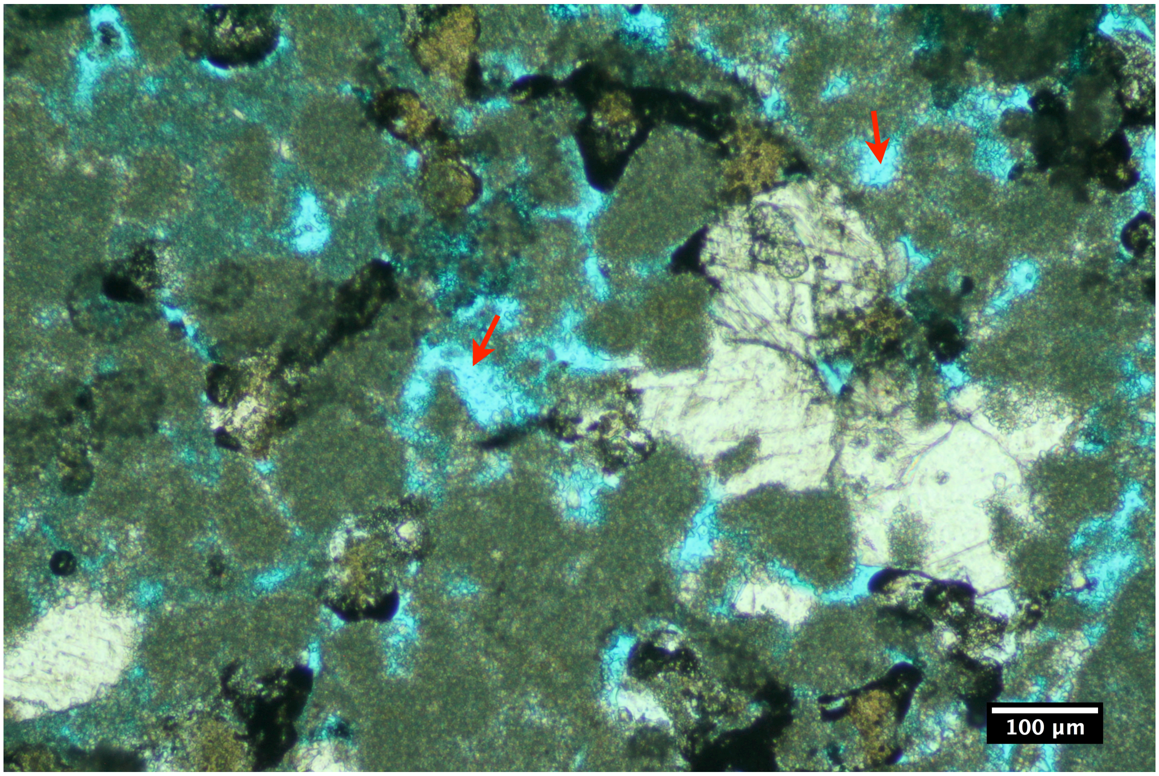
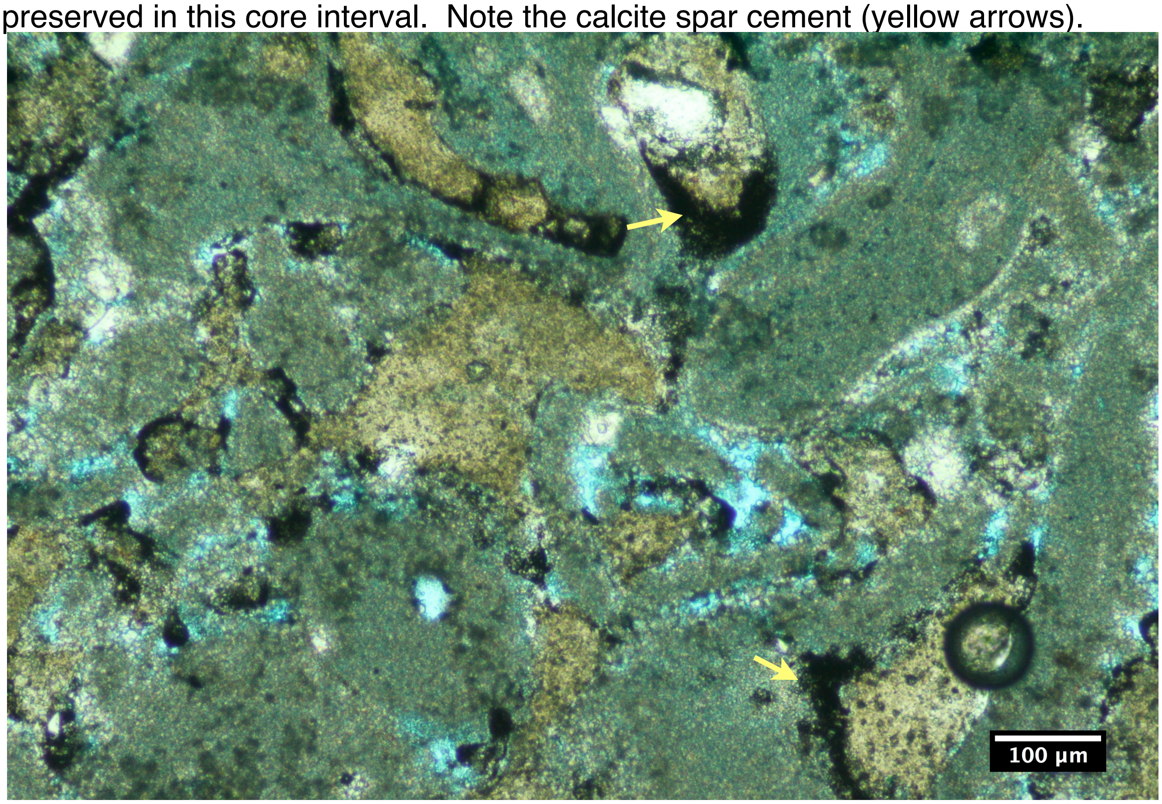
753.5 - 754.5 ft.; MI#18087-05



5C. Intercrystalline and interparticle macroporosity (blue; red arrows) are locally well preserved in this core interval. Note the calcite spar cement (yellow arrows).



5D. Organic matter particles (black; yellow arrows) are common throughout the interval.

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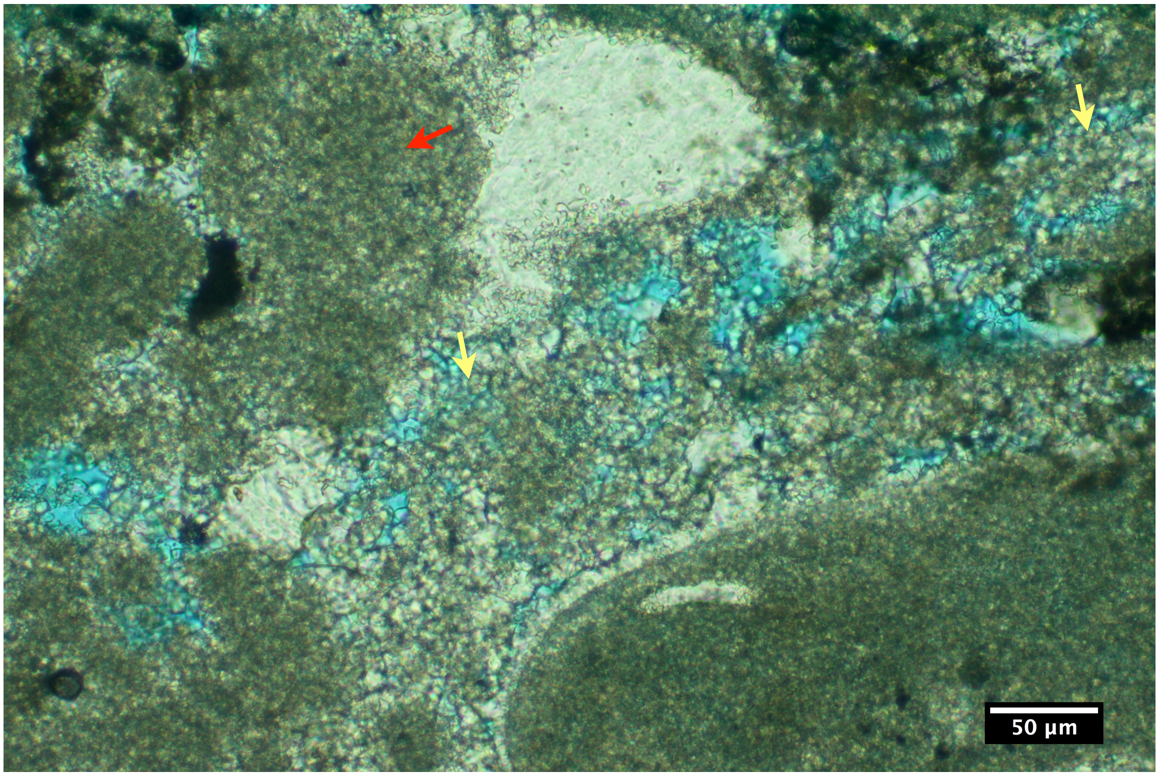
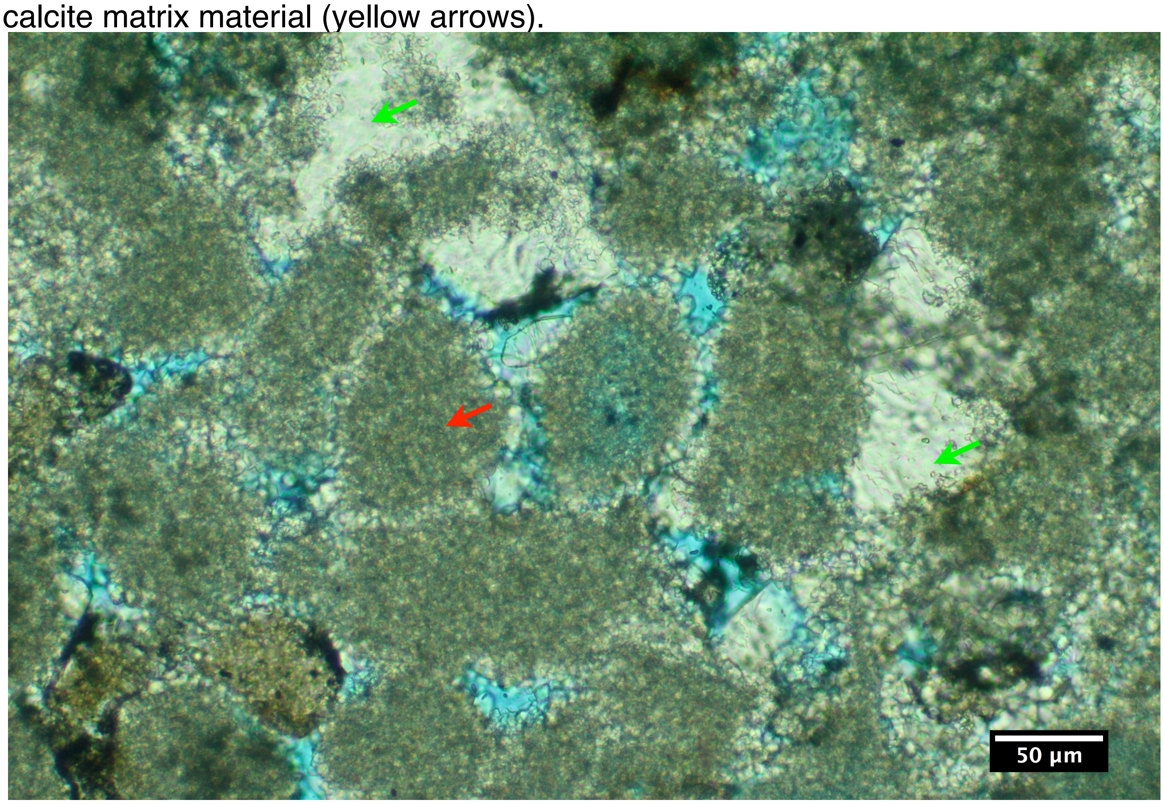
753.5 - 754.5 ft.; MI#18087-05



5E. Calcareous algae plates (red arrows) with loosely packed microcrystalline calcite matrix material (yellow arrows).



5F. Patchy calcite spar cement (white; green arrows) + moderately well interconnected interparticle porosity (blue).

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753.5 - 754.5 ft. - MI#18087-05 - SEM

Summary: The SEM sample for this foram-rich lime packstone is characterized by a poorly sorted framework of grain-supported foram tests and pisoliths that are each dominated by densely crystalized microcrystalline calcite cement. Scattered macropores can be seen throughout the SEM specimen and these voids are typically rimmed with microcrystalline calcite spar cement. Scattered pockets of medium to coarsely-crystalline calcite spar cement are locally present and reflect the late stage crystallization of authigenic calcite within selected macropores of the limestone.

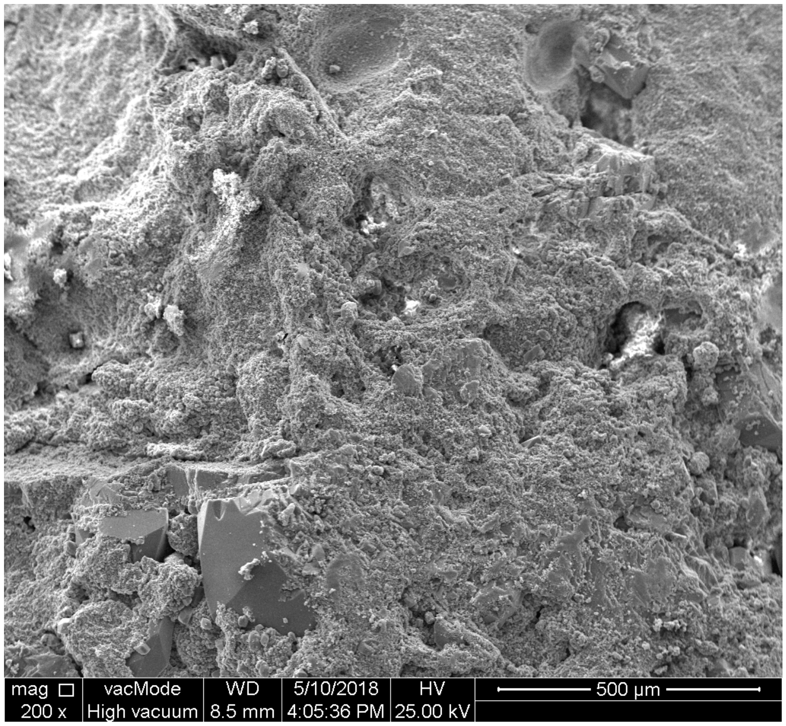
The following image tags are used to identify selected features on the SEM images:

Igneous rock fragment	IgRF
Pore filling matrix	PFM
Authigenic clay matrix	AM
Intergranular porosity	Bp
Secondary moldic porosity	2Mp
Secondary intragranular porosity	2Wp
Feldspar	F

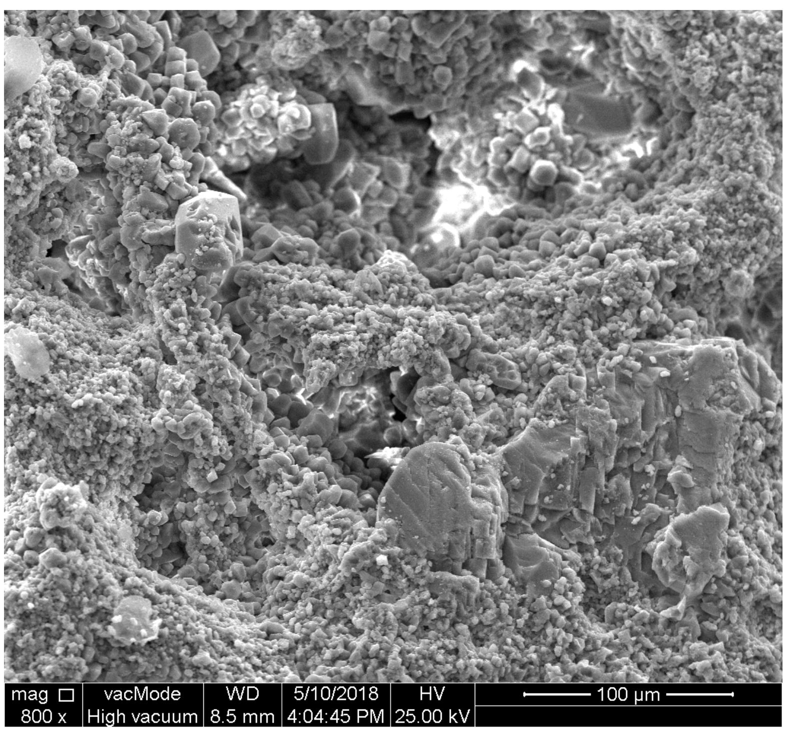
18087-05 Photo Index: (bookmarks)

Sample ID	Magnification
18087-05A	200X
18087-05B	800X
18087-05C	3000X
18087-05D	400X
18087-05E	1500X
18087-05F	6000X

18087-05A 200X



18087-05B 800X



18087-05 Photo Index

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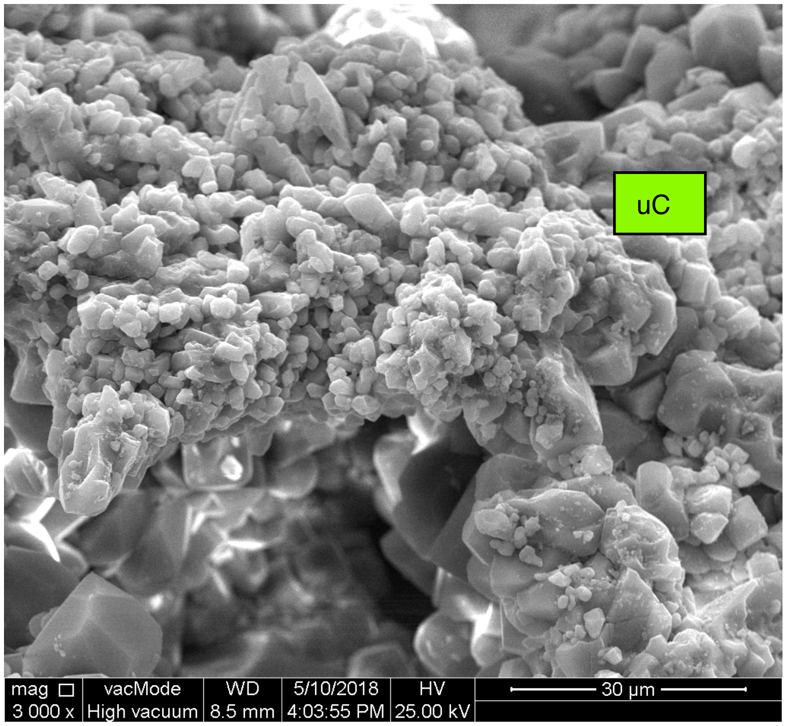
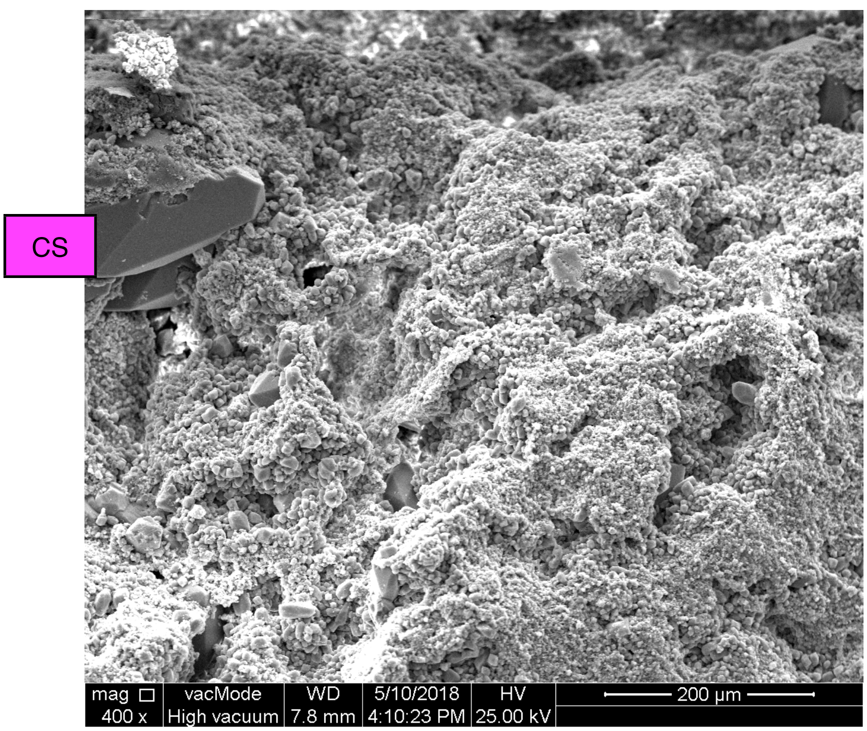
18087-05C 3000X



18087-05D 400X



18087-05 Photo Index

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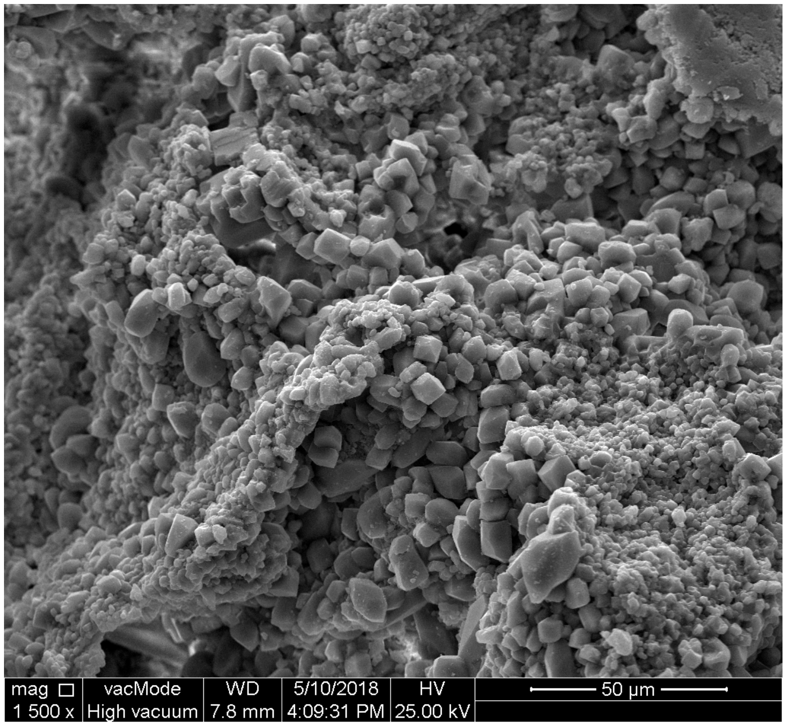
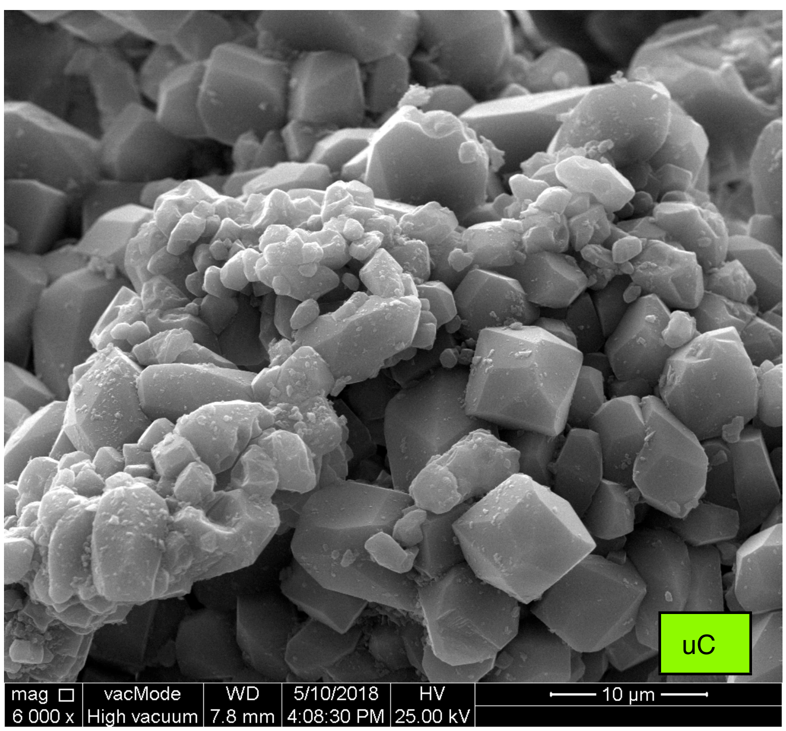
18087-05E 1500X



18087-05F 6000X



[18087-05 Photo Index](#)

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NBU-CH-1
Core Depth: 880.1-881.1 ft
18087-06

This core sample is described as a very finely crystalline, subhedral to euhedral, ***dolomite***. Some characteristics of the sedimentary fabric and reservoir quality for this interval are noted as follows:

- The sample fabric is very finely crystalline and consists of subhedral to euhedral crystals of dolomite that are tightly interlocked and incorporate locally significant amounts of intercrystalline macro and microporosity. The core interval is burrow-mottled, moderately porous, and locally cemented with celestite.
- The celestite cement (strontium sulfate) occurs as a patchy pore filling cement that is microcrystalline to finely crystalline and very irregularly distributed within the sample framework. Celestite accounts for ~21% of the mineral mass within the XRD sample prepared for this interval, however, this phase appears to be quite irregularly distributed within the sample fabric.
- Pore space within the dolomite-rich portion of the sample fabric consists of well-preserved intercrystalline macro and microporosity associated with the dolomite groundmass. The helium porosity is quite variable for this core interval with values ranging from ~5.5%-22.8% depending on the orientation and location of the core plug. The vertical air-permeability for this interval is measured at 86.6 md.

The following image tags are used to help identify selected features on the thin section & SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

Sample ID	Magnification
18087-06A	32X
18087-06B	32X
18087-06C	100X
18087-06D	100X

Mineralogical data for this limestone sample are summarized below:

Mineral Constituents	Concentration (%)
Quartz	2
Calcite	11
Dolomite	66
Celestite ($SrSO_4$)	21

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880.1 - 881.1 ft.; MI#18087-06 - Macro

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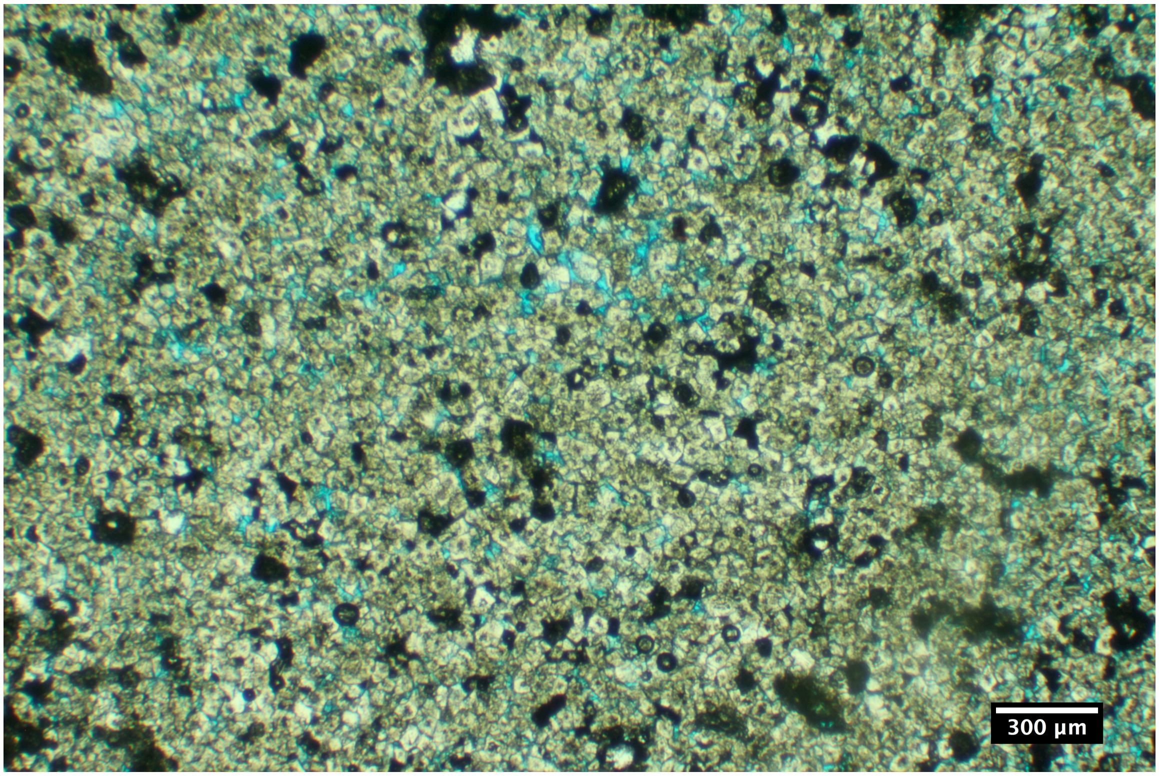
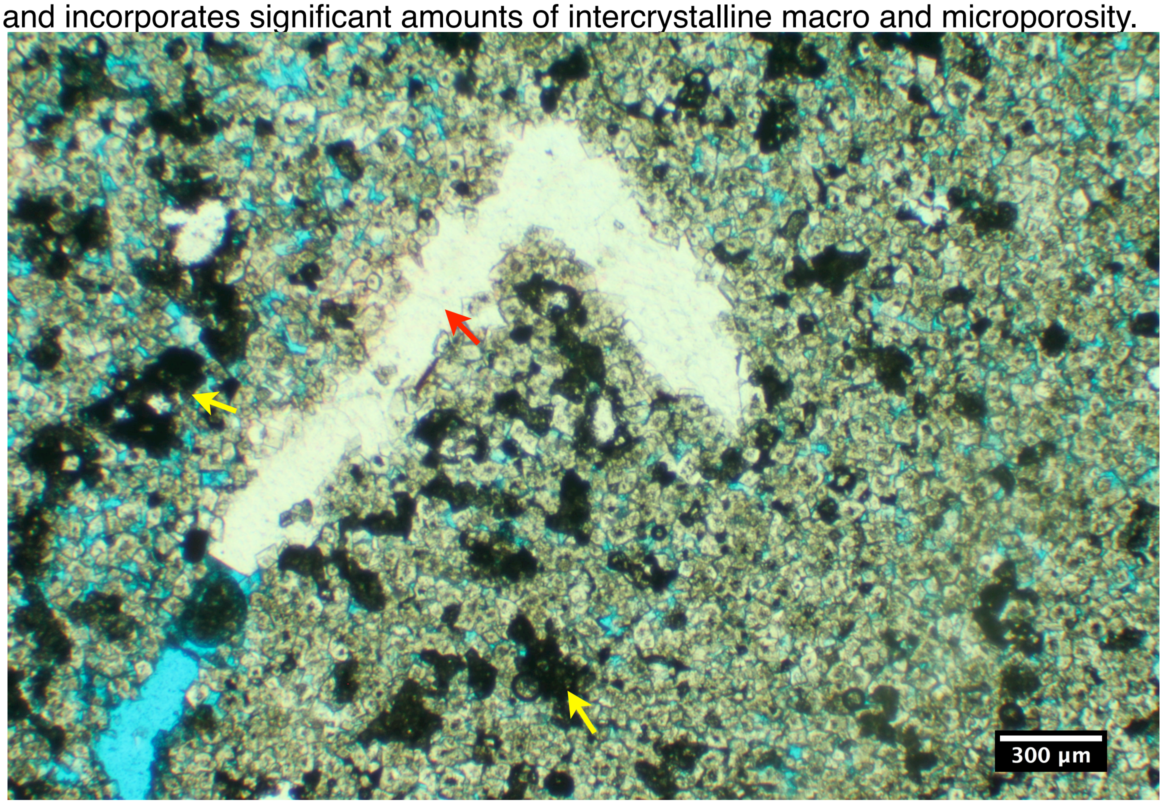
880.1 - 881.1 ft.; MI#18087-06



2A. The dolomite is very finely crystalline, subhedral to euhedral, tightly interlocked and incorporates significant amounts of intercrystalline macro and microporosity.



6B. Calcite spar cement (red arrow) partially filling a skel-moldic pore. The dolomite fabric includes significant amounts of organic matter + traces of microcrystalline pyrite cement (black; yellow arrows).

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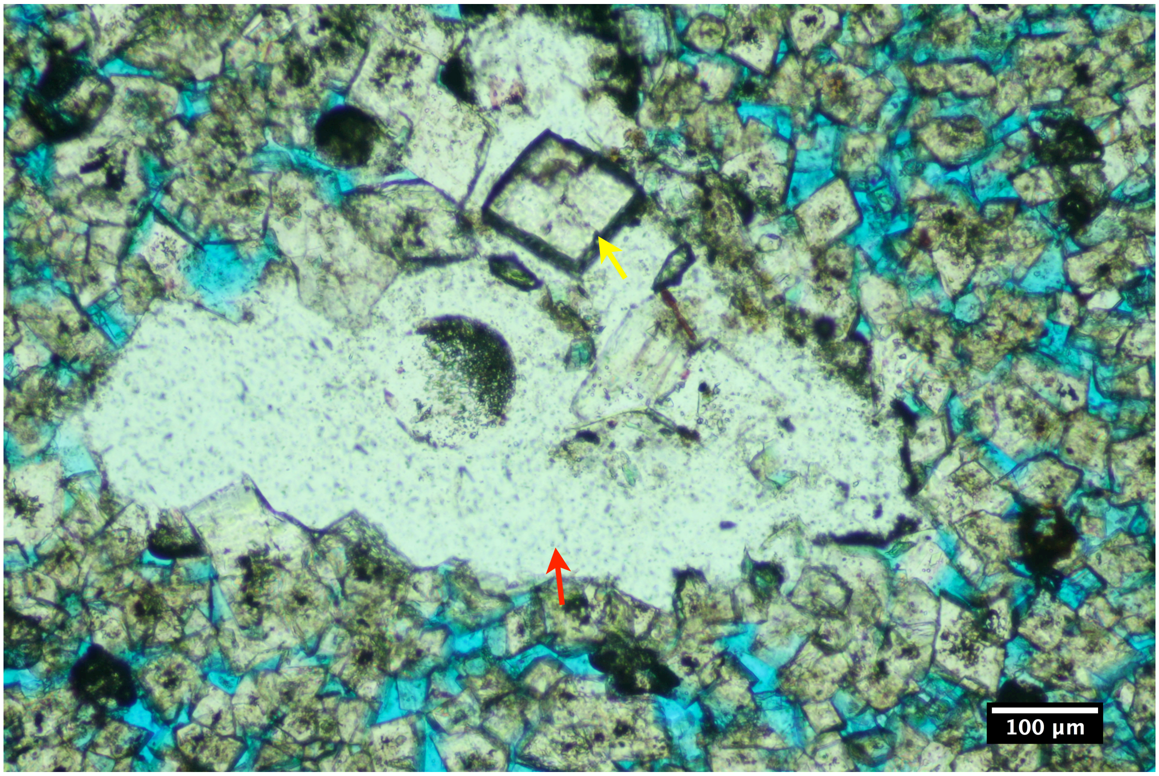
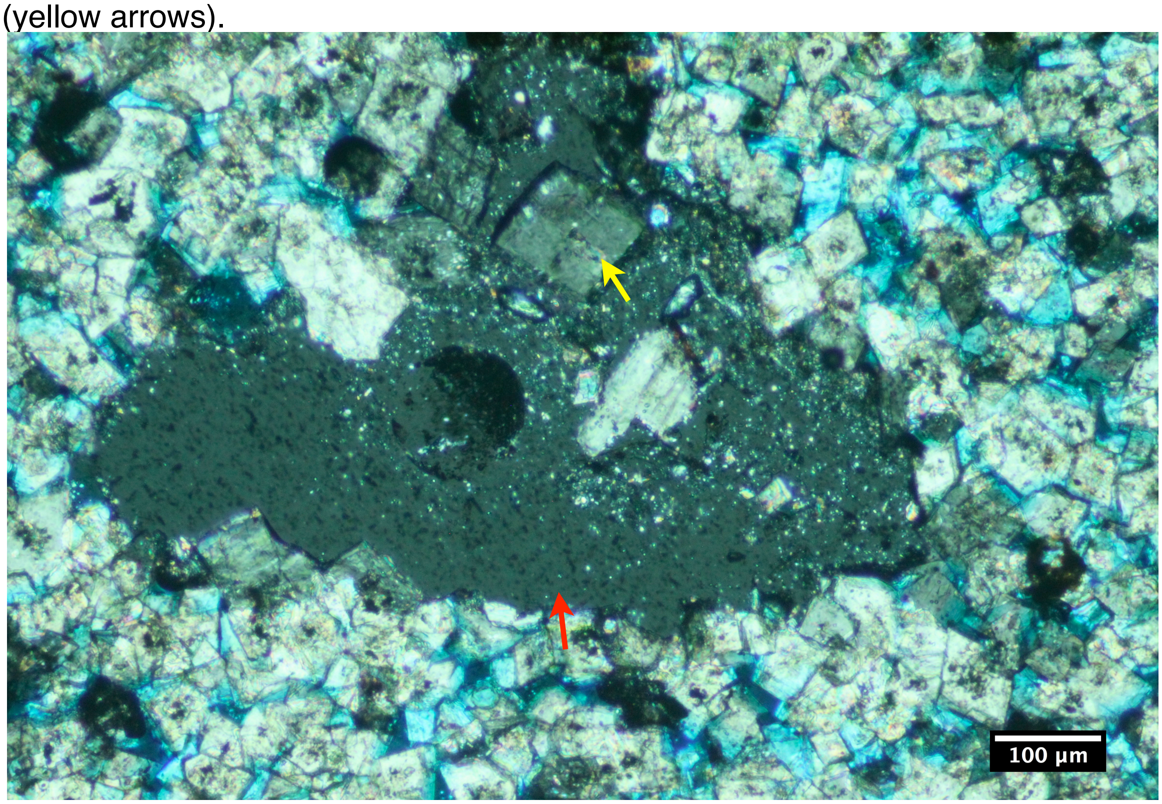
880.1 - 881.1 ft.; MI#18087-06



6C. Pore-filling celestite cement (red arrow) locally incorporating rhombs of dolomite (yellow arrows).



6D. As in Figure 6C, with cross polarized light. Note the abundance of intercrystalline macroporosity (blue) in this field of view.

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880.1 - 881.1 ft. - MI#18087-06 - SEM

Summary: The SEM images for this specimen reveal a dolomitic fabric that is very finely crystalline and consists of subhedral to euhedral crystals of dolomite that are tightly interlocked and incorporate locally significant amounts of intercrystalline macro and microporosity. Traces of clay matrix minerals are locally present in association with the dolomite occurring as irregular and scattered lath-shaped crystals draping the dolomite crystal rhombs. Intercrystalline macroporosity is preferentially associated with the dolomitic portions of the fabric within this interval. Helium porosity measured within the vertical core plug accounts for 22.5% of the bulk volume, with a grain density of 2.84 g/cm^3. In contrast, the horizontal core plug for core #6 exhibits a helium porosity of ~5.9%, with a grain density value of 2.71 g/cm^3. The grain density for the horizontal core plug specimen is suggestive of a calcite-rich mineralogy, whereas the relatively elevated grain density value of 2.84 g/cm^3 (as measured for the vertical core plug sample) is suggestive of a dolomite-rich mineralogy supplemented with strontium sulfate cement.

The following image tags are used to identify selected features on the SEM images:

Igneous rock fragment	IgRF
Pore filling matrix	PFM
Authigenic clay matrix	AM
Intergranular porosity	Bp
Secondary moldic porosity	2Mp
Secondary intragranular porosity	2Wp
Feldspar	F

18087-06 Photo Index: (bookmarks)

Sample ID	Magnification
18087-06A	130X
18087-06B	500X
18087-06C	2000X
18087-06D	150X
18087-06E	600X
18087-06F	2500X

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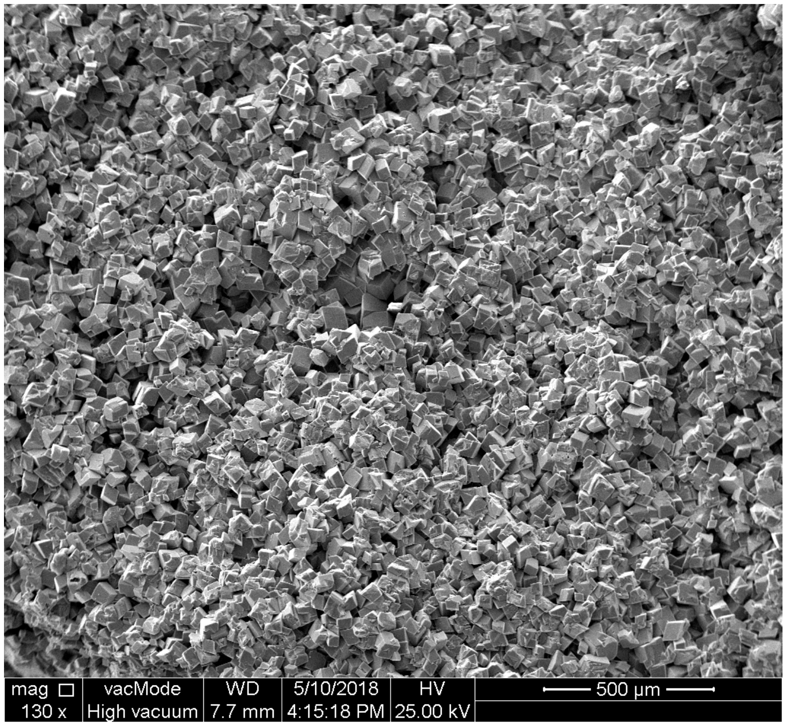
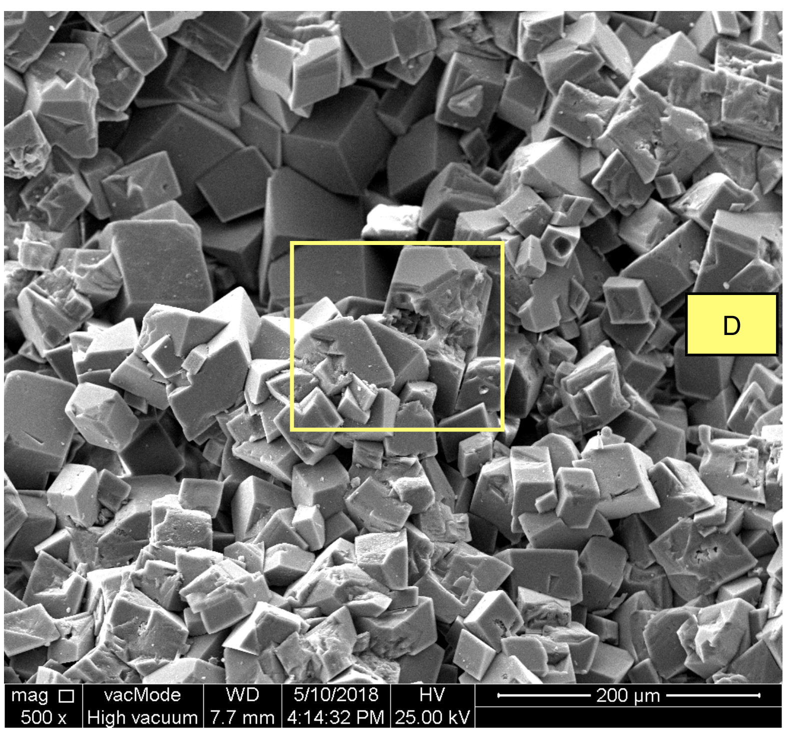
18087-06A 130X



18087-06B 500X



18087-06 Photo Index

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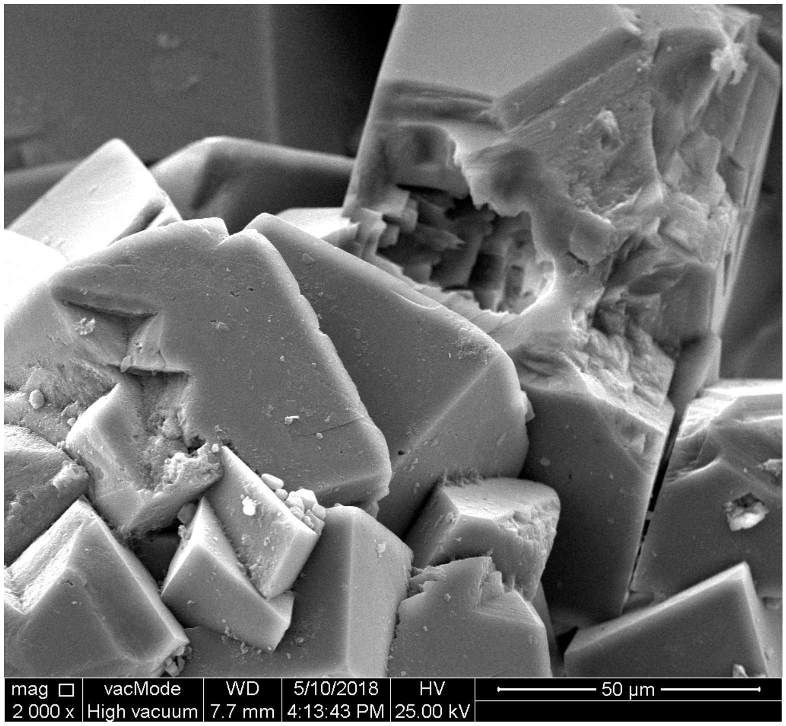
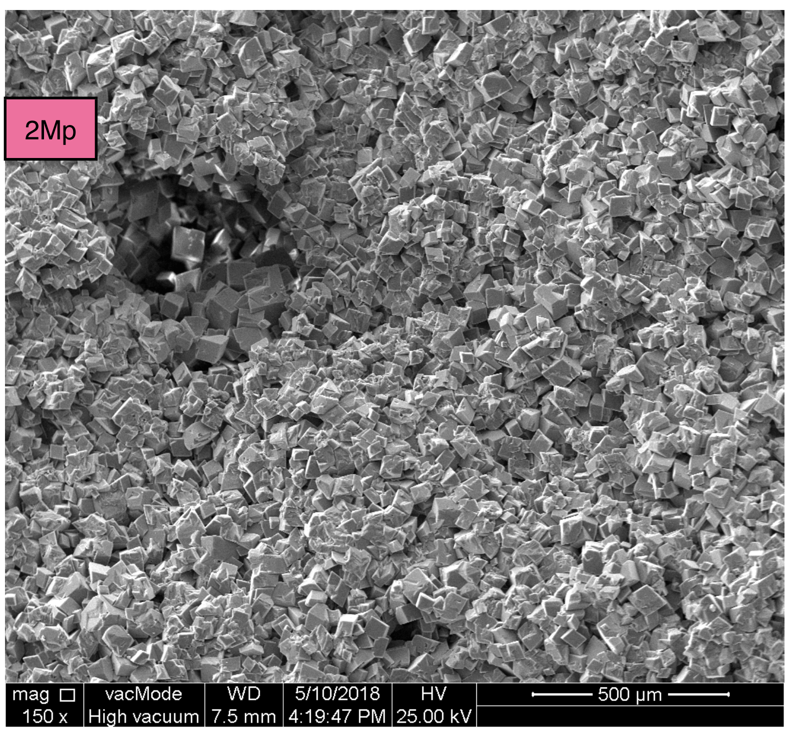
18087-06C 2000X



18087-06D 150X



18087-06 Photo Index

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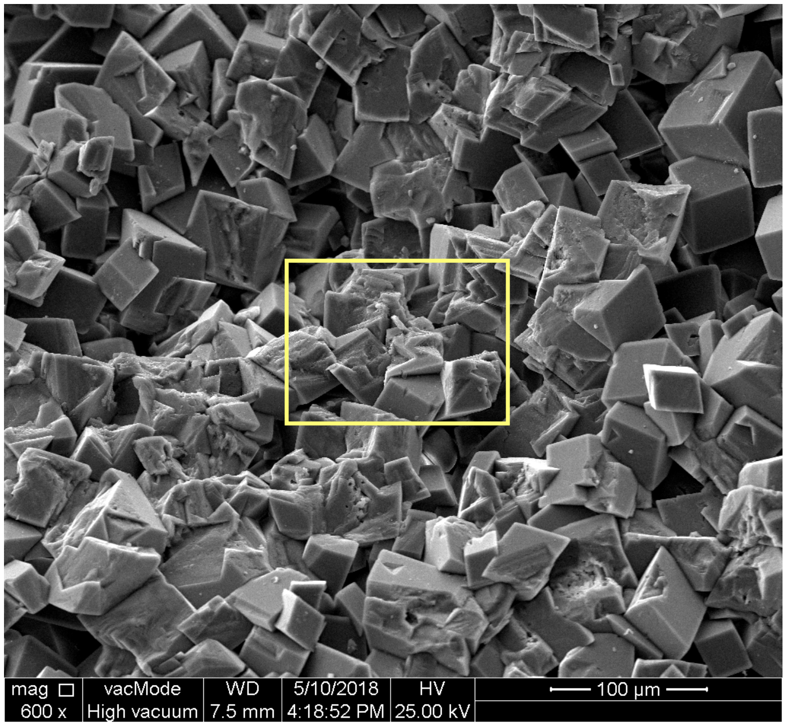
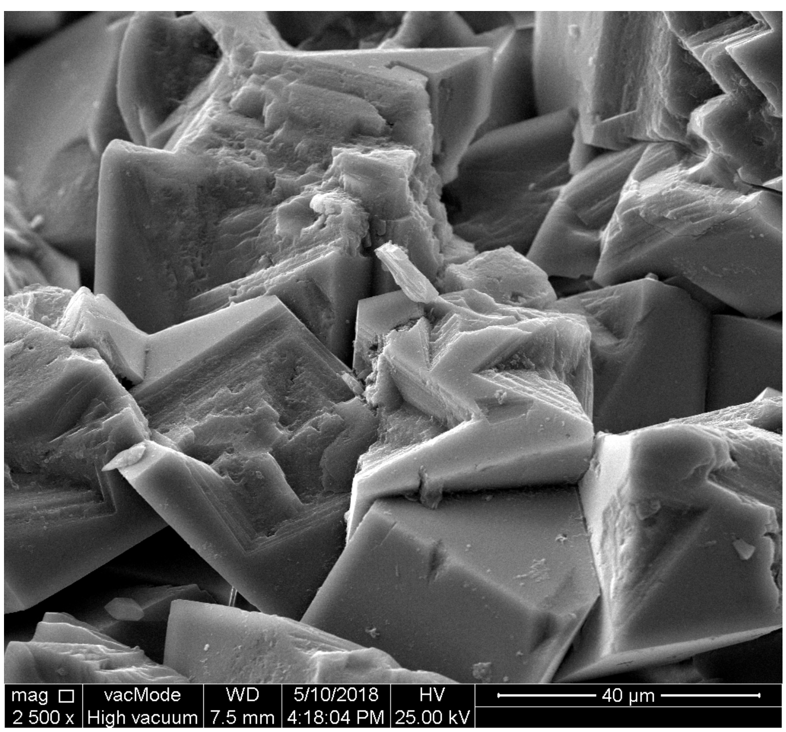
18087-06E 600X



18087-06F 2500X



18087-06 Photo Index

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NBU-CH-1
Core Depth: 977.8-978.8 ft
18087-07

This core sample is described as a very finely crystalline, subhedral to euhedral, ***dolomite***. Some characteristics of the sedimentary fabric and reservoir quality for this interval are noted as follows:

- The sample fabric is well-crystalized and interlocked, with dolomite crystals that range in size from ~5 μm to a maximum of ~200 μm. The mean crystal diameter for this sample is estimated at ~50 μm..
- The sedimentary fabric is burrow-mottled and exhibits an irregular preservation of intercrystalline macro and microporosity. Portions of the fabric are densely interlocked and contain relatively sparse distributions of intercrystalline void space. These areas of the fabric are interspersed with relatively porous dolomite that exhibits locally significant concentrations of intercrystalline macro and microporosity as well as scattered concentrations of skel-moldic void space.
- Scattered patches of strontium sulfate cement are locally present within a few of the skel-moldic pores within the thin section sample. The celestite cement accounts for <0.5% within the thin section specimen.
- The helium porosity for this interval is measured at 25.4%, with a grain density value of 2.83 g/cm^3. The horizontal gas permeability measured for this core interval is 660 md. The measured permeability for this core plug sample is partially influenced by an unseparated crack or fracture present within the core interval.

The following image tags are used to help identify selected features on the thin section & SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

Sample ID	Magnification
18087-07A	32X
18087-07B	100X
18087-07C	100X
18087-07D	100X

Mineralogical data for this limestone sample are summarized below:

Mineral Constituents	Concentration (%)
Quartz	<0.5
Calcite	2
Dolomite	98

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977.8 - 978.8 ft.; MI#18087-07 - Macro

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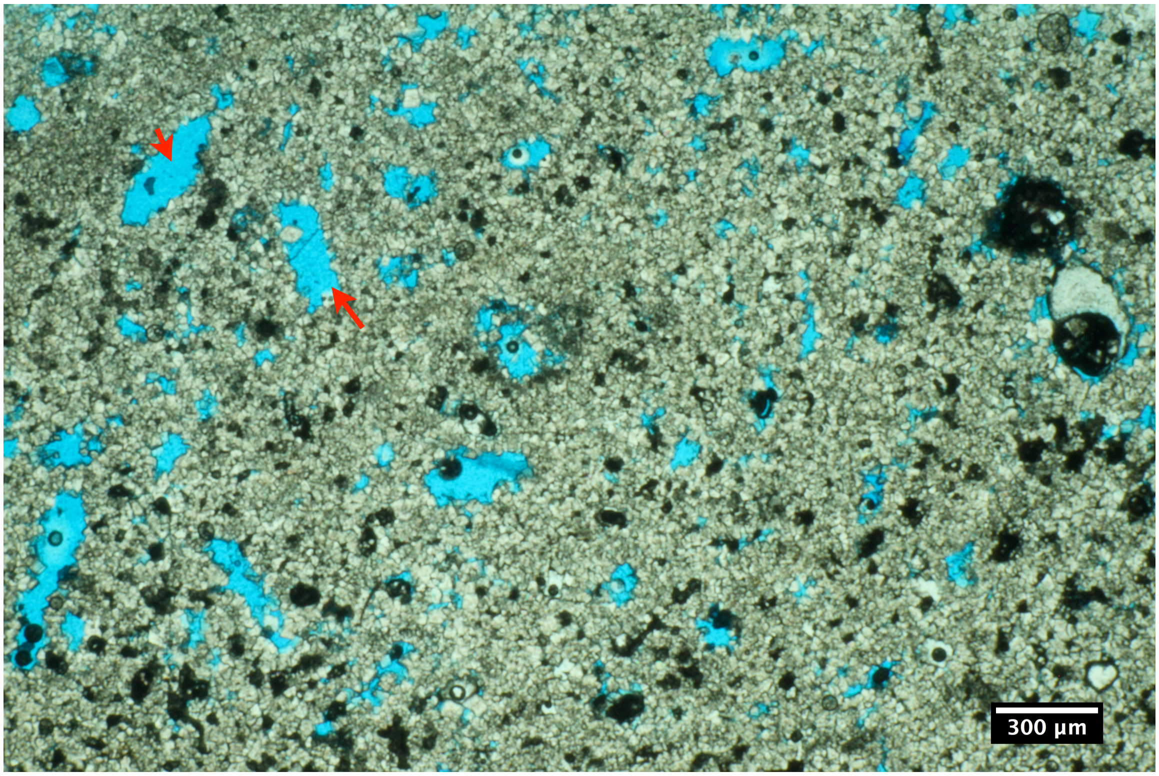
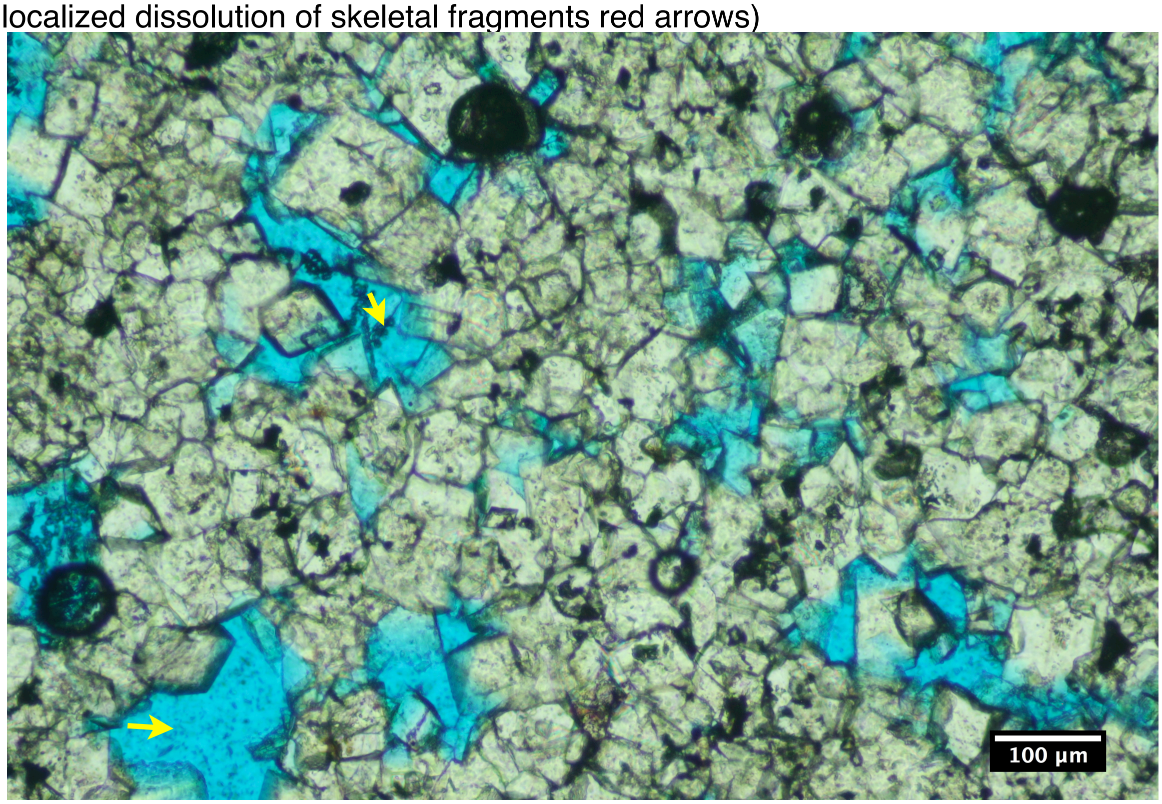
977.8 - 978.8 ft.; MI#18087-07



2A. The dolomite fabric contains scattered skel-moldic voids attributed to the localized dissolution of skeletal fragments red arrows)



7B. Intercrystalline macro & microporosity (yellow arrows) are locally well represented in this interval.

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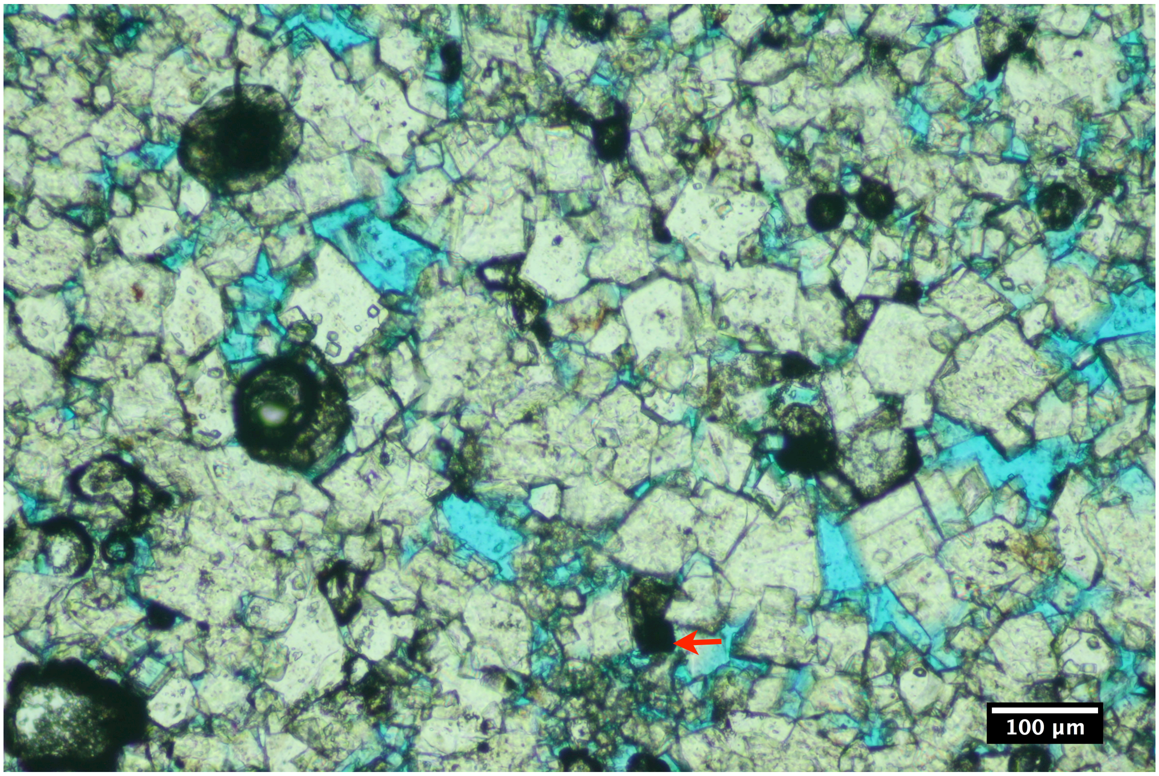
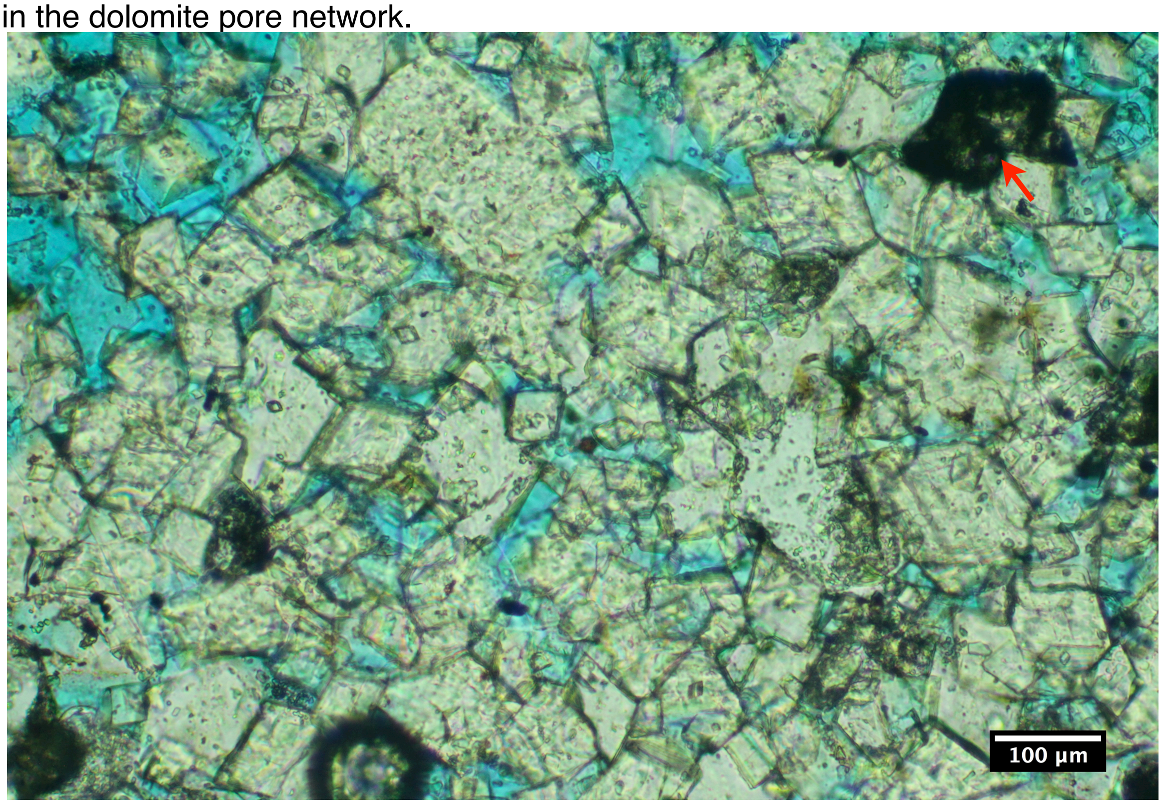
977.8 - 978.8 ft.; MI#18087-07



7C. Irregular clusters of amorphous organic material (red arrows) are locally present in the dolomite pore network.



7D. Porosity accounts for 25.4% of the bulk volume, with a grain density value of 2.83 g/cm^3. The horizontal gas permeability measured for this core interval is 660 md.

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977.8 - 978.8 ft. - MI#18087-07 - SEM

Summary: The SEM specimen prepared for this interval is indicative of a moderately to densely crystalized and interlocked, very finely crystalline dolomite. The dolomite is moderately porous and exhibits relatively well-preserved intercrystalline macro and micropore space coupled with scattered skel-moldic voids attributed to the localized dissolution of skeletal fragments within the precursor limestone fabric. A few of the voids contain clusters of a late stage microcrystalline cement tentatively identified as celestite within the SEM specimen. The celestite in these samples occurs as a microcrystalline cement with crystal diameters that are estimated to range from 0.5-5 μm. In addition to the celestite cement, traces of clay matrix minerals (including kaolinite and illite) are locally present commingled with the dolomite crystals within the intercrystalline voids.

The following image tags are used to identify selected features on the SEM images:

Igneous rock fragment	IgRF
Pore filling matrix	PFM
Authigenic clay matrix	AM
Intergranular porosity	Bp
Secondary moldic porosity	2Mp
Secondary intragranular porosity	2Wp
Feldspar	F

18087-07 Photo Index: (bookmarks)

Sample ID	Magnification
18087-07A	200X
18087-07B	800X
18087-07C	3000X
18087-07D	200X
18087-07E	800X
18087-07F	3000X

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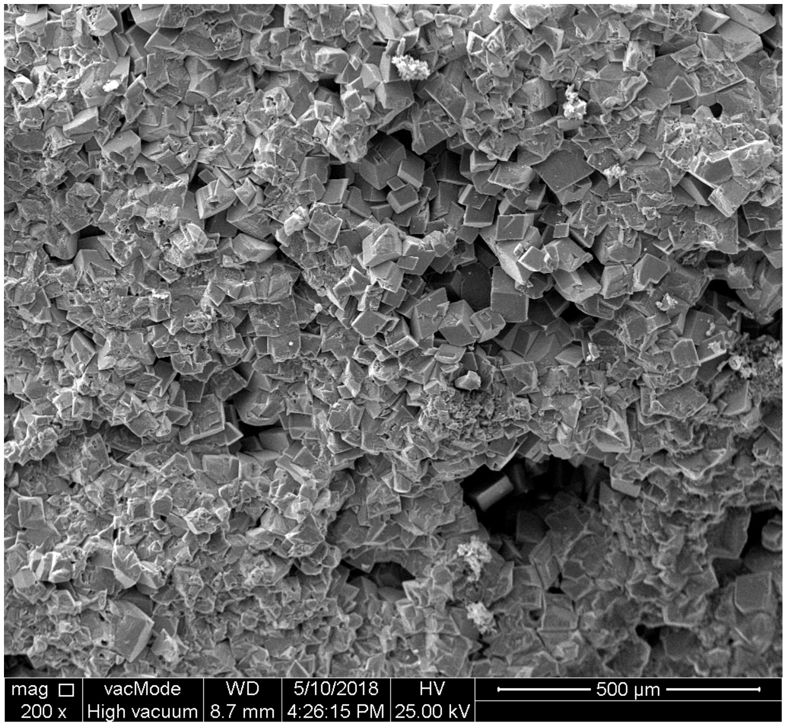
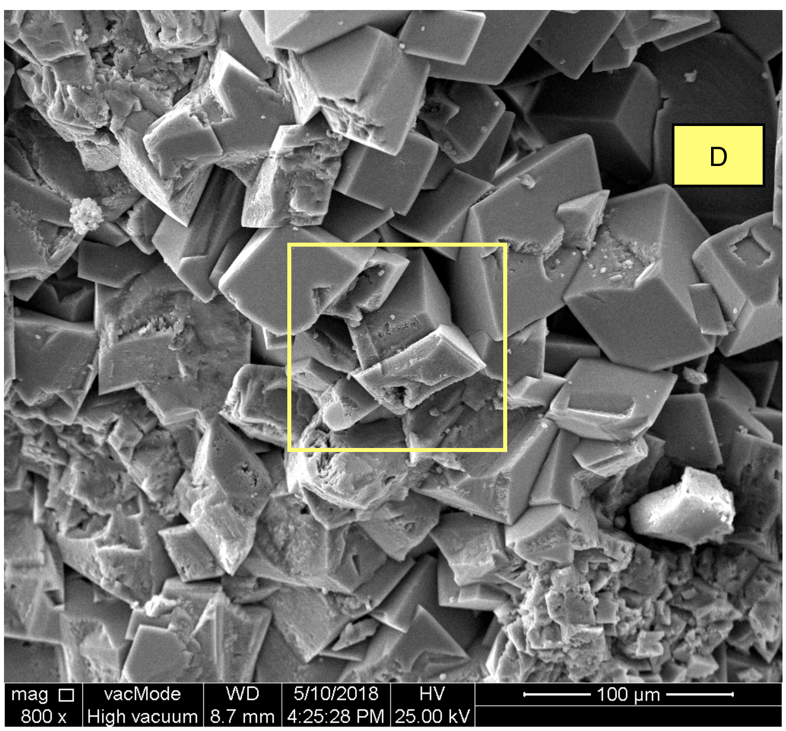
18087-07A 200X



18087-07B 800X



18087-07 Photo Index

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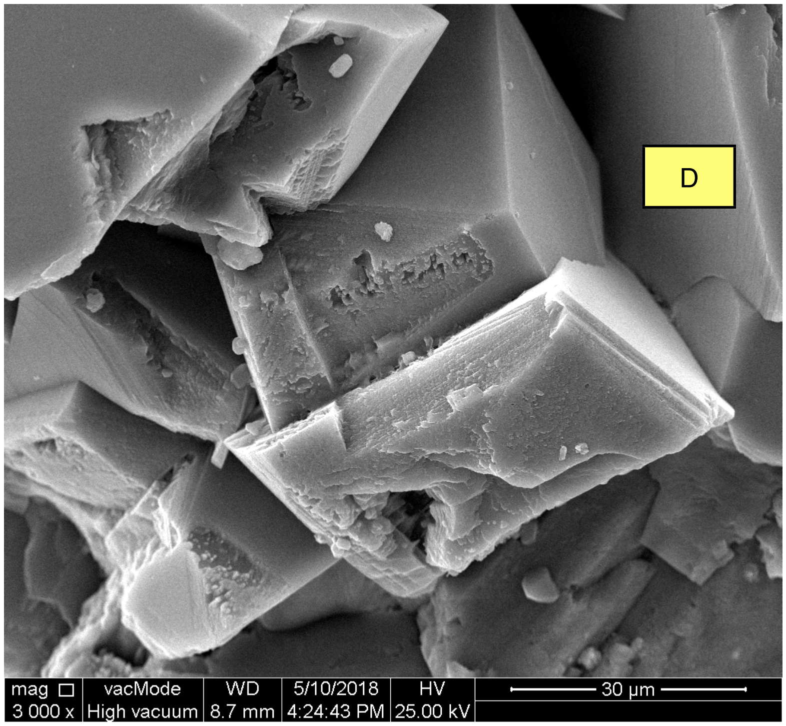
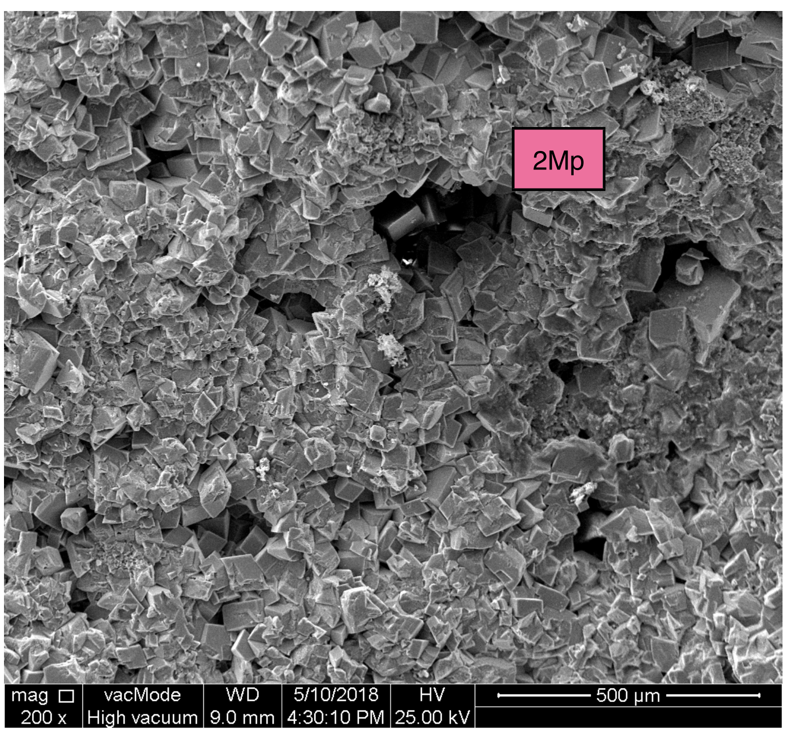
18087-07C 3000X



18087-07D 200X



18087-07 Photo Index

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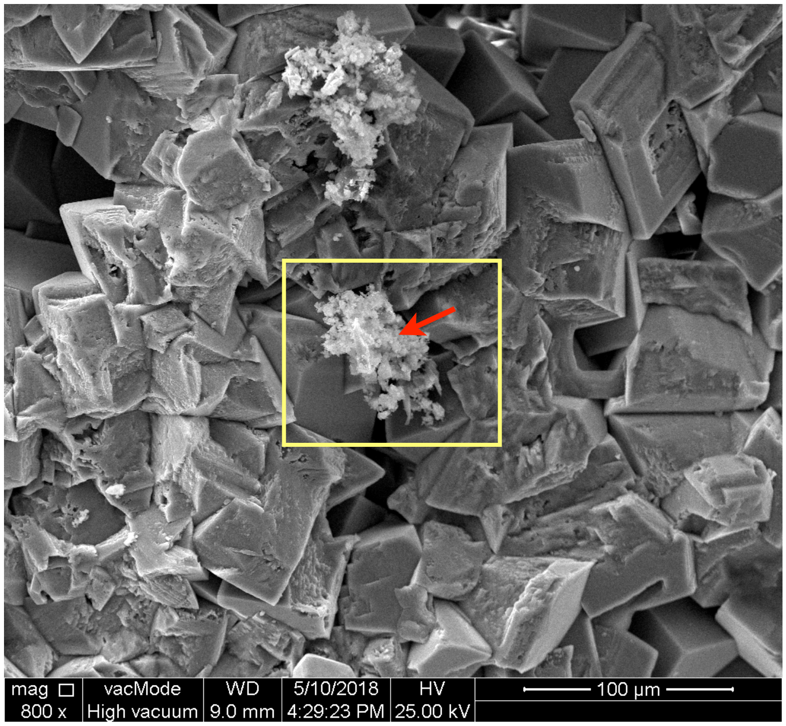
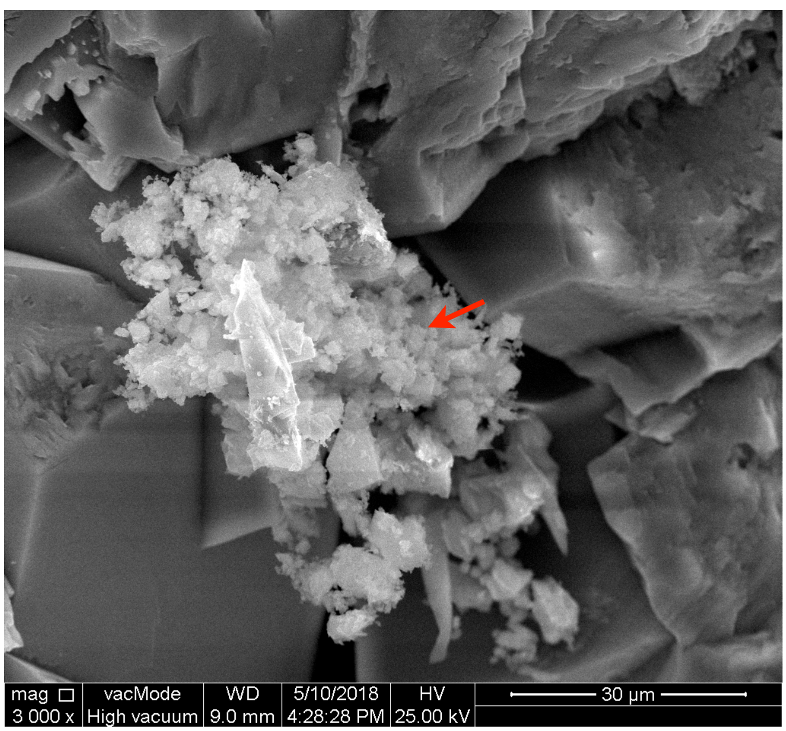
18087-07E 800X



18087-07F 3000X

Pore-filling microcrystalline celestite cement (red arrows)



18087-07 Photo Index

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NBU-CH-1
Core Depth: 1026.8-1027.8 ft
18087-08

This core interval is characterized as a fossiliferous and calcareous, very finely crystalline ***dolomite***. Some characteristics of the sedimentary fabric and reservoir quality for this interval are noted as follows:

- The thin section sample exhibits a stratified fabric with a grain-rich, packstone-like dolomite fabric that transitions into a more sparsely fossiliferous and matrix-rich wackstone-like texture.
- Skeletal allochems are abundant in this core sample and include an abundance of foram tests, calcareous algae plates, mollusk shell fragments, echinoderm plates and spaces, pisoliths, quartz-rich sand grains, and undifferentiated skeletal fragments.
- The fabric is variably grain supported and/or matrix supported and exhibit a ubiquitous presence of very finely crystalline dolomite cement that is locally admixed with traces of residual calcite spar. The dolomite cement is densely interlocked and relatively nonporous.
- The core sample includes a sinuous stylolite seam that exhibits significant concentrations of organic matter-rich clay matrix minerals coupled with significant amounts of quartz-rich sand and silt. Much of the macroporosity reported in Table V for this core interval is attributed to dissolution porosity concentrated peripheral to the stylolite seam in this core specimen. The adjoining dolomite-rich fabric appears largely limited to intercrystalline microporosity and is likely to serve as a very effective permeability barrier within the aquifer system.
- The helium porosity for this interval is measured at 10.0%, with a grain density value of 2.72 g/cm^3. The horizontal gas permeability measured for this core interval is 3.21 md. The measured permeability for this core plug sample is partially influenced by an unseparated crack or fracture present within the core interval.

The following image tags are used to help identify selected features on the thin section & SEM images:

Microcrystalline calcite	uC
Calcite spar cement	CS
Dolomite	D
Intercrystalline porosity	Bp
Secondary moldic porosity	2Mp
Calcareous skeletal fragments	SF

Sample ID	Magnification
18087-08A	16X
18087-08B	32X
18087-08C	100X
18087-08D	200X
18087-08E	200X

Mineralogical data for this limestone sample are summarized below:

Mineral Constituents	Concentration (%)
Quartz	1
Calcite	47.5
Dolomite	51
Kaolinite	0.5
Illite/Mica	<0.5

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1026.8 - 1027.8 ft.; MI#18087-08 - Macro

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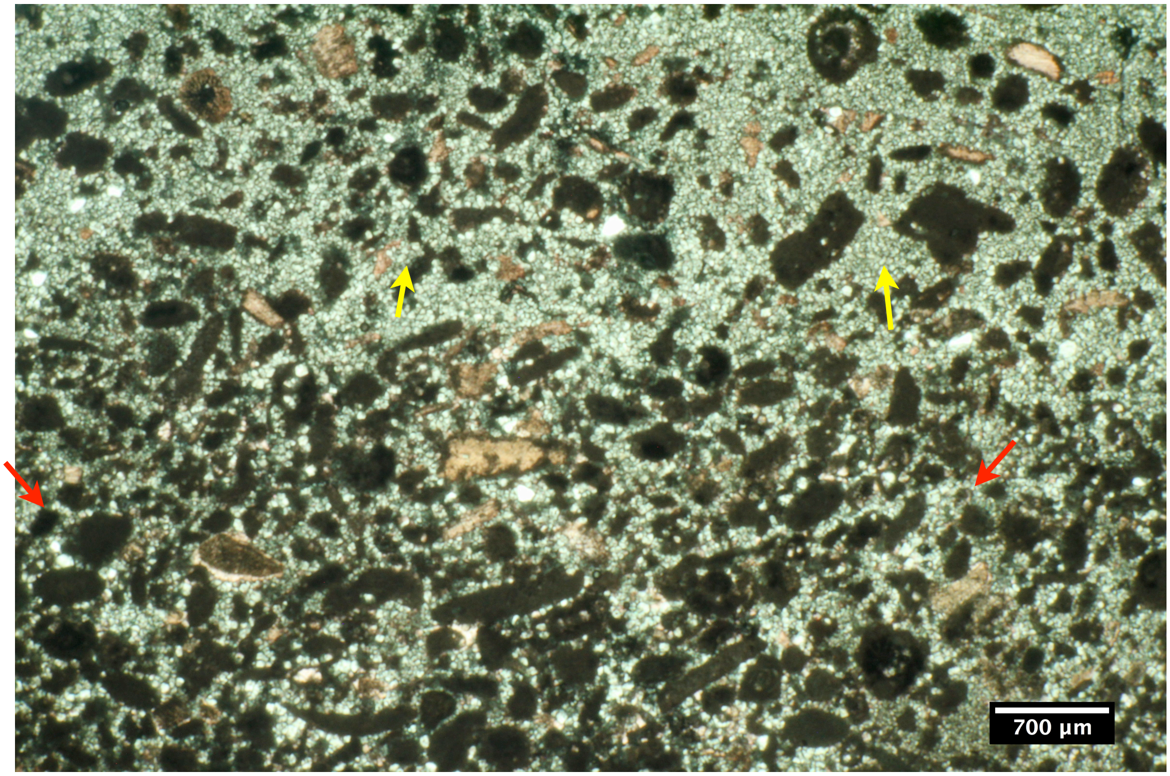
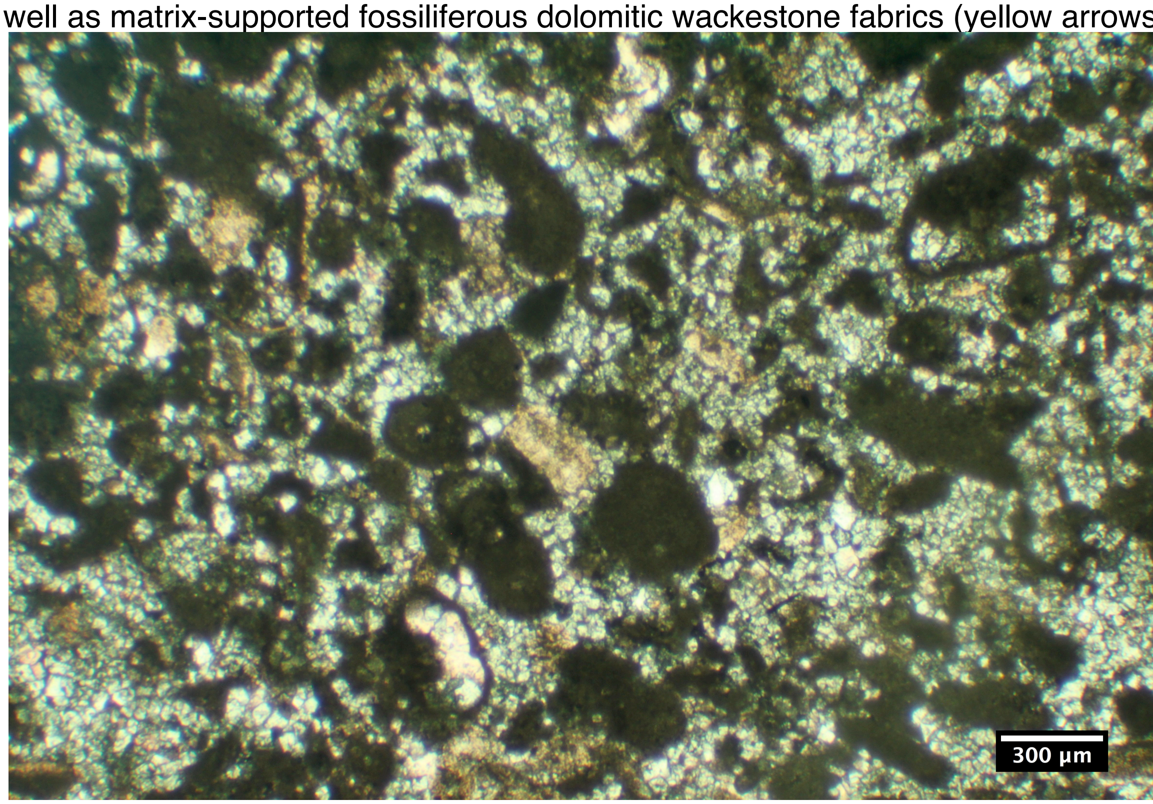
1026.8 - 1027.8 ft.; MI#18087-08



8A. The core interval includes grain-supported packstone materials (red arrows) as well as matrix-supported fossiliferous dolomitic wackestone fabrics (yellow arrows).



8B. Carbonate grain types include foram tests, calcareous algae plates, mollusk shell fragments, echinoderm plates and spaces, pisoliths, quartz-rich sand grains, and undifferentiated skeletal fragments

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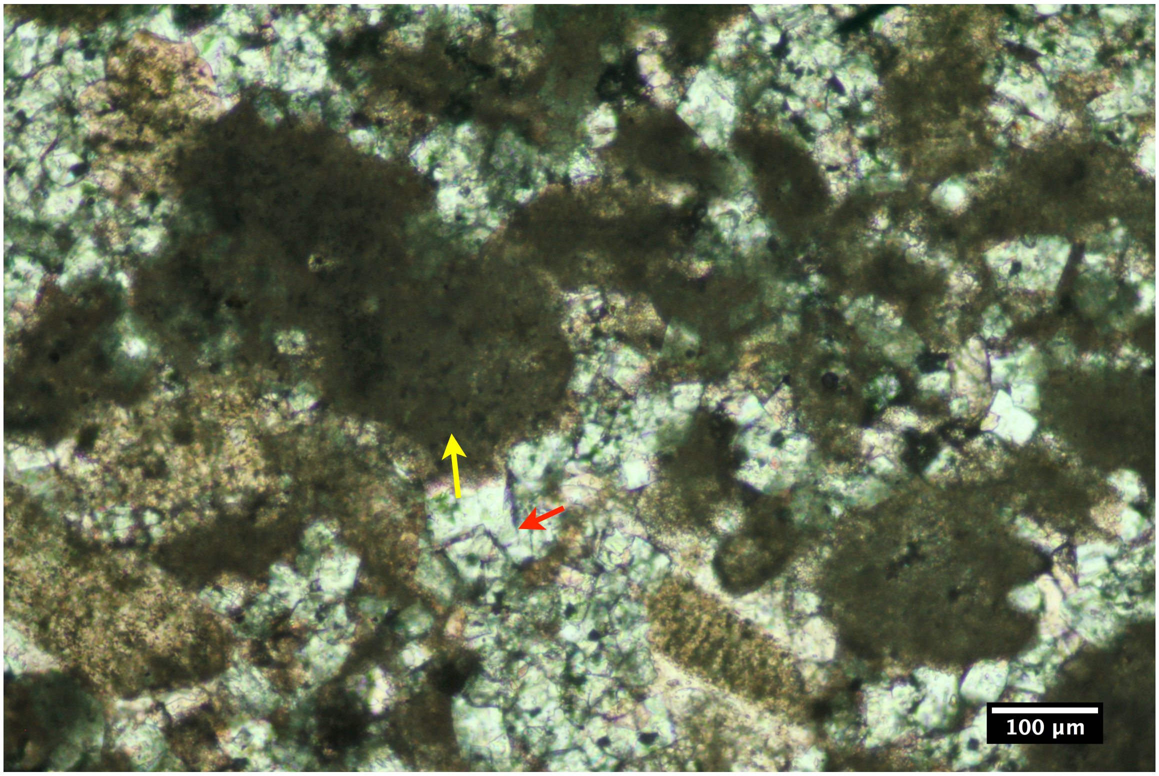
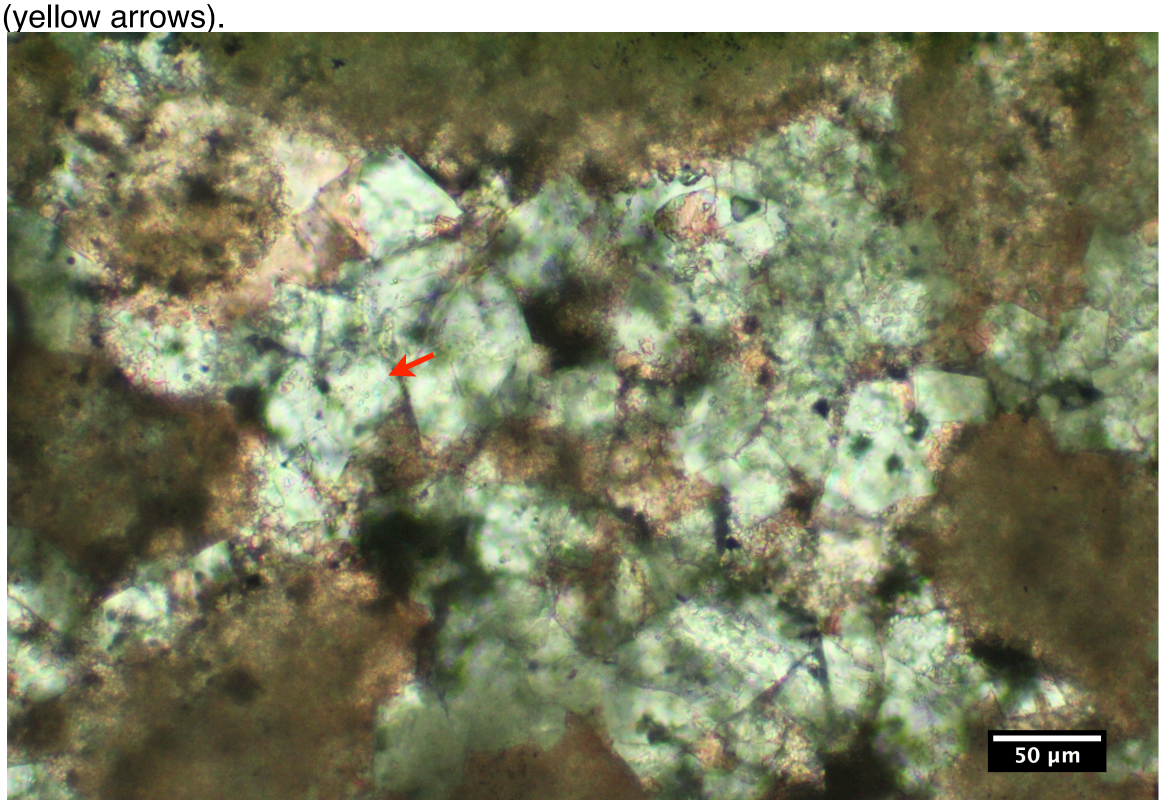
1026.8 - 1027.8 ft.; MI#18087-08



8C. Pore-filling dolomite cement (red arrows) + dense, microcrystalline algae plates (yellow arrows).



8D. Detail of the dolomite cement (red arrows)

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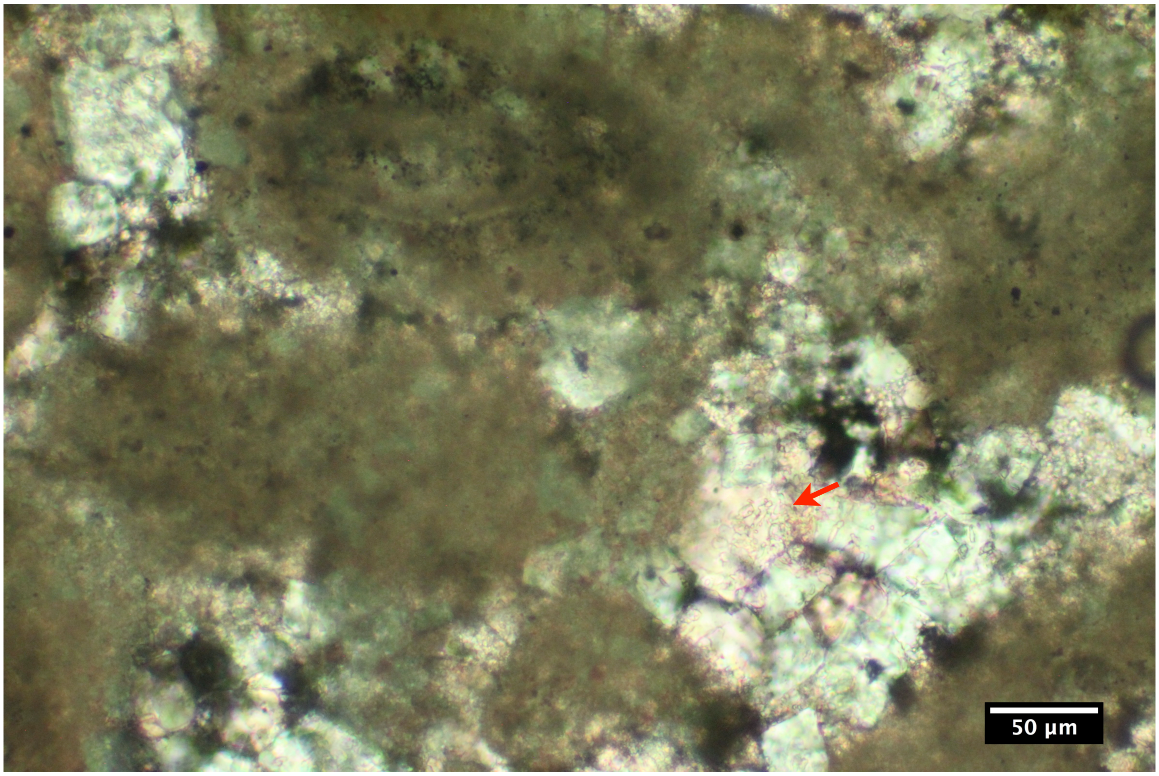
1026.8 - 1027.8 ft.; MI#18087-08



8E. Traces of residual calcite spar cement (pink, red arrows) are locally admixed with the dolomite.

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1026.8 - 1027.8 ft. - MI#18087-08 - SEM

Summary: The SEM specimen prepared for this interval is from a relatively calcite-rich portion of the aquifer fabric and exhibits a framework of calcareous skeletal grains comprised almost exclusively of microcrystalline calcite that is densely interlocked and locally microporous. The calcareous allochems are interspersed with patches of pore filling dolomite cement that appears very finely crystalline and subhedral to euhedral throughout the SEM specimen. Patches of residual intercrystalline macroporosity are associated with the dolomite-rich portions of the sample fabric. Nearly all of the intercrystalline macroporosity is associated with the pore filling dolomite cement occupying the interparticle spaces of the carbonate fabric. Selected calcareous allochems within the core interval exhibit locally significant concentrations of dissolution microporosity in association with the calcareous skeletal materials. The SEM images 18087-08E & 08F provide illustrations of the dissolution void space. Traces of authigenic kaolinite and illite are locally present as accessory components admixed with some of the pore filling dolomite cement in this sample.

The following image tags are used to identify selected features on the SEM images:

Igneous rock fragment	IgRF
Pore filling matrix	PFM
Authigenic clay matrix	AM
Intergranular porosity	Bp
Secondary moldic porosity	2Mp
Secondary intragranular porosity	2Wp
Feldspar	F

18087-08 Photo Index: (bookmarks)

Sample ID	Magnification
18087-08A	200X
18087-08B	800X
18087-08C	3000X
18087-08D	200X
18087-08E	800X
18087-08F	3000X

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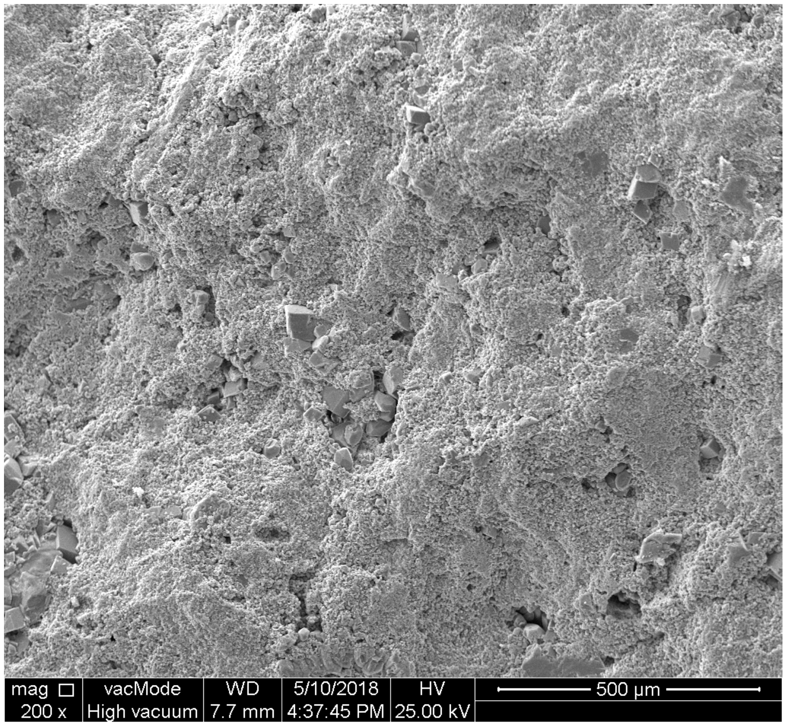
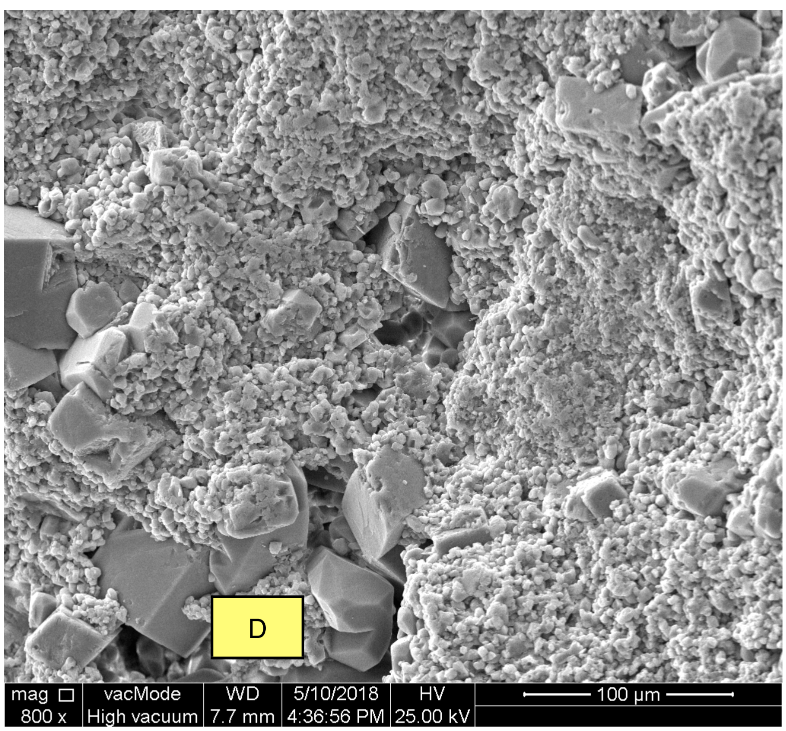
18087-08A 200X



18087-08B 800X



18087-08 Photo Index

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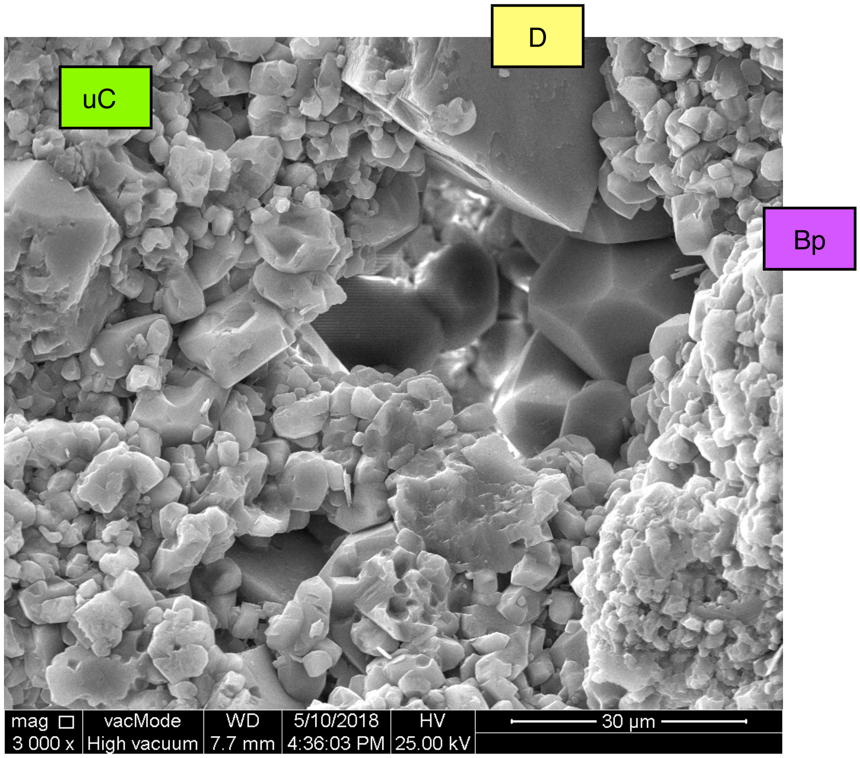
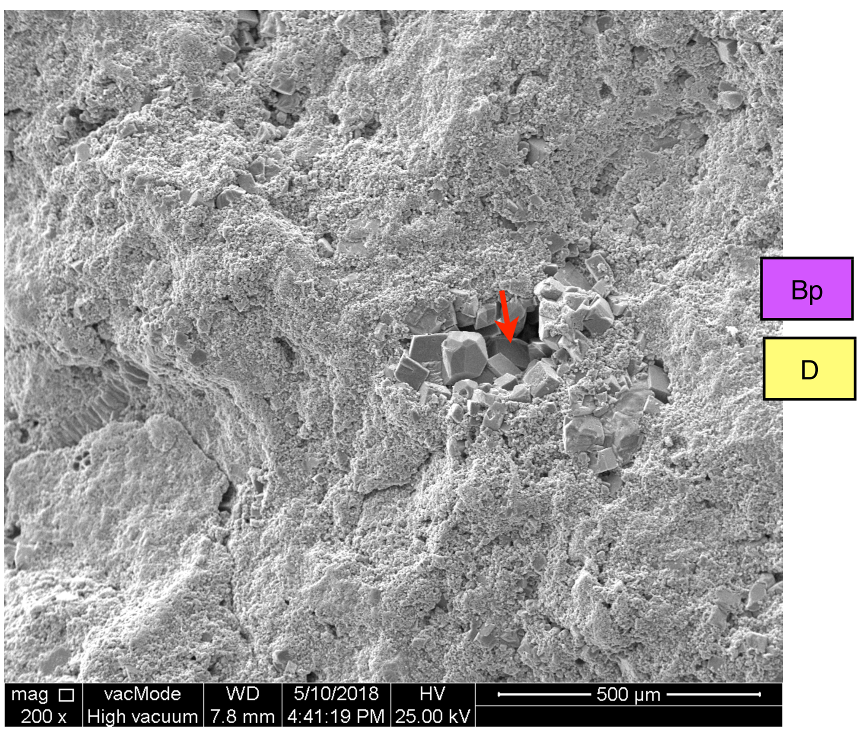
18087-08C 3000X



18087-08D 200X



[18087-08 Photo Index](#)

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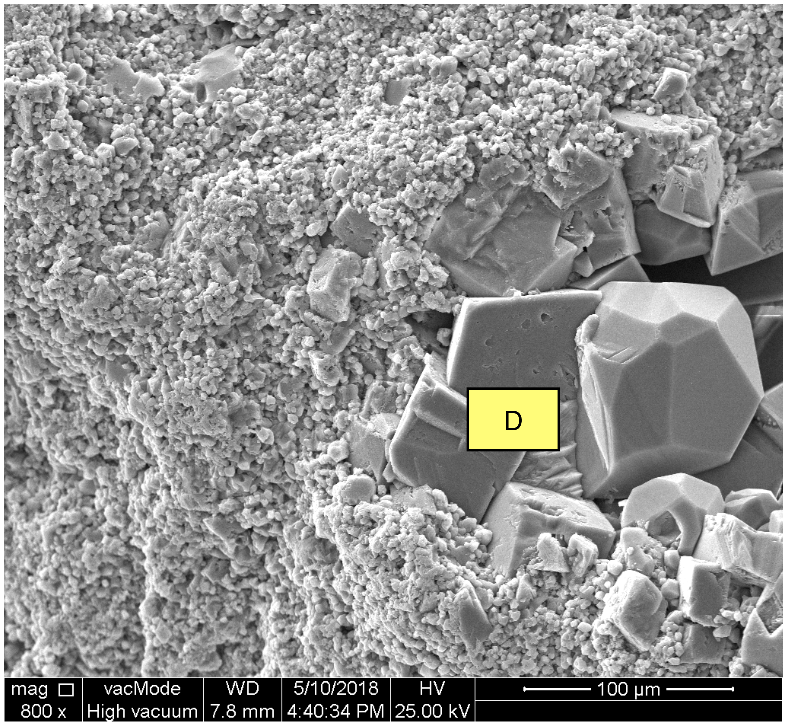
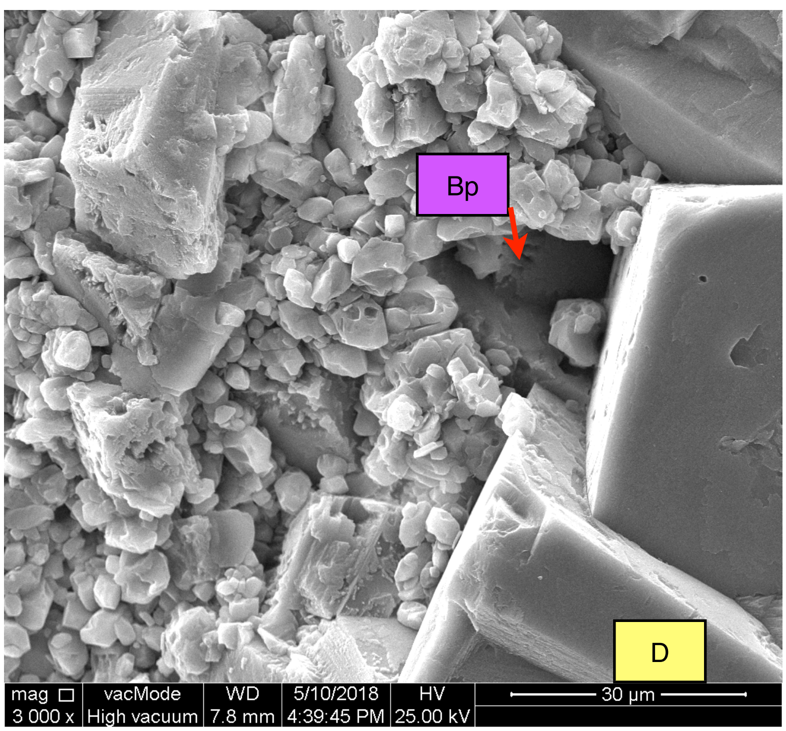
18087-08E 800X



18087-08F 3000X



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10.5 Appendix E. Core photos

Core photos included on DVD in each hard copy, and in separate file of electronic submittal on flash drive.

10.6 Appendix F. Geochemical analysis report

REPORT CERTIFICATION

This report entitled "Technical Memorandum: New Braunfels Utilities NBU-CH-1 Upper Edwards Formation ASR Evaluation – Geochemistry Update, November 9, 2018," has been prepared by Richard K. Glanzman, PhD, PG, Glanzman Geochemical LLC, Lakewood, Colorado, a professional company, under the responsible charge of R. David G. Pyne, P.E., President, ASR Systems LLC, a professional company licensed to practice engineering in Texas.

STATE OF TEXAS
R DAVID G PYNE
91405
LICENSED
PROFESSIONAL ENGINEER

R. David G. Pyne, P.E.

ASR Systems LLC

Texas COR # 6433

Date: 02/06/2019

Richard K. Glanzman, PhD, PG

Glanzman Geochemical LLC

Wyoming PG # 1923

Date: 02/18/2019

TECHNICAL MEMORANDUM

TO: David Pyne/ ASR Systems LLC/ Gainesville, FL

FROM: Dick Glanzman/ Glanzman Geochemical LLC/ Lakewood, CO

DATE: November 9, 2018

SUBJECT: New Braunfels Utilities NBU-CH-1 Upper Edwards Formation ASR Evaluation – Geochemistry Update

SUMMARY

Available data from chemical analyses of two recharge water sources, native groundwater from the Upper Edwards Limestone aquifer (UEL) and both chemical and physical characterization of eight cores representing the Upper and Lower Edwards Limestone aquifer suggest that there are no apparent problems for planned ASR operations. Other than the high total dissolved solids, sulfate and chloride, all other parameters are within or well within their respective drinking water standards. Sampling and modeling results indicate that carbon dioxide gas will not present a problem for the ASR project. The bore hole may need to be cased to between 592 and 610 feet to control the hydrogen sulfide gas in the uppermost UEL and lower Georgetown Formation. A plug would need to be installed at the 710 ft depth to separate the UEL from the Lower Edwards aquifer.

INTRODUCTION

This report is a preliminary geochemical evaluation of available data characterization for the Upper Edwards Limestone ASR project. A representative Edwards Limestone groundwater and a treated surface water from a Water Treatment Plant are two potential sources for recharge water. The chemical analyses of these two potential recharge waters and two native groundwater samples from the UEL in the ASR monitoring well (AW01) are listed on Table 1. The two UEL native groundwater analyses are listed only for comparative purposes. The initial UEL native groundwater analysis collected on June 27, 2018 has a mass balance error too elevated to be considered credible. The second UEL native groundwater analysis collected on September 13, 2018 has an excellent mass balance and is therefore used for this geochemical work.

Groundwater Management Associates, Inc. (GMA) (2018) coring report describes the lithologic and hydrology characteristics of both the stratigraphic/and hydrologic section in NBU Core Hole NBU-CH-1. They selected eight cores to represent the Georgetown Formation, Person Formation, the upper part of the Edwards Group and the Kainer Formation of the lower part of the Edwards Group. These eight cores were physically, chemically and mineralogically characterized by, and an interpretative report was written by, Mineralogy, Inc. (2018).

The mass balance of major ions in the WTP treated water and native groundwater chemical analyses indicates that the chemical analysis for the UEL is of excellent quality.

RECHARGE WATER SOURCES

Two chemical analyses were available to represent the potential recharge water chemistry. One is a groundwater from the Edwards Limestone and the second is a treated surface water from the water treatment plant. Both are relatively similar (Table 1). They are both calcium-bicarbonate water chemistry types with a total dissolved solids (TDS) concentration of 359 and 262 mg/L, respectively, a laboratory pH of 7.55 and 7.91, respectively, and although there are no dissolved oxygen (DO) or oxidation reduction potential (ORP) measurements, probably both are oxidized to highly oxidized (Table 1).

The total organic carbon (TOC) concentration of the groundwater is less than one mg/L while the treated surface water contains 2.59 mg/L. Nitrate concentrations were 1.9 and 0.7 mg/L, respectively. Ammonia assumed as nitrogen concentrations are less than 1 and 0.7 mg/L, respectively while the Total Kjeldahl nitrogen (TKN) are 1 and 2 mg/L respectively. Subtracting the ammonia nitrogen from the TKN estimates a very low organic nitrogen concentration of perhaps 1 and 1.3 mg/L, respectively. Since the organic nitrogen is directly related to the microbial population, the microbial population in these source waters is apparently very low. Total phosphorus is less than 0.1 mg/L in both waters.

Copper, zinc, cadmium and selenium concentration are all less than their respective detection limits in the treated surface water and significantly less than their respective drinking water standards in the groundwater.

Thermodynamic equilibrium modeling (Geochemist's Workbench software) estimates that the Edwards Limestone groundwater is supersaturated with respect to calcite but in equilibrium with chalcedony, cristobalite and potassium feldspar. Chalcedony is the silica mineral commonly present as chert while cristobalite is an ephemeral silica mineral that commonly converts to either chert or quartz with time. Potassium feldspar may or may not be present as a measurable mineral in the limestone.

Most water and particularly groundwater are in equilibrium with calcite since the mineral readily dissolves or precipitates in response to its local geochemical environment. Modeling estimates that the pH of 7.20 is in equilibrium with calcite with this groundwater chemistry and temperature. This estimated pH is less than the reported measurement of 7.55 for the Edwards Aquifer reported pH measurement and may be a laboratory rather than a field measured pH value. Laboratory values are commonly higher than the field measured pH because dissolved carbon dioxide in the groundwater fractionally escapes from its dissolved state, thereby increasing the pH of the water. The dissolved carbon dioxide in equilibrium with the temperature, pH and water chemistry is estimated to be a relatively elevated 26 mg/L.

Modeling of the treated surface water is similarly supersaturated with respect to calcite but in equilibrium with chalcedony, cristobalite and a swelling smectite clay mineral. Modeling estimates that the pH in equilibrium with respect to calcite of 7.50 is similarly lower than the reported pH of 7.91, for the same reasons as that of the groundwater. The pH of the treated surface water in the distribution system is likely to be close to the estimated pH in equilibrium with respect to calcite. The dissolved carbon dioxide in equilibrium with the treated surface water in equilibrium with the temperature, pH and treated water chemistry is estimated to be 10 mg/L.

GROUNDWATER CHEMISTRY

Field parameters for the September 13, 2018 groundwater from the UEL in the monitor well AW01 has a temperature of 26.08 °C, specific conductance of 11,790 µS and pH of 6.67 (Table 1). The DO was a very low 0.08 mg/L. These measurements indicate a relatively warm, slightly acidic, low oxidized to slightly reduced brackish groundwater. The slightly acidic pH likely reflects the laboratory-determined carbon dioxide of 60 mg/L. The quality assurance tests indicate that this measurement may be 70 to 72 percent too low suggesting a carbon dioxide content between 83.0 and 85.7 mg/L.

A sample of the native groundwater was collected in a clear glass container to observe changes, if any, occurring in the sample with time. As collected, the sample had an initial very slight cloudy character that rapidly cleared and remained clear indicating that any entrained carbon dioxide dissipates rapidly and this concentration is not likely to be a problem.

The laboratory analysis reports a TDS of 9,420 mg/L and a total dissolved solids sum of reported parameter concentrations (TDSS) of 8,140 mg/L. This difference suggests that there may have been dispersed colloidal-sized particles in the native groundwater. Groundwater samples collected from wells that have been idled for several months can contain a considerable amount of these particles so small that they are not visible. This difference in measured TDS and calculated TDSS may be reflecting the field turbidity measured during pumping that consistently increased from 3.62 to 4.92 nephelometric turbidity units (NTU) during the 15 minutes the field parameters were monitored.

The sodium concentration of 1,410 mg/L represents 44 percent of the cations while the calcium concentration of 769 mg/L is second representing an additional 29 percent. Magnesium at 378 mg/L represents most of the remainder with 23 percent while the potassium of 66.1 mg/L and strontium of 17 mg/L completes the major cation composition. The chloride concentration of 2,780 mg/L represents 57 percent of the anions. Sulfate at 2,460 mg/L represents 37 percent while the total alkalinity of 376 mg/L represents 6 percent. The bromide concentration of 11 mg/L is too low to measurably affect these percentages. These cation and anion concentrations and percentages suggest seawater mixing with a native groundwater to form this groundwater chemistry of the UEL.

These native groundwater (AW01 GW) and the water treatment plant recharge water (WTP RW) cation and anion percentages are plotted on the trilinear diagram on Figure 1. The trilinear diagram can be used to estimate the percentage of native groundwater mixed with the recharge water in the recovered water from the ASR well. This mixture will form a straight line between these two end members if there are no chemical reactions occurring between this mixture and the aquifer mineralogy. Deviations from a straight line provide an estimate of chemical reactions with the aquifer mineralogy responsible for the deviation.

The total organic carbon is less than 1.0 mg/L. Nitrate is less than 0.20 mg/L but ammonia-nitrogen is reported to be 3.7 mg/L. This ammonia-nitrogen concentration is slightly higher than the total Kjeldahl nitrogen (TKN) concentration of 3.3 mg/L. TKN is the sum of the ammonia-nitrogen and organic-nitrogen produced by microbial metabolic processes. This relationship indicates that the microbial population in the UEL is likely to be essentially non-existent. The total phosphorous and orthophosphate concentrations are less than their respective low detection limits, providing further support for the lack of microbial activity in the UEL.

The 1.0 mg/L detection limit for the dissolved and total iron is considerably higher than the more common 0.010 mg/L or the previous 0.101 mg/L for the June sample. However the June sample indicates that the iron concentration is likely to be less than 0.101 mg/L. Both the dissolved and total manganese are less than 0.025 mg/L. Analyses of almost all other metals and metalloids (antimony, beryllium, arsenic, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium and vanadium) are less than their respective very low detection limits. Only zinc (0.027 mg/L) and aluminum (0.089 mg/L) had laboratory-reported concentrations above their respective detection limits. Both are also higher than their concentrations in the June samples, perhaps because of analytical methods/procedures in the different laboratories.

The elevated sulfate concentration suggests that pyrite oxidation has likely contributed to this concentration. However, the iron, manganese and arsenic concentrations in the September native water sample are all non-detected at their respective detection limits. Assuming that the iron concentration less than 0.101 mg/L in the June sample is correct and the less-than-detect concentrations of other metals for the two sampling events (Table 1), these would indicate that pyrite oxidation is not likely to be measurable in the UEL at this well location. This may be due to either the very low DO or that the pyrite is largely encapsulated within the limestone and dolomite and therefore not exposed. Even though the oxidation reduction potential (ORP) was not measured, the elevated sulfate suggests that the groundwater ORP is not sufficiently low enough to reduce sulfate ions to sulfide.

Thermodynamic Equilibrium Modeling

Thermodynamic equilibrium modeling estimates that the UEL native groundwater from AW01 is in equilibrium with respect to calcite, aragonite, dolomite dissolution, chalcedony, cristobalite, gypsum (calcium-sulfate), celestite (strontium-sulfate) and fluorite (calcium-fluoride).

The estimated equilibrium dissolved carbon dioxide concentration is 81.9 mg/L. This is considerably higher than the laboratory reported 60 mg but within the quality control estimate of 83.0 and 85.7 mg/L.

Modeling the mixture of the WTP recharge water with the UEL AW01 native groundwater estimates a rapid decrease in the TDS to about half of the native groundwater concentration by a 3:1 WTP to native groundwater mix. Mixing of the two waters estimated improvements in the water chemistry without potential precipitation problems. The pH is estimated to slowly increase with WTP water from 6.67 to about 7.2. Similar to TDS, the equilibrium carbon dioxide concentration rapidly decreases by almost half in a 1 to 1 mixture of WTP water to UEL native groundwater. It decreases at a rate that is almost equal to that of the chloride concentration decrease relative to the decrease in TDS. Correlation coefficients for the TDS-chloride and TDS-carbon dioxide linear least square fit equations for the two were 0.94 and 0.93 respectively. In other words, the estimated carbon dioxide concentration appears to be essentially equal to the dilution rate produced by the mixing of WTP water with the UEL native groundwater. However, the carbon dioxide concentration decrease is controlled and reflected by the pH and bicarbonate concentration measurements occurring during the mixing of the two waters. The linear least square fit equation for carbon dioxide-pH-bicarbonate ion estimates has a correlation coefficient of 0.99 indicating nearly an ideal fit. The modeling estimates that the carbon dioxide concentration of potable recovered water is likely to range between 10 and 20 mg/L and therefore unlikely to present a degassing problem.

EDWARDS LIMESTONE

The lithologic log and coring report for the NBU CH-1 ASR core hole provides valuable insights into hydrologic and geochemical characteristics of the stratigraphic and hydrologic characteristics of sediments in the core hole, particularly the Edwards Group (Groundwater Management Associates (GMA, 2018). Pyrite was described extending from the lower part of the confining Del Rio Clay into the uppermost part of the Georgetown Formation to a depth of about 548 feet. The Georgetown Formation extends from 532 to 583 feet. A strong "sulfur odor" interpreted to mean the rotten egg odor of hydrogen sulfide gas was reported from the lower part of the Georgetown Formation at a core hole depth between about 568 and 586 feet that extends about 3 feet into the very uppermost part of the Person Formation, suggesting the presence of fine-grained pyrite being oxidized in this depth interval.

The Person Formation of the Edwards Group extends from 583 to 734 feet. "Some fracturing" was reported between about 647 and 677 feet and a "heavily fractured" nature of the Person Formation between about 677 and 697 foot depths. "Vuggy porosity" was reported at a depth of 707 feet, the top of a "dense limestone" just above the "Regional Dense Member" beginning at 711.5 feet and extending to about 734 feet. A depth interval of "virtually no porosity" extends between about 718 and 726 feet. A relatively thick zone of "some porosity along bedding" extends from a depth of about 727 to 775 feet of the upper part of the Kainer Formation. This description suggests that vertical permeability may be restricted in this depth interval.

These core description relationships suggest that the UEL characteristics of the Person Formation extend between about 647 to 708 feet. The upper part of the Person likely contributes groundwater but the sulfur odor at the top of the Person and lowermost part of the Georgetown should be avoided to a depth of at least about 605 feet. The presence of the "Regional Dense Limestone" with "virtually no porosity beginning at a depth of 712 feet with the underlying depth interval of "some porosity along bedding" to a depth of 775 feet suggests about a 64 foot depth interval that may hydraulically separate groundwater in the UEL Person Formation from that of the Lower Edwards Limestone aquifer (LEL) Kainer Formation. The Kainer Formation contains a native groundwater with a higher TDS than the UEL. These relationships suggest about a 100 foot ASR storage zone between a depth of about 610 and 710 feet.

Cores

Eight core samples from the Georgetown, Person and Kainer Formations were selected to represent the physiochemical characteristics of these formations at the NBU-CH-1 core hole location and sent to Mineralogy, Inc. for analysis (Mineralogy, Inc., 2018). The chemical precipitation nature of the carbonate rocks is demonstrated by the x-ray fluorescence analyses in this report. Non-detection of sodium and particularly titanium often coupled with very low silica and particularly aluminum is very rare in sedimentary rocks, clearly indicating the dominance of chemical precipitation characteristic of the carbonate deposition.

The **Georgetown Formation** 545.4 to 546.3 foot depth interval core sample is a densely microcrystalline limestone with both dolomite and calcite pore-filling cement. The Mineralogy Inc. (2018) report describes it as an "effective permeability barrier" with a hydraulic permeability of 0.0005 md.   Its mineralogy is comprised of 97 percent calcite, 1.5 percent quartz, 0.5 percent the minor minerals, pyrite, kaolinite, illite/mica, respectively, and a trace (<0.5 percent) of mixed-layer illite/smectite (MLIS) clay. Most of the quartz is probably represented by black chert in the core. The chemistry supports the mineralogical composition. For example, the sulfur concentration suggests about 0.6 percent pyrite if all of the sulfur was present as pyrite. This Georgetown core contained the highest iron concentration of the eight cores and suggests that about two thirds of it is likely present as pyrite while another third is present in other parts of the mineralogy, likely the clays. This core sample also contains the highest phosphorus concentration likely present as a trace of the calcium-phosphate mineral, apatite, often associated with pyrite in carbonate rocks.

The **UEL Person Formation** 673.6 to 674.6 foot depth interval core sample is comprised of 99.5 percent dolomite with only 0.5 percent calcite, and less than 0.5 percent quartz and kaolinite, respectively. The chemistry reflects this mineralogy but includes 0.36 percent sulfur suggesting a low 0.7 percent pyrite in the core. Iron may also be present in both the pyrite and clays. Phosphorus is likely present as a trace amount of apatite. A trace amount of irregular lath-like organic matter particles are locally comingled with dolomite crystals in the core. However, this is a clean dolomite with few trace minerals and a chemistry that suggests an aquifer presenting minimal if any apparent chemical interactions with recharge water that would result in problem(s) in the recovered water chemistry if the entire aquifer thickness had the same characteristics as this dolomite.

This dolomite is likely a result of a microbial metabolic dolomitization process acting on a previously deposited and similarly clean Person limestone. This origin usually adds traces of organic matter and sulfur and opens up pore space by converting calcite to dolomite. This is reflected in this UEL sample having the highest helium porosity (34.9 percent) of the eight samples; the second highest nitrogen gas permeability (310 millidarcies (md)); and shares the highest grain densities (2.83 grams per cubic centimeter) with a deep lower Edwards Limestone aquifer (LEL) dolomite (977.8 to 978.8 foot depth core) with the highest nitrogen gas permeability (660 md). Dolomitization changes the mineralogy but the total volume of the previous limestone is essentially unchanged, thereby creating pore space and permeability.

Two analyzed core samples were from within the **Regional Dense Limestone member** of the Lower Person Formation: 724.8 to 725.8 and 729.2 to 730.3 foot depth intervals, respectively. Both are limestones comprised of 92 and 99.6 percent calcite, respectively. The shallower of the two contains 5 percent dolomite but otherwise is similar to the Georgetown Formation core sample. Mineralogy Inc. (2018) states that this limestone represents an "effective permeability barrier." The deeper of the two cores is comprised of 99.6 percent calcite with a trace of kaolinite clay. It has about 11 percent of weakly interconnected total void space with widespread pore-filling calcite cement. The hydraulic conductivity of the two depth intervals are 0.0028 and 0.0109 md, respectively.

Four cores from the **LEL Kainer Formation** were analyzed by Mineralogy, Inc. The shallowest core, 753.5 to 754.5 foot depth interval, is 100 percent microcrystalline calcite and contains considerable numbers of microfossils. It has 24 percent helium porosity and 201 md of horizontal nitrogen gas permeability.

The second core, from 880.1 to 881.1 foot depth interval, is comprised of 66 percent dolomite, 16 percent celestite (strontium sulfate), 11 percent calcite and 2 percent quartz. Celestite is only slightly soluble so this mineralogy is relatively stable. The core has a very low nitrogen gas horizontal permeability of 0.00106 md but a considerably higher vertical fracture permeability of 86.6 md. It has a relatively low helium porosity of 3.4l percent.

The third core from 977.8 to 978.8 foot depth interval is comprised of 98 percent dolomite, 2 percent calcite and a trace of quartz. It also contains a trace of celestite as a cement along with kaolinite and illite clays locally comingled with dolomite crystals in void spaces. It has the highest horizontal nitrogen gas permeability of 660 md of all eight cores and the second highest helium porosity of 25.4 percent.

The deepest core, from 1026.8 to 1027.8 foot depth interval, is comprised of 51 percent dolomite, 47.5 percent calcite, 1 percent quartz, 0.5 percent kaolinite and a trace of illite. Dolomitization is probably continuing in this depth interval and is just over half completed. It has a horizontal nitrogen gas permeability of 3.2 md that is ascribed largely to a fracture and a helium porosity of 10 percent, much of which is peripheral to an organic-rich-clay seam in the core.

RECOVERED WATER

Interpretation and modeling of the available data estimates that there are no apparent problems using either of the recharge water sources for ASR purposes in the UEL. There will be a volume of the initial recharge water with elevated TDS as the recharge water mixes with and dilutes the native groundwater, eventually reaching a TDS in the recovered water perhaps similar to that of the recharge water. The same is true for the major, minor and trace ion concentrations. Local hydrologic conditions for the ASR location will determine the volume of the initial recovered water that will have, in this case, a TDS, that meets the drinking water standard. Measuring the specific conductance during recovery can ascertain the point at which the TDS will meet the standard. The volume of water that exceeds that measure can, and is recommended to, be left in the aquifer as a buffer zone both for this standard and that of other dissolved parameters such as iron and arsenic.

Initial formation and maintenance of a buffer zone separating the stored drinking water from the surrounding native groundwater is commonly applied at ASR wells to provide acceptable recovered water quality. Once the buffer zone volume has been achieved, essentially full recovery of the subsequently-stored water is possible. Based upon operating experience at other brackish limestone confined aquifers, the buffer zone volume required is probably about 30 to 50% of the Target Storage Volume (TSV) for the ASR well. The buffer zone is a one-time addition of water to the well. It is essentially the final step in well construction.

REFERENCES

GMA GROUNDWATER MANAGEMENT ASSOCIATES, 2018, Aquifer Storage Recovery Program Coring Report, New Braunfels Utilities, New Braunfels, Texas, June 22, 2018, 20p.

Mineralogy Inc, 2018, New Braunfels Utility NBU-CH-1, Edwards Formation, ASR Evaluation, June 21, 2018, 84p.

10.7 Appendix G. Upper Edwards aquifer lab water quality report and field data

Table 10-1: Table G-1 Field parameters from Upper interval sampling event #1

Date	Time	Temperature (°C)	pH	Specific Conductivity (uS/cm)	DO (mg/L)	TDS (ppm)
5/23/2018	21:22	26.02	6.49	11620	3.10	10160
5/23/2018	21:27	26.01	6.51	11560	2.18	9964
5/23/2018	21:32	26.00	6.52	11580	1.73	9962
5/23/2018	21:37	25.99	6.53	11590	1.35	9968

Table 10-2: Table G-2 Field parameters from Upper interval sampling event #2

Date	Time	Temperature (°C)	pH	Specific Conductivity (uS/cm)	DO (mg/L)	Turbidity (NTU)
9/13/2018	11:40	26.08	6.68	11780	0.08	3.62
9/13/2018	11:45	26.07	6.67	11790	0.08	3.67
9/13/2018	11:50	26.09	6.67	11790	0.09	4.30
9/13/2018	11:55	26.08	6.67	11790	0.08	4.92

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October 01, 2018

Neil Deeds
INTERA Inc.
1812 Centre Creek Drive
Suite 300
Austin, TX 78754

Work Order: **HS18090667**

Laboratory Results for: **EAA/NBU Water Quality Sampling Plan**

Dear Neil,

ALS Environmental received 2 sample(s) on Sep 14, 2018 for the analysis presented in the following report.

The analytical data provided relates directly to the samples received by ALS Environmental and for only the analyses requested. Results are expressed as "as received" unless otherwise noted.

QC sample results for this data met EPA or laboratory specifications except as noted in the Case Narrative or as noted with qualifiers in the QC batch information. Should this laboratory report need to be reproduced, it should be reproduced in full unless written approval has been obtained by ALS Environmental. Samples will be disposed in 30 days unless storage arrangements are made.

If you have any questions regarding this report, please feel free to call me.

Sincerely,

Generated By: JUMOKE.LAWAL

RJ Modashia
Project Manager

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
Work Order: HS18090667

SAMPLE SUMMARY

Lab Samp ID	Client Sample ID	Matrix	TagNo	Collection Date	Date Received	Hold
HS18090667-01	NBU-AW01 Upper	Water		13-Sep-2018 12:10	14-Sep-2018 08:46	☐
HS18090667-02	Trip Blank	Water		13-Sep-2018 00:00	14-Sep-2018 08:46	☐

Client: INTERA Inc.

Project: EAA/NBU Water Quality Sampling Plan

Work Order: HS18090667

CASE NARRATIVE

Work Order Comments

- Sample received outside method holding time for pH. pH is an immediate test. Sample results are flagged with an "H" qualifier.

  The temperature at the time of pH is reported. Please note that all pH results are already normalized to a temperature of 25 °C.

- The analysis for Silicon was subcontracted to ALS Environmental Fort Collins in Colorado. Final report attached.

  The analysis for CO2 was subcontracted to ALS Environmental in Simi Valley, CA . Final report attached.

Metals by Method SM1030E

Batch ID: R324382

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

Metals by Method E200.8

Batch ID: 132765

Sample ID: NBU-AW01 Upper (HS18090667-01)

- Sample ran at a 5x due to high Sodium concentration.

Metals by Method SW6020

Batch ID: 132544

Sample ID: HS18090696-01MS

- MS/MSD and DUPs are for an unrelated sample

Sample ID: NBU-AW01 Upper (HS18090667-01)

- Sample ran at a 50x due to internal standard 6 (Beryllium) failure.

WetChemistry by Method SM2320B

Batch ID: R323736

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

WetChemistry by Method SW9060

Batch ID: R324197,R324198,R324199

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

Batch ID: R324332

Sample ID: NBU-AW01 Upper (HS18090667-01MS)

- The recovery of the Matrix Spike (MS) and/or Matrix Spike Duplicate (MSD) associated with this analyte was outside of the established control limits. However, the LCS was within control limits. The recovery of the MS/MSD may be due to sample matrix interference. (Total Carbon, Dissolved)

WetChemistry by Method M2510 B

Batch ID: R323948

Client: INTERA Inc.

Project: EAA/NBU Water Quality Sampling Plan

Work Order: HS18090667

CASE NARRATIVE

WetChemistry by Method M2510 B

Batch ID: R323948

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

WetChemistry by Method M2540C

Batch ID: R323733

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

WetChemistry by Method E365.3

Batch ID: 132647

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

WetChemistry by Method SM4500H+ B

Batch ID: R323714

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

WetChemistry by Method E300

Batch ID: R323700

Sample ID: CCB

- All reported samples bracketed by this CCB are 10 times greater than the Chloride and Sulfate content in this CCB.

Sample ID: NBU-AW01 Upper (HS18090667-01)

- The reporting limit is elevated due to dilution for high concentrations of non-target analytes. (Nitrogen, Nitrate (As N),Phosphorus, Dissolved Orthophosphate (As P))

Batch ID: R324086

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

WetChemistry by Method M4500 NH3 D

Batch ID: 132630

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

WetChemistry by Method SM4500 NH3-B-F

Batch ID: 132612

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

Client:	INTERA Inc.		**ANALYTICAL REPORT**
Project:	EAA/NBU Water Quality Sampling Plan		WorkOrder:HS18090667
Sample ID:	NBU-AW01 Upper		Lab ID:HS18090667-01
Collection Date:	13-Sep-2018 12:10		Matrix:Water

ANALYSES	RESULT	QUAL	REPORT LIMIT	UNITS	DILUTION FACTOR	DATE ANALYZED
DISSOLVED METALS BY E200.8		**Method:E200.8 (dissolved)**		Prep:E200.8 / 24-Sep-2018		Analyst: JDE
Iron	ND		1000	ug/L	5	28-Sep-2018 12:56
Manganese	ND		25.0	ug/L	5	28-Sep-2018 12:56
ION BALANCE - SM1030E		**Method:SM1030E**				Analyst: DQ
Anions	ND		0.100	meq/L	1	28-Sep-2018 16:47
Cations	ND		0.100	meq/L	1	28-Sep-2018 16:47
Ion Balance % Diff.	ND		0.100	%	1	28-Sep-2018 16:47
ICP-MS METALS BY SW6020A		**Method:SW6020**		Prep:SW3010A / 18-Sep-2018		Analyst: JDE
Aluminum	**0.0894**		**0.0500**	**mg/L**	5	26-Sep-2018 12:36
Antimony	ND		0.0100	mg/L	5	26-Sep-2018 12:36
Arsenic	ND		0.0100	mg/L	5	26-Sep-2018 12:36
Beryllium	ND		0.100	mg/L	50	26-Sep-2018 12:22
Cadmium	ND		0.0100	mg/L	5	26-Sep-2018 12:36
Calcium	**769**		**2.50**	**mg/L**	5	26-Sep-2018 12:36
Chromium	ND		0.0200	mg/L	5	26-Sep-2018 12:36
Copper	ND		0.0100	mg/L	5	26-Sep-2018 12:36
Iron	ND		1.00	mg/L	5	26-Sep-2018 12:36
Lead	ND		0.0100	mg/L	5	26-Sep-2018 12:36
Magnesium	**378**		**1.00**	**mg/L**	5	26-Sep-2018 12:36
Manganese	ND		0.0250	mg/L	5	26-Sep-2018 12:36
Nickel	ND		0.0100	mg/L	5	26-Sep-2018 12:36
Potassium	**66.2**		**1.00**	**mg/L**	5	26-Sep-2018 12:36
Selenium	ND		0.0100	mg/L	5	26-Sep-2018 12:36
Silver	ND		0.0100	mg/L	5	26-Sep-2018 12:36
Sodium	**1,410**		**10.0**	**mg/L**	50	26-Sep-2018 12:22
Strontium	**15.3**		**0.250**	**mg/L**	50	26-Sep-2018 12:22
Thallium	ND		0.0100	mg/L	5	26-Sep-2018 12:36
Vanadium	ND		0.0250	mg/L	5	26-Sep-2018 12:36
Zinc	**0.0271**		**0.0200**	**mg/L**	5	26-Sep-2018 12:36
ANIONS BY E300.0		**Method:E300**				Analyst: KMU
Bromide	**11.0**		**2.00**	**mg/L**	20	24-Sep-2018 18:55
Chloride	**2,780**		**50.0**	**mg/L**	100	15-Sep-2018 05:03
Fluoride	**2.42**		**0.200**	**mg/L**	2	15-Sep-2018 04:34
Nitrogen, Nitrate (As N)	ND		0.200	mg/L	2	15-Sep-2018 04:34
Phosphorus, Dissolved Orthophosphate (As P)	ND		0.200	mg/L	2	15-Sep-2018 04:34
Sulfate	**2,460**		**50.0**	**mg/L**	100	15-Sep-2018 05:03
PHOSPHORUS BY E365.3		**Method:E365.3**		Prep:E365.3 / 20-Sep-2018		Analyst: MZD
Phosphorus, Total (As P)	ND		0.0500	mg/L	1	20-Sep-2018 15:15
SPECIFIC CONDUCTIVITY BY SM2510 B		**Method:M2510 B**				Analyst: AJH
Specific Conductivity	**14,000**		**10.0**	**umhos/cm**	2	22-Sep-2018 18:00

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client:	INTERA Inc.		**ANALYTICAL REPORT**
Project:	EAA/NBU Water Quality Sampling Plan		WorkOrder:HS18090667
Sample ID:	NBU-AW01 Upper		Lab ID:HS18090667-01
Collection Date:	13-Sep-2018 12:10		Matrix:Water

ANALYSES	RESULT	QUAL	REPORT LIMIT	UNITS	DILUTION FACTOR	DATE ANALYZED
TOTAL DISSOLVED SOLIDS BY SM2540C		**Method:M2540C**				Analyst: KAH
Total Dissolved Solids (Residue, Filterable)	**9,420**		**10.0**	**mg/L**	1	18-Sep-2018 16:50
TOTAL KJELDAHL NITROGEN BY SM4500 NH3 D		**Method:M4500 NH3 D**		Prep:M4500-N C / 19-Sep-2018		Analyst: MZD
Nitrogen, Total Kjeldahl	**3.3**		**0.50**	**mg/L**	1	20-Sep-2018 11:00
ALKALINITY BY SM2320B		**Method:SM2320B**				Analyst: AJH
Alkalinity, Bicarbonate (As CaCO3)	**376**		**5.00**	**mg/L**	1	19-Sep-2018 00:06
Alkalinity, Carbonate (As CaCO3)	ND		5.00	mg/L	1	19-Sep-2018 00:06
Alkalinity, Hydroxide (As CaCO3)	ND		5.00	mg/L	1	19-Sep-2018 00:06
Alkalinity, Total (As CaCO3)	**376**		**5.00**	**mg/L**	1	19-Sep-2018 00:06
AMMONIA AS N BY SM4500 NH3-B-F		**Method:SM4500 NH3-B-F**		Prep:M4500-NH3 B / 19-Sep-2018		Analyst: KVL
Nitrogen, Ammonia (as N)	**3.7**		**0.25**	**mg/L**	5	20-Sep-2018 13:40
PH BY SM4500H+ B		**Method:SM4500H+ B**				Analyst: MZD
pH	**6.59**	H	**0.100**	**pH Units**	1	19-Sep-2018 13:35
Temp Deg C @pH	**21.7**	H	**0**	**°C**	1	19-Sep-2018 13:35
DISSOLVED INORGANIC CARBON BY SW9060A		**Method:SW9060**				Analyst: KMU
Dissolved Inorganic Carbon	**74**		**1.0**	**mg/L**	1	26-Sep-2018 16:29
TOTAL ORGANIC CARBON BY SW9060A		**Method:SW9060**				Analyst: AJH
Organic Carbon, Total	ND		1.00	mg/L	1	22-Sep-2018 19:26
DISSOLVED ORGANIC CARBON BY SW9060A		**Method:SW9060 (dissolved)**				Analyst: AJH
Organic Carbon, Dissolved	ND		1.00	mg/L	1	22-Sep-2018 21:20
DISSOLVED TOTAL CARBON BY SW9060A		**Method:SW9060 (dissolved)**				Analyst: AJH
Total Carbon, Dissolved	**74.0**		**5.00**	**mg/L**	5	25-Sep-2018 21:38
SUBCONTRACT ANALYSIS - CO2		**Method:NA**				Analyst: SUBCA
Subcontract Analysis	See Attached			NA	1	01-Oct-2018 15:11
SUBCONTRACT ANALYSIS - METALS ANALYSIS		**Method:NA**				Analyst: SUBFC
Subcontract Analysis	See Attached			NA	1	24-Sep-2018 18:01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Lab ID:	HS18090667-01
Sample ID:	NBU-AW01 Upper

	mg/L		Cations
Analyte	Final Val	meqWT	meq/L
Calcium	769.0	20.04	38.373
Magnesium	378.0	12.16	31.086
Potassium	66.2	39.1	1.693
Sodium	1410.0	23	61.304
Iron (II)	0.00	27.9	0.000
Manganese	0.00	27.465	0.000
	Total Cations, meq/L		132.456

	mg/L		Anions
Analyte	Final Val	meqWT	meq/L
Chloride	2780.00	35.450	78.420
Bromide	0.00	79.900	0.000
Nitrogen, Nitrate (As N)	0.00	14.007	0.000
Sulfate	2460.00	48.030	51.218
T . ALK (as CaCO3)	376.00	50.000	7.520
	Total Anions, meq/L		137.158
	Anion-Cation Balance % Difference:		-1.744

% Difference Guideline: 10%

Reference: SM 1030E, 21st Edition

TDS, mg/L	9420		
Spec Cond, µmhos/cm	14000	TDS/SpCond Ratio:	0.673
	TDS/SpCond Ratio Guideline: 0.55-0.8		

TSS, mg/L	
Turbidity, NTU	

WEIGHT LOG

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

Batch ID: 132544 **Method:** ICP-MS METALS BY SW6020A **Prep:** 3010A

SampID	Container	Sample Wt/Vol	Final Volume	Prep Factor
HS18090667-01	1	10	10 (mL)	1

Batch ID: 132612 **Method:** AMMONIA AS N BY SM4500 NH3-B-F **Prep:** NIT_AMM_W_PR

SampID	Container	Sample Wt/Vol	Final Volume	Prep Factor
HS18090667-01	1	25	25 (mL)	1

Batch ID: 132630 **Method:** TOTAL KJELDAHL NITROGEN BY SM4500 NH3 D **Prep:** TKN_W_PR

SampID	Container	Sample Wt/Vol	Final Volume	Prep Factor
HS18090667-01	1	25	50 (mL)	2

Batch ID: 132647 **Method:** PHOSPHORUS BY E365.3 **Prep:** P_TW_PR

SampID	Container	Sample Wt/Vol	Final Volume	Prep Factor
HS18090667-01	1	50	50 (mL)	1

Batch ID: 132765 **Method:** DISSOLVED METALS BY E200.8 **Prep:** 200.8_DISSPR

SampID	Container	Sample Wt/Vol	Final Volume	Prep Factor
HS18090667-01	1	10	10 (mL)	1

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

DATES REPORT

Sample ID	Client Samp ID	Collection Date	TCLP Date	Prep Date	Analysis Date	DF
Batch ID 132544	**Test Name :** ICP-MS METALS BY SW6020A			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10		18 Sep 2018 13:00	26 Sep 2018 12:36	5
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10		18 Sep 2018 13:00	26 Sep 2018 12:22	50
Batch ID 132612	**Test Name :** AMMONIA AS N BY SM4500 NH3-B-F			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10		19 Sep 2018 16:00	20 Sep 2018 13:40	5
Batch ID 132630	**Test Name :** TOTAL KJELDAHL NITROGEN BY SM4500 NH3 D			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10		19 Sep 2018 09:30	20 Sep 2018 11:00	1
Batch ID 132647	**Test Name :** PHOSPHORUS BY E365.3			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10		20 Sep 2018 09:30	20 Sep 2018 15:15	1
Batch ID 132765	**Test Name :** DISSOLVED METALS BY E200.8			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10		24 Sep 2018 11:00	28 Sep 2018 12:56	5
Batch ID R323700	**Test Name :** ANIONS BY E300.0			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			15 Sep 2018 05:03	100
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			15 Sep 2018 04:34	2
Batch ID R323714	**Test Name :** PH BY SM4500H+ B			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			19 Sep 2018 13:35	1
Batch ID R323733	**Test Name :** TOTAL DISSOLVED SOLIDS BY SM2540C			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			18 Sep 2018 16:50	1
Batch ID R323736	**Test Name :** ALKALINITY BY SM2320B			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			19 Sep 2018 00:06	1
Batch ID R323948	**Test Name :** SPECIFIC CONDUCTIVITY BY SM2510 B			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			22 Sep 2018 18:00	2
Batch ID R324023	**Test Name :** SUBCONTRACT ANALYSIS - METALS ANALYSIS			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			24 Sep 2018 18:01	1
Batch ID R324086	**Test Name :** ANIONS BY E300.0			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			24 Sep 2018 18:55	20
Batch ID R324197	**Test Name :** DISSOLVED INORGANIC CARBON BY SW9060A			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			26 Sep 2018 16:29	1
Batch ID R324198	**Test Name :** TOTAL ORGANIC CARBON BY SW9060A			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			22 Sep 2018 19:26	1
Batch ID R324199	**Test Name :** DISSOLVED ORGANIC CARBON BY SW9060A			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			22 Sep 2018 21:20	1
Batch ID R324332	**Test Name :** DISSOLVED TOTAL CARBON BY SW9060A			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			25 Sep 2018 21:38	5

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

DATES REPORT

Sample ID	Client Samp ID	Collection Date	TCLP Date	Prep Date	Analysis Date	DF
Batch ID R324382	**Test Name :** ION BALANCE - SM1030E			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			28 Sep 2018 16:47	1
Batch ID R324499	**Test Name :** SUBCONTRACT ANALYSIS - CO2			**Matrix:** Water		
HS18090667-01	NBU-AW01 Upper	13 Sep 2018 12:10			01 Oct 2018 15:11	1

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: **132544** **Instrument:** **ICPMS05** **Method:** **SW6020**

MBLK Sample ID: **MBLK-132544** Units: **mg/L** Analysis Date: **19-Sep-2018 16:13**
Client ID: Run ID: **ICPMS05_323685** SeqNo: **4733061** PrepDate: **18-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Aluminum	ND	0.0100								
Antimony	ND	0.00200								
Arsenic	ND	0.00200								
Beryllium	ND	0.00200								
Cadmium	ND	0.00200								
Calcium	ND	0.500								
Chromium	ND	0.00400								
Copper	ND	0.00200								
Iron	ND	0.200								
Lead	ND	0.00200								
Magnesium	ND	0.200								
Manganese	ND	0.00500								
Nickel	ND	0.00200								
Potassium	ND	0.200								
Selenium	ND	0.00200								
Silver	ND	0.00200								
Sodium	ND	0.200								
Strontium	ND	0.00500								
Thallium	ND	0.00200								
Vanadium	ND	0.00500								
Zinc	ND	0.00400								

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: 132544 **Instrument:** ICPMS05 **Method:** SW6020

LCS Sample ID: **LCS-132544** Units: **mg/L** Analysis Date: **19-Sep-2018 16:15**

Client ID: Run ID: **ICPMS05_323685** SeqNo: **4733062** PrepDate: **18-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Aluminum	0.1086	0.0100	0.1	0	109	80 - 120				
Antimony	0.04879	0.00200	0.05	0	97.6	80 - 120				
Arsenic	0.05053	0.00200	0.05	0	101	80 - 120				
Beryllium	0.0526	0.00200	0.05	0	105	80 - 120				
Cadmium	0.04986	0.00200	0.05	0	99.7	80 - 120				
Calcium	5.067	0.500	5	0	101	80 - 120				
Chromium	0.05045	0.00400	0.05	0	101	80 - 120				
Copper	0.05116	0.00200	0.05	0	102	80 - 120				
Iron	5.14	0.200	5	0	103	80 - 120				
Lead	0.05247	0.00200	0.05	0	105	80 - 120				
Magnesium	5.029	0.200	5	0	101	80 - 120				
Manganese	0.05067	0.00500	0.05	0	101	80 - 120				
Nickel	0.05206	0.00200	0.05	0	104	80 - 120				
Potassium	4.943	0.200	5	0	98.9	80 - 120				
Selenium	0.05168	0.00200	0.05	0	103	80 - 120				
Silver	0.04639	0.00200	0.05	0	92.8	80 - 120				
Sodium	5.181	0.200	5	0	104	80 - 120				
Strontium	0.1002	0.00500	0.1	0	100	80 - 120				
Thallium	0.04434	0.00200	0.05	0	88.7	80 - 120				
Vanadium	0.04999	0.00500	0.05	0	100.0	80 - 120				
Zinc	0.05019	0.00400	0.05	0	100	80 - 120				

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: **132544** **Instrument:** **ICPMS05** **Method:** **SW6020**

MS Sample ID: **HS18090696-01MS** Units: **mg/L** Analysis Date: **20-Sep-2018 12:55**
Client ID: Run ID: **ICPMS05_323782** SeqNo: **4733827** PrepDate: **18-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Aluminum	0.1616	0.0100	0.1	0.02722	134	80 - 120				S
Antimony	0.04843	0.00200	0.05	0.000042	96.8	80 - 120				
Arsenic	0.05341	0.00200	0.05	0.00287	101	80 - 120				
Beryllium	0.04893	0.00200	0.05	0.000011	97.8	80 - 120				
Cadmium	0.04981	0.00200	0.05	0.000013	99.6	80 - 120				
Calcium	203	0.500	5	201.2	35.8	80 - 120				SEO
Chromium	0.05014	0.00400	0.05	0.000492	99.3	80 - 120				
Iron	6.64	0.200	5	1.606	101	80 - 120				
Lead	0.04556	0.00200	0.05	0.000022	91.1	80 - 120				
Magnesium	28.7	0.200	5	24.26	88.7	80 - 120				O
Manganese	0.444	0.00500	0.05	0.3852	118	80 - 120				O
Nickel	0.04975	0.00200	0.05	0.00078	97.9	80 - 120				
Potassium	6.655	0.200	5	1.771	97.7	80 - 120				
Selenium	0.05095	0.00200	0.05	-0.000008	102	80 - 120				
Silver	0.04681	0.00200	0.05	0.000007	93.6	80 - 120				
Sodium	328.7	0.200	5	324.3	87.5	80 - 120				EO
Strontium	1.378	0.00500	0.1	1.242	135	80 - 120				SO
Thallium	0.04463	0.00200	0.05	0.000013	89.2	80 - 120				
Vanadium	0.05019	0.00500	0.05	-0.000666	102	80 - 120				
Zinc	0.05223	0.00400	0.05	0.002442	99.6	80 - 120				

MS Sample ID: **HS18090696-01MS** Units: **mg/L** Analysis Date: **20-Sep-2018 16:46**
Client ID: Run ID: **ICPMS05_323782** SeqNo: **4734356** PrepDate: **18-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Copper	0.04792	0.00200	0.05	0	95.8	80 - 120				

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: 132544 **Instrument: ICPMS05** **Method: SW6020**

MSD Sample ID: **HS18090696-01MSD** Units: **mg/L** Analysis Date: **20-Sep-2018 12:57**
Client ID: Run ID: **ICPMS05_323782** SeqNo: **4733828** PrepDate: **18-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Aluminum	0.1618	0.0100	0.1	0.02722	135	80 - 120	0.1616	0.116	20	S
Antimony	0.04814	0.00200	0.05	0.000042	96.2	80 - 120	0.04843	0.596	20	
Arsenic	0.05286	0.00200	0.05	0.00287	100.0	80 - 120	0.05341	1.03	20	
Beryllium	0.04844	0.00200	0.05	0.000011	96.9	80 - 120	0.04893	0.996	20	
Cadmium	0.0493	0.00200	0.05	0.000013	98.6	80 - 120	0.04981	1.02	20	
Calcium	202.7	0.500	5	201.2	29.1	80 - 120	203	0.165	20	SEO
Chromium	0.04969	0.00400	0.05	0.000492	98.4	80 - 120	0.05014	0.904	20	
Iron	6.559	0.200	5	1.606	99.1	80 - 120	6.64	1.23	20	
Lead	0.04494	0.00200	0.05	0.000022	89.8	80 - 120	0.04556	1.37	20	
Magnesium	28.5	0.200	5	24.26	84.7	80 - 120	28.7	0.689	20	O
Manganese	0.4363	0.00500	0.05	0.3852	102	80 - 120	0.444	1.75	20	O
Nickel	0.05049	0.00200	0.05	0.00078	99.4	80 - 120	0.04975	1.48	20	
Potassium	6.537	0.200	5	1.771	95.3	80 - 120	6.655	1.79	20	
Selenium	0.05138	0.00200	0.05	-0.000008	103	80 - 120	0.05095	0.848	20	
Silver	0.04517	0.00200	0.05	0.000007	90.3	80 - 120	0.04681	3.57	20	
Sodium	322.9	0.200	5	324.3	-27.7	80 - 120	328.7	1.77	20	SEO
Strontium	1.325	0.00500	0.1	1.242	82.2	80 - 120	1.378	3.92	20	O
Thallium	0.04536	0.00200	0.05	0.000013	90.7	80 - 120	0.04463	1.63	20	
Vanadium	0.04918	0.00500	0.05	-0.000666	99.7	80 - 120	0.05019	2.03	20	
Zinc	0.05097	0.00400	0.05	0.002442	97.1	80 - 120	0.05223	2.45	20	

MSD Sample ID: **HS18090696-01MSD** Units: **mg/L** Analysis Date: **20-Sep-2018 16:48**
Client ID: Run ID: **ICPMS05_323782** SeqNo: **4734357** PrepDate: **18-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Copper	0.04835	0.00200	0.05	0	96.7	80 - 120	0.04792	0.889	20	

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: **132544** **Instrument:** **ICPMS05** **Method:** **SW6020**

PDS Sample ID: **HS18090696-01PDS** Units: **mg/L** Analysis Date: **20-Sep-2018 12:59**
Client ID: Run ID: **ICPMS05_323782** SeqNo: **4733829** PrepDate: **18-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Aluminum	0.1292	0.0100	0.1	0.02722	102	75 - 125				
Antimony	0.08591	0.00200	0.1	0.000042	85.9	75 - 125				
Arsenic	0.09942	0.00200	0.1	0.00287	96.5	75 - 125				
Beryllium	0.09755	0.00200	0.1	0.000011	97.5	75 - 125				
Cadmium	0.09369	0.00200	0.1	0.000013	93.7	75 - 125				
Chromium	0.09666	0.00400	0.1	0.000492	96.2	75 - 125				
Iron	11.12	0.200	10	1.606	95.2	75 - 125				
Lead	0.08764	0.00200	0.1	0.000022	87.6	75 - 125				
Magnesium	32.11	0.200	10	24.26	78.5	75 - 125				
Manganese	0.4676	0.00500	0.1	0.3852	82.4	75 - 125				
Nickel	0.09552	0.00200	0.1	0.00078	94.7	75 - 125				
Potassium	11.38	0.200	10	1.771	96.1	75 - 125				
Selenium	0.09773	0.00200	0.1	-0.000008	97.7	75 - 125				
Silver	0.08738	0.00200	0.1	0.000007	87.4	75 - 125				
Strontium	1.313	0.00500	0.1	1.242	70.9	75 - 125				SO
Thallium	0.09714	0.00200	0.1	0.000013	97.1	75 - 125				
Vanadium	0.0956	0.00500	0.1	-0.000666	96.3	75 - 125				
Zinc	0.09658	0.00400	0.1	0.002442	94.1	75 - 125				

PDS Sample ID: **HS18090696-01PDS** Units: **mg/L** Analysis Date: **19-Sep-2018 16:37**
Client ID: Run ID: **ICPMS05_323685** SeqNo: **4733073** PrepDate: **18-Sep-2018** DF: **10**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Calcium	283.5	5.00	100	192.7	90.8	75 - 125				
Sodium	386.1	2.00	100	328.6	57.5	75 - 125				S

PDS Sample ID: **HS18090696-01PDS** Units: **mg/L** Analysis Date: **20-Sep-2018 16:50**
Client ID: Run ID: **ICPMS05_323782** SeqNo: **4734358** PrepDate: **18-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Copper	0.09261	0.00200	0.1	0	92.6	75 - 125				

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: **132544** **Instrument:** **ICPMS05** **Method:** **SW6020**

SD Sample ID: **HS18090696-01SD** Units: **mg/L** Analysis Date: **20-Sep-2018 12:53**
Client ID: Run ID: **ICPMS05_323782** SeqNo: **4733826** PrepDate: **18-Sep-2018** DF: **5**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%D	%D Limit	Qual
Aluminum	0.03161	0.0500					0.02722	0	10	J
Antimony	ND	0.0100					0.000042	0	10	
Arsenic	0.002326	0.0100					0.00287	0	10	J
Beryllium	ND	0.0100					0.000011	0	10	
Cadmium	ND	0.0100					0.000013	0	10	
Chromium	ND	0.0200					0.000492	0	10	
Iron	1.638	1.00					1.606	2.02	10	
Lead	ND	0.0100					0.000022	0	10	
Magnesium	24.72	1.00					24.26	1.88	10	
Manganese	0.3735	0.0250					0.3852	3.04	10	
Nickel	ND	0.0100					0.00078	0	10	
Selenium	ND	0.0100					-0.000008	0	10	
Silver	ND	0.0100					0.000007	0	10	
Strontium	1.304	0.0250					1.242	4.96	10	
Thallium	ND	0.0100					0.000013	0	10	
Vanadium	ND	0.0250					-0.000666	0	10	
Zinc	ND	0.0200					0.002442	0	10	

SD Sample ID: **HS18090696-01SD** Units: **mg/L** Analysis Date: **19-Sep-2018 16:31**
Client ID: Run ID: **ICPMS05_323685** SeqNo: **4733070** PrepDate: **18-Sep-2018** DF: **50**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%D	%D Limit	Qual
Calcium	205.6	25.0					192.7	6.67	10	
Sodium	338.7	10.0					328.6	3.09	10	

SD Sample ID: **HS18090696-01SD** Units: **mg/L** Analysis Date: **20-Sep-2018 16:44**
Client ID: Run ID: **ICPMS05_323782** SeqNo: **4734355** PrepDate: **18-Sep-2018** DF: **5**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%D	%D Limit	Qual
Copper	ND	0.0100					-0.000139	0	10	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: 132765 **Instrument:** ICPMS05 **Method:** E200.8 (dissolved) (DISSOLVED)

MBLK Sample ID: **MBLK-132765** Units: **ug/L** Analysis Date: **28-Sep-2018 12:54**
Client ID: Run ID: **ICPMS05_324340** SeqNo: **4746851** PrepDate: **24-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Iron	ND	200								
Manganese	ND	5.00								

LCS Sample ID: **LCS-132765** Units: **ug/L** Analysis Date: **28-Sep-2018 12:50**
Client ID: Run ID: **ICPMS05_324340** SeqNo: **4746849** PrepDate: **24-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Iron	4922	200	5000	0	98.4	85 - 115				
Manganese	48.32	5.00	50	0	96.6	85 - 115				

MS Sample ID: **HS18090667-01MS** Units: **ug/L** Analysis Date: **28-Sep-2018 13:00**
Client ID: **NBU-AW01 Upper** Run ID: **ICPMS05_324340** SeqNo: **4746854** PrepDate: **24-Sep-2018** DF: **5**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Iron	4944	1000	5000	18.2	98.5	85 - 115				
Manganese	51.84	25.0	50	4.494	94.7	85 - 115				

MSD Sample ID: **HS18090667-01MSD** Units: **ug/L** Analysis Date: **28-Sep-2018 13:04**
Client ID: **NBU-AW01 Upper** Run ID: **ICPMS05_324340** SeqNo: **4746856** PrepDate: **24-Sep-2018** DF: **5**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Iron	4966	1000	5000	18.2	99.0	85 - 115	4944	0.445	20	
Manganese	52.63	25.0	50	4.494	96.3	85 - 115	51.84	1.53	20	

PDS Sample ID: **HS18090667-01PDS** Units: **ug/L** Analysis Date: **28-Sep-2018 13:06**
Client ID: **NBU-AW01 Upper** Run ID: **ICPMS05_324340** SeqNo: **4746857** PrepDate: **24-Sep-2018** DF: **5**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Iron	47930	1000	50000	0	95.9	75 - 125				
Manganese	469.8	25.0	500	4.494	93.1	75 - 125				

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: 132765 **Instrument:** ICPMS05 **Method:** E200.8 (dissolved) (DISSOLVED)

SD Sample ID: **HS18090667-01SD** Units: **ug/L** Analysis Date: **28-Sep-2018 12:58**

Client ID: **NBU-AW01 Upper** Run ID: **ICPMS05_324340** SeqNo: **4746853** PrepDate: **24-Sep-2018** DF: **25**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%D	%D Limit	Qual
Iron	ND	5000					18.2	0	10	
Manganese	6.752	125					4.494	0	10	J

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: 132612 **Instrument:** UV-2450 **Method:** SM4500 NH3-B-F

MBLK Sample ID: **MBLK-132612** Units: **mg/L** Analysis Date: **20-Sep-2018 13:40**
Client ID: Run ID: **UV-2450_323808** SeqNo: **4734017** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Ammonia (as N)	ND	0.050								

LCS Sample ID: **LCS-132612** Units: **mg/L** Analysis Date: **20-Sep-2018 13:40**
Client ID: Run ID: **UV-2450_323808** SeqNo: **4734015** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Ammonia (as N)	0.565	0.050	0.5	0	113	85 - 115				

LCSD Sample ID: **LCSD-132612** Units: **mg/L** Analysis Date: **20-Sep-2018 13:40**
Client ID: Run ID: **UV-2450_323808** SeqNo: **4734016** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Ammonia (as N)	0.557	0.050	0.5	0	111	85 - 115	0.565	1.43	20	

MS Sample ID: **HS18090614-06MS** Units: **mg/L** Analysis Date: **20-Sep-2018 13:40**
Client ID: Run ID: **UV-2450_323808** SeqNo: **4734013** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Ammonia (as N)	0.58	0.050	0.5	0.066	103	80 - 120				

MSD Sample ID: **HS18090614-06MSD** Units: **mg/L** Analysis Date: **20-Sep-2018 13:40**
Client ID: Run ID: **UV-2450_323808** SeqNo: **4734014** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Ammonia (as N)	0.559	0.050	0.5	0.066	98.6	80 - 120	0.58	3.69	20	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: 132630 **Instrument:** WetChem_HS **Method:** M4500 NH3 D

MBLK Sample ID: **MBLK-132630** Units: **mg/L** Analysis Date: **20-Sep-2018 11:00**
Client ID: Run ID: **WetChem_HS_323781** SeqNo: **4733396** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Total Kjeldahl	ND	0.50								

LCS Sample ID: **LCS-132630** Units: **mg/L** Analysis Date: **20-Sep-2018 11:00**
Client ID: Run ID: **WetChem_HS_323781** SeqNo: **4733394** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Total Kjeldahl	19.43	0.50	20	0	97.2	85 - 115				

LCSD Sample ID: **LCSD-132630** Units: **mg/L** Analysis Date: **20-Sep-2018 11:00**
Client ID: Run ID: **WetChem_HS_323781** SeqNo: **4733395** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Total Kjeldahl	20.04	0.50	20	0	100	85 - 115	19.43	3.09	20	

MS Sample ID: **HS18090614-06MS** Units: **mg/L** Analysis Date: **20-Sep-2018 11:00**
Client ID: Run ID: **WetChem_HS_323781** SeqNo: **4733392** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Total Kjeldahl	19.87	0.50	20	0.3432	97.6	75 - 125				

MSD Sample ID: **HS18090614-06MSD** Units: **mg/L** Analysis Date: **20-Sep-2018 11:00**
Client ID: Run ID: **WetChem_HS_323781** SeqNo: **4733393** PrepDate: **19-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Nitrogen, Total Kjeldahl	19.64	0.50	20	0.3432	96.5	75 - 125	19.87	1.18	20	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: 132647 **Instrument: UV-2450** **Method: E365.3**

MBLK Sample ID: **MBLK-132647** Units: **mg/L** Analysis Date: **20-Sep-2018 15:15**
Client ID: Run ID: **UV-2450_323816** SeqNo: **4734132** PrepDate: **20-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Phosphorus, Total (As P)	ND	0.0500								

LCS Sample ID: **LCS-132647** Units: **mg/L** Analysis Date: **20-Sep-2018 15:15**
Client ID: Run ID: **UV-2450_323816** SeqNo: **4734130** PrepDate: **20-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Phosphorus, Total (As P)	0.243	0.0500	0.25	0	97.2	80 - 120				

LCSD Sample ID: **LCSD-132647** Units: **mg/L** Analysis Date: **20-Sep-2018 15:15**
Client ID: Run ID: **UV-2450_323816** SeqNo: **4734131** PrepDate: **20-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Phosphorus, Total (As P)	0.242	0.0500	0.25	0	96.8	80 - 120	0.243	0.412	20	

MS Sample ID: **HS18090894-02MS** Units: **mg/L** Analysis Date: **20-Sep-2018 15:15**
Client ID: Run ID: **UV-2450_323816** SeqNo: **4734128** PrepDate: **20-Sep-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Phosphorus, Total (As P)	0.238	0.0500	0.25	0.006	92.8	80 - 120				

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R323700 **Instrument:** ICS2100 **Method:** E300

MBLK Sample ID: **WBLKW2-091418** Units: **mg/L** Analysis Date: **15-Sep-2018 01:39**
Client ID: Run ID: **ICS2100_323700** SeqNo: **4731910** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Chloride	ND	0.500								
Fluoride	ND	0.100								
Nitrogen, Nitrate (As N)	ND	0.100								
Phosphorus, Dissolved Orthophosphate (As P)	ND	0.100								
Sulfate	ND	0.500								

LCS Sample ID: **WLCSW2-091418** Units: **mg/L** Analysis Date: **15-Sep-2018 01:54**
Client ID: Run ID: **ICS2100_323700** SeqNo: **4731911** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Chloride	20.57	0.500	20	0	103	90 - 110				
Fluoride	4.195	0.100	4	0	105	90 - 110				
Nitrogen, Nitrate (As N)	4.049	0.100	4	0	101	90 - 110				
Phosphorus, Dissolved Orthophosphate (As P)	3.935	0.100	4	0	98.4	90 - 110				
Sulfate	19.88	0.500	20	0	99.4	90 - 110				

LCSD Sample ID: **WLCSDW2-091418** Units: **mg/L** Analysis Date: **15-Sep-2018 02:08**
Client ID: Run ID: **ICS2100_323700** SeqNo: **4731912** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Chloride	21.71	0.500	20	0	109	90 - 110	20.57	5.36	20	
Fluoride	4.396	0.100	4	0	110	90 - 110	4.195	4.68	20	
Nitrogen, Nitrate (As N)	4.234	0.100	4	0	106	90 - 110	4.049	4.47	20	
Phosphorus, Dissolved Orthophosphate (As P)	4.084	0.100	4	0	102	90 - 110	3.935	3.72	20	
Sulfate	20.85	0.500	20	0	104	90 - 110	19.88	4.74	20	

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R323700 **Instrument:** ICS2100 **Method:** E300

MS Sample ID: **HS18090693-01MS** Units: **mg/L** Analysis Date: **15-Sep-2018 03:21**
Client ID: Run ID: **ICS2100_323700** SeqNo: **4731917** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Chloride	11.06	0.500	10	0.71	103	80 - 120				
Fluoride	2.15	0.100	2	0.046	105	80 - 120				
Nitrogen, Nitrate (As N)	2.016	0.100	2	0.079	96.8	80 - 120				
Phosphorus, Dissolved Orthophosphate (As P)	1.828	0.100	2	0	91.4	80 - 120				
Sulfate	11.24	0.500	10	1.359	98.8	80 - 120				

MS Sample ID: **HS18090689-01MS** Units: **mg/L** Analysis Date: **15-Sep-2018 02:37**
Client ID: Run ID: **ICS2100_323700** SeqNo: **4731914** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Chloride	37.67	0.500	10	27.56	101	80 - 120				
Fluoride	2.163	0.100	2	0.083	104	80 - 120				
Nitrogen, Nitrate (As N)	2.573	0.100	2	0.621	97.6	80 - 120				
Phosphorus, Dissolved Orthophosphate (As P)	1.792	0.100	2	0	89.6	80 - 120				
Sulfate	26.53	0.500	10	15.89	106	80 - 120				

MSD Sample ID: **HS18090693-01MSD** Units: **mg/L** Analysis Date: **15-Sep-2018 03:35**
Client ID: Run ID: **ICS2100_323700** SeqNo: **4731918** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Chloride	10.94	0.500	10	0.71	102	80 - 120	11.06	1.06	20	
Fluoride	2.108	0.100	2	0.046	103	80 - 120	2.15	1.97	20	
Nitrogen, Nitrate (As N)	1.974	0.100	2	0.079	94.8	80 - 120	2.016	2.11	20	
Phosphorus, Dissolved Orthophosphate (As P)	1.805	0.100	2	0	90.2	80 - 120	1.828	1.27	20	
Sulfate	11.46	0.500	10	1.359	101	80 - 120	11.24	1.91	20	

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: **R323700** **Instrument:** **ICS2100** **Method:** **E300**

MSD Sample ID: **HS18090689-01MSD** Units: **mg/L** Analysis Date: **15-Sep-2018 02:52**

Client ID: Run ID: **ICS2100_323700** SeqNo: **4731915** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Chloride	36.57	0.500	10	27.56	90.1	80 - 120	37.67	2.95	20	
Fluoride	2.097	0.100	2	0.083	101	80 - 120	2.163	3.1	20	
Nitrogen, Nitrate (As N)	2.494	0.100	2	0.621	93.6	80 - 120	2.573	3.12	20	
Phosphorus, Dissolved Orthophosphate (As P)	1.783	0.100	2	0	89.2	80 - 120	1.792	0.503	20	
Sulfate	25.24	0.500	10	15.89	93.6	80 - 120	26.53	4.95	20	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: **R323714** **Instrument:** **WetChem_HS** **Method:** **SM4500H+ B**

DUP Sample ID: **HS18090822-01DUP** Units: **pH Units** Analysis Date: **19-Sep-2018 13:35**

Client ID: Run ID: **WetChem_HS_323714** SeqNo: **4732140** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
pH	7.51	0.100					7.49	0.267	10	
Temp Deg C @pH	21.9	0					21.8	0.458	10	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R323733 **Instrument:** Balance1 **Method:** M2540C

MBLK Sample ID: **WBLK-091818** Units: **mg/L** Analysis Date: **18-Sep-2018 16:50**
Client ID: Run ID: **Balance1_323733** SeqNo: **4732541** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Total Dissolved Solids (Residue, Filterable)	ND	10.0								

LCS Sample ID: **WLCS-091818** Units: **mg/L** Analysis Date: **18-Sep-2018 16:50**
Client ID: Run ID: **Balance1_323733** SeqNo: **4732542** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Total Dissolved Solids (Residue, Filterable)	1004	10.0	1000	0	100	85 - 115				

DUP Sample ID: **HS18090769-02DUP** Units: **mg/L** Analysis Date: **18-Sep-2018 16:50**
Client ID: Run ID: **Balance1_323733** SeqNo: **4733897** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Total Dissolved Solids (Residue, Filterable)	276	10.0					278	0.722	5	

DUP Sample ID: **HS18090533-01DUP** Units: **mg/L** Analysis Date: **18-Sep-2018 16:50**
Client ID: Run ID: **Balance1_323733** SeqNo: **4732536** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Total Dissolved Solids (Residue, Filterable)	742	10.0					758	2.13	5	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R323736 **Instrument:** ManTech01 **Method:** SM2320B

MBLK Sample ID: **WBLKW1-180918** Units: **mg/L** Analysis Date: **18-Sep-2018 20:50**
Client ID: Run ID: **ManTech01_323736** SeqNo: **4732557** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Alkalinity, Bicarbonate (As CaCO3)	ND	5.00								
Alkalinity, Carbonate (As CaCO3)	ND	5.00								
Alkalinity, Hydroxide (As CaCO3)	ND	5.00								
Alkalinity, Total (As CaCO3)	ND	5.00								

LCS Sample ID: **WLCS1-180918** Units: **mg/L** Analysis Date: **18-Sep-2018 20:58**
Client ID: Run ID: **ManTech01_323736** SeqNo: **4732558** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Alkalinity, Carbonate (As CaCO3)	1056	5.00	1000	0	106	85 - 115				
Alkalinity, Total (As CaCO3)	1081	5.00	1000	0	108	85 - 115				

LCSD Sample ID: **WLCSD1-180918** Units: **mg/L** Analysis Date: **18-Sep-2018 21:07**
Client ID: Run ID: **ManTech01_323736** SeqNo: **4732559** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Alkalinity, Carbonate (As CaCO3)	1053	5.00	1000	0	105	85 - 115	1056	0.237	20	
Alkalinity, Total (As CaCO3)	1077	5.00	1000	0	108	85 - 115	1081	0.394	20	

DUP Sample ID: **HS18090845-01DUP** Units: **mg/L** Analysis Date: **18-Sep-2018 21:31**
Client ID: Run ID: **ManTech01_323736** SeqNo: **4732563** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Alkalinity, Bicarbonate (As CaCO3)	467.7	5.00					463.9	0.811	20	
Alkalinity, Carbonate (As CaCO3)	ND	5.00					0	0	20	
Alkalinity, Hydroxide (As CaCO3)	ND	5.00					0	0	20	
Alkalinity, Total (As CaCO3)	467.7	5.00					463.9	0.811	20	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R323948 **Instrument:** WetChem_HS **Method:** M2510 B

MBLK Sample ID: **MBLK-R323948** Units: **umhos/cm** Analysis Date: **22-Sep-2018 18:00**
Client ID: Run ID: **WetChem_HS_323948** SeqNo: **4736943** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Specific Conductivity	ND	5.00								

LCS Sample ID: **LCS-R323948** Units: **umhos/cm** Analysis Date: **22-Sep-2018 18:00**
Client ID: Run ID: **WetChem_HS_323948** SeqNo: **4736942** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Specific Conductivity	1424	5.00	1413	0	101	80 - 120				

DUP Sample ID: **HS18090667-01DUP** Units: **umhos/cm** Analysis Date: **22-Sep-2018 18:00**
Client ID: **NBU-AW01 Upper** Run ID: **WetChem_HS_323948** SeqNo: **4736944** PrepDate: DF: **2**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Specific Conductivity	14040	10.0					14040	0	20	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R324086 **Instrument:** ICS2100 **Method:** E300

MBLK Sample ID: **WBLKW1-092418** Units: **mg/L** Analysis Date: **24-Sep-2018 16:37**
Client ID: Run ID: **ICS2100_324086** SeqNo: **4740003** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Bromide	ND	0.100								

LCS Sample ID: **WLCSW1-092418** Units: **mg/L** Analysis Date: **24-Sep-2018 17:14**
Client ID: Run ID: **ICS2100_324086** SeqNo: **4740004** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Bromide	3.683	0.100	4	0	92.1	90 - 110				

LCSD Sample ID: **WLCSDW1-092418** Units: **mg/L** Analysis Date: **24-Sep-2018 17:28**
Client ID: Run ID: **ICS2100_324086** SeqNo: **4740005** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Bromide	3.671	0.100	4	0	91.8	90 - 110	3.683	0.326	20	

MS Sample ID: **HS18091182-01MS** Units: **mg/L** Analysis Date: **24-Sep-2018 17:57**
Client ID: Run ID: **ICS2100_324086** SeqNo: **4740007** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Bromide	1.635	0.100	2	0	81.8	80 - 120				

MS Sample ID: **HS18091134-01MS** Units: **mg/L** Analysis Date: **24-Sep-2018 21:35**
Client ID: Run ID: **ICS2100_324086** SeqNo: **4740022** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Bromide	1.873	0.100	2	0.158	85.8	80 - 120				

MSD Sample ID: **HS18091182-01MSD** Units: **mg/L** Analysis Date: **24-Sep-2018 18:12**
Client ID: Run ID: **ICS2100_324086** SeqNo: **4740008** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Bromide	1.554	0.100	2	0	77.7	80 - 120	1.635	5.08	20	S

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R324086 **Instrument:** ICS2100 **Method:** E300

MSD Sample ID: **HS18091134-01MSD** Units: **mg/L** Analysis Date: **24-Sep-2018 21:50**

Client ID: Run ID: **ICS2100_324086** SeqNo: **4740023** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Bromide	1.856	0.100	2	0.158	84.9	80 - 120	1.873	0.912	20	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: **R324197** **Instrument:** **TOC_02** **Method:** **SW9060**

MBLK Sample ID: **MBLK-R324197** Units: **mg/L** Analysis Date: **26-Sep-2018 16:29**
Client ID: Run ID: **TOC_02_324197** SeqNo: **4742281** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Dissolved Inorganic Carbon	ND	1.0								

LCS Sample ID: **LCS-R324197** Units: **mg/L** Analysis Date: **26-Sep-2018 16:29**
Client ID: Run ID: **TOC_02_324197** SeqNo: **4742280** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Dissolved Inorganic Carbon	9.941	1.0	10	0	99.4	80 - 120				

LCSD Sample ID: **LCSD-R324197** Units: **mg/L** Analysis Date: **26-Sep-2018 16:29**
Client ID: Run ID: **TOC_02_324197** SeqNo: **4742279** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Dissolved Inorganic Carbon	10.01	1.0	10	0	100	80 - 120	9.941	0.692	20	

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R324198 **Instrument:** TOC_02 **Method:** SW9060

MBLK Sample ID: **WBLKW1-180922** Units: **mg/L** Analysis Date: **22-Sep-2018 18:40**
Client ID: Run ID: **TOC_02_324198** SeqNo: **4742308** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon, Total	ND	1.00								

LCS Sample ID: **WLCSW1-180922** Units: **mg/L** Analysis Date: **22-Sep-2018 18:56**
Client ID: Run ID: **TOC_02_324198** SeqNo: **4742309** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon, Total	9.373	1.00	10	0	93.7	85 - 115				

LCSD Sample ID: **WLCSDW1-180922** Units: **mg/L** Analysis Date: **22-Sep-2018 19:11**
Client ID: Run ID: **TOC_02_324198** SeqNo: **4742310** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon, Total	9.423	1.00	10	0	94.2	85 - 115	9.373	0.532	20	

MS Sample ID: **HS18090667-01MS** Units: **mg/L** Analysis Date: **22-Sep-2018 19:43**
Client ID: **NBU-AW01 Upper** Run ID: **TOC_02_324198** SeqNo: **4742312** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon, Total	9.979	1.00	10	0.5715	94.1	80 - 120				

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R324199 **Instrument:** TOC_02 **Method:** SW9060 (dissolved) (DISSOLVED)

MBLK Sample ID: **WBLKW1-180922** Units: **mg/L** Analysis Date: **22-Sep-2018 20:32**
Client ID: Run ID: **TOC_02_324199** SeqNo: **4742329** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon, Dissolved	ND	1.00								

LCS Sample ID: **WLCSW1-180922** Units: **mg/L** Analysis Date: **22-Sep-2018 20:49**
Client ID: Run ID: **TOC_02_324199** SeqNo: **4742330** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon, Dissolved	9.475	1.00	10	0	94.8	85 - 115				

LCSD Sample ID: **WLCSDW1-180922** Units: **mg/L** Analysis Date: **22-Sep-2018 21:04**
Client ID: Run ID: **TOC_02_324199** SeqNo: **4742331** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon, Dissolved	9.432	1.00	10	0	94.3	85 - 115	9.475	0.455	20	

MS Sample ID: **HS18090667-01MS** Units: **mg/L** Analysis Date: **22-Sep-2018 21:37**
Client ID: **NBU-AW01 Upper** Run ID: **TOC_02_324199** SeqNo: **4742333** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon, Dissolved	9.709	1.00	10	0.502	92.1	85 - 115				

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
WorkOrder: HS18090667

QC BATCH REPORT

Batch ID: R324332 **Instrument:** TOC_02 **Method:** SW9060 (dissolved) (DISSOLVED)

MBLK Sample ID: **WBLKW1-180925** Units: **mg/L** Analysis Date: **25-Sep-2018 21:03**
Client ID: Run ID: **TOC_02_324332** SeqNo: **4745710** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Total Carbon, Dissolved	ND	1.00								

LCS Sample ID: **WLCSW1-180925** Units: **mg/L** Analysis Date: **25-Sep-2018 21:16**
Client ID: Run ID: **TOC_02_324332** SeqNo: **4745711** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Total Carbon, Dissolved	9.941	1.00	10	0	99.4	85 - 115				

LCSD Sample ID: **WLCSDW1-180925** Units: **mg/L** Analysis Date: **25-Sep-2018 21:27**
Client ID: Run ID: **TOC_02_324332** SeqNo: **4745712** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Total Carbon, Dissolved	10.01	1.00	10	0	100	85 - 115	9.941	0.692	20	

MS Sample ID: **HS18090667-01MS** Units: **mg/L** Analysis Date: **25-Sep-2018 21:49**
Client ID: **NBU-AW01 Upper** Run ID: **TOC_02_324332** SeqNo: **4745714** PrepDate: DF: **5**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Total Carbon, Dissolved	108	5.00	50	74.05	67.9	85 - 115				S

The following samples were analyzed in this batch: HS18090667-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client:	INTERA Inc.	**QUALIFIERS, ACRONYMS, UNITS**
Project:	EAA/NBU Water Quality Sampling Plan	
WorkOrder:	**HS18090667**	

Qualifier	Description
*	Value exceeds Regulatory Limit
a	Not accredited
B	Analyte detected in the associated Method Blank above the Reporting Limit
E	Value above quantitation range
H	Analyzed outside of Holding Time
J	Analyte detected below quantitation limit
M	Manually integrated, see raw data for justification
n	Not offered for accreditation
ND	Not Detected at the Reporting Limit
O	Sample amount is > 4 times amount spiked
P	Dual Column results percent difference > 40%
R	RPD above laboratory control limit
S	Spike Recovery outside laboratory control limits
U	Analyzed but not detected above the MDL/SDL

Acronym	Description
DCS	Detectability Check Study
DUP	Method Duplicate
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MBLK	Method Blank
MDL	Method Detection Limit
MQL	Method Quantitation Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PDS	Post Digestion Spike
PQL	Practical Quantitaion Limit
SD	Serial Dilution
SDL	Sample Detection Limit
TRRP	Texas Risk Reduction Program

CERTIFICATIONS,ACCREDITATIONS & LICENSES

Agency	Number	Expire Date
North Carolina	624-2018	31-Dec-2018
Arkansas	88-0356	27-Mar-2019
Texas	T10470231-18-21	30-Apr-2019
North Dakota	R193 2018-2019	30-Apr-2019
Illinois	004438	29-Jun-2019
Louisiana	03087	30-Jun-2019
Dept of Defense	ANAB L2231	22-Dec-2018
Kentucky	123043 - 2018	30-Apr-2019
Kansas	E-10352 2018-2019	31-Jul-2019
Oklahoma	2018-156	31-Aug-2019

Client: INTERA Inc.
Project: EAA/NBU Water Quality Sampling Plan
Work Order: HS18090667

SAMPLE TRACKING

Lab Samp ID	Client Sample ID	Action	Date	Person	New Location
HS18090667-01	NBU-AW01 Upper	Login	9/14/2018 1:28:26 PM	RPG	WET231
HS18090667-01	NBU-AW01 Upper	Login	9/14/2018 1:28:26 PM	RPG	WET231
HS18090667-01	NBU-AW01 Upper	Login	9/14/2018 1:28:26 PM	RPG	MET093
HS18090667-01	NBU-AW01 Upper	Login	9/14/2018 1:28:26 PM	RPG	MET093
HS18090667-01	NBU-AW01 Upper	Login	9/14/2018 1:28:26 PM	RPG	MET093
HS18090667-01	NBU-AW01 Upper	Login	9/14/2018 1:28:26 PM	RPG	WET231
HS18090667-01	NBU-AW01 Upper	Login	9/14/2018 1:28:26 PM	RPG	WET231
HS18090667-01	NBU-AW01 Upper	Login	9/14/2018 1:28:26 PM	RPG	WET231

Sample Receipt Checklist

Client Name:	Intera-AUS	Date/Time Received:	**14-Sep-2018 08:46**
Work Order:	HS18090667	Received by:	**RPG**

Checklist completed by:	*Raegen Giga* (eSignature)	14-Sep-2018 (Date)	Reviewed by:	*RJ Modashia* (eSignature)	14-Sep-2018 (Date)

Matrices: **Water** Carrier name: **FedEx Priority Overnight**

	Yes	No	Not Present / N/A
Shipping container/cooler in good condition?	☑	☐	Not Present ☐
Custody seals intact on shipping container/cooler?	☑	☐	Not Present ☐
Custody seals intact on sample bottles?	☐	☐	Not Present ☑
Chain of custody present?	☑	☐	
Chain of custody signed when relinquished and received?	☑	☐	
Chain of custody agrees with sample labels?	☐	☑	
Samples in proper container/bottle?	☑	☐	
Sample containers intact?	☑	☐	
TX1005 solids received in hermetically sealed vials?	☐	☐	N/A ☑
Sufficient sample volume for indicated test?	☑	☐	
All samples received within holding time?	☑	☐	
Container/Temp Blank temperature in compliance?	☑	☐	
Temperature(s)/Thermometer(s):	2.8c/2.4c uc/c		IR 11
Cooler(s)/Kit(s):	43348		
Date/Time sample(s) sent to storage:	09/14/2018 13:57		
Water - VOA vials have zero headspace?	☑	☐	No VOA vials submitted ☐
Water - pH acceptable upon receipt?	☑	☐	N/A ☐
pH adjusted?	☐	☑	N/A ☐
pH adjusted by:			

Login Notes: Trip Blank Placed on Hold, not indicated on COC

Client Contacted: Date Contacted: Person Contacted:

Contacted By: Regarding:

Comments:

Corrective Action:

ALS

Cincinnati, OH +1 513 733 5336
Fort Collins, CO +1 970 490 1511
Everett, WA +1 425 356 2600
Holland, MI +1 616 399 6070

Chain of Custody Fori

Page _____ of _____

COC ID: 188281

HS18090667
INTERA Inc.
EAA/NBU Water Quality Sampling Plan

n, WV
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ALS Project Manager:

Customer Information		Project Information			
Purchase Order		Project Name	EAA/NBU Water Quality Sampling Pl	A	300_W, Alk, pH, Cond, TDS
Work Order		Project Number	Arcadis, C001, NBU	B	ICP_TW (Metals Sel list)/Sub Total Silica to ALS Fort C
Company Name	INTERA Inc.	Bill To Company	INTERA Inc.	C	Ammonia, TKN, Total Phosphorus
Send Report To	Neil Deeds	Invoice Attn	Neil Deeds	D	Dissolved Inorganic Carbon - lab filter (DIC)
Address	1812 Centre Creek Drive Suite 300	Address	1812 Centre Creek Drive Suite 300	E	Dissolved Metals + Filter ((Fe and Mg Only))
				F	TOC_W 9060 (TOC)
City/State/Zip	Austin, TX 78754	City/State/Zip	Austin TX 78754	G	TOC_9060_Diss + Filter (DOC)
Phone	(512) 425-2000	Phone	(512) 425-2000	H	CO_2 Gas
Fax	(512) 425-2099	Fax	(512) 425-2099	I	
e-Mail Address	ndeeds@intera.com	e-Mail Address	ndeeds@intera.com	J	

No.	Sample Description	Date	Time	Matrix	Pres.	# Bottles	A	B	C	D	E	F	G	H	I	J	Hold
1	NBU AW01 Upper	9/13/2018	1210	W	HNO_3, H_2SO_4	16	X	X	X	X	X	X	X	X			
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Sampler(s) Please Print & Sign: James Pinkard [signature]

Shipment Method: Fed Ex

Required Turnaround Time: (Check Box) ☐ Other ______ [X] STD 10 Wk Days ☐ 5 Wk Days ☐ 2 Wk Days ☐ 24 Hour

Results Due Date:

Relinquished by:	Date:	Time:	Received by:
James Pinkard	9/13/2018	1345	
Relinquished by:	Date: 09/14/18	Time: 08.46	Received by (Laboratory): KG
Logged by (Laboratory):	Date:	Time:	Checked by (Laboratory):

Notes: EAA_NBU Water Quality Sampling Plan

Cooler ID	Cooler Temp.
43348	1/C 2.8

QC Package: (Check One Box Below)
[X] Level II Std QC ☐ TRRP Checklist
☐ Level III Std QC/Raw Date ☐ TRRP Level IV
☐ Level IV SW846/CLP
☐ Other ______

Preservative Key: 1-HCl 2-HNO_3 3-H_2SO_4 4-NaOH 5-$Na_2S_2O_3$ 6-$NaHSO_4$ 7-Other 8-4°C 9-5035

Note: 1. Any changes must be made in writing once samples and COC Form have been submitted to ALS Environmental.
2. Unless otherwise agreed in a formal contract, services provided by ALS Environmental are expressly limited to the terms and conditions stated on the reverse.
3. The Chain of Custody is a legal document. All information must be completed accurately.

FedEx
TRK# 0221 4380 [illegible]532 4721
FRI – 14 SEP 10:[illegible]A
PRIORITY OVERNIGHT

43 SGRA

77099
TX–US IAH

Seal Broken By: RG
Date: 9/14

Friday, September 21, 2018

RJ Modashia
ALS Environmental
10450 Stancliff Rd, Suite 210
Houston, TX 77099

Re: ALS Workorder: 1809297
Project Name:
Project Number: HS18090667

Dear Mr. Modashia:

One water sample was received from ALS Environmental, on 9/17/2018. The sample was scheduled for the following analysis:

Metals

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental
Jeff R. Kujawa
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
AIHA	214884
Alaska (AK)	UST-086
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
PJ-LA (DoD ELAP/ISO 170250)	95377
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280

1809297

Metals:
The sample was analyzed following SW-846, 3rd Edition procedures. Analysis by Trace ICP followed method 6010B and the current revision of SOP 834.

All acceptance criteria were met.

ADDRESS 225 Commerce Drive, Fort Collins Colorado 80524 USA | PHONE +1 970 490 1511 | FAX +1 970 490 1522

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1809297
Client Name: ALS Environmental
Client Project Name:
Client Project Number: HS18090667
Client PO Number: 10-9823

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
NBU-AW01 Upper	1809297-1		WATER	13-Sep-18	12:10

10450 Stancliff Rd, Ste 210
Houston, TX 77099
T: +1 281 530 5656
F: +1 281 530 5887
www.alsglobal.com

1809297

Subcontract Chain of Custody

COC ID: 9823

SUBCONTRACT TO:

ALS Environmental, Fort Collins
225 Commerce Drive
Fort Collins, CO 80524

Phone: +1 970 490 1511

CUSTOMER INFORMATION:

Company: ALS Houston
Contact: RJ Modashia
Address: 10450 Stancliff Rd, Ste 210
Phone: +1 281 530 5656
Email: RJ.Modashia@alsglobal.com
Alternate Contact: Jumoke M. Lawal
Email: jumoke.lawal@alsglobal.com

INVOICE INFORMATION:

Company: ALS Houston
Contact: Accounts Payable
Address: 10450 Stancliff Rd, Ste 210
Phone: +1 281 530 5656
Reference: HS18090667
TSR: Jennifer Bell

	LAB SAMPLE ID / ANALYSIS REQUESTED	CLIENT SAMPLE ID	MATRIX	COLLECT DATE / DUE DATE
1.	**HS18090667-01**	**NBU-AW01 Upper**	**Water**	**13 Sep 2018 12:10**
	SUB_METALS Total Silica 6010			24 Sep 2018

Comments: Please analyze for the analysis listed above.
Send report to the emails shown above.

QC Level: STD (Laboratory Standard QC: method blank and LCS required)

Relinquished By:	J. Lawal	Date/Time:	9/14/18 18:00
Received By:	[signature]	Date/Time:	9/17/18 0900
Cooler ID(s):		Temperature(s):	

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: ALS Tx　　Workorder No: 1809297

Project Manager: JK　　Initials: ND　　Date: 9/17/18

1.	Are airbills / shipping documents present and/or removable?	DROP OFF	YES	NO
2.	Are custody seals on **shipping** containers intact?	NONE	YES	NO
3.	Are custody seals on **sample** containers intact?	NONE	YES	NO
4.	Is there a COC (chain-of-custody) present?		YES	NO
5.	Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)		YES	NO
6.	Are short-hold samples present?		YES	NO
7.	Are all samples within holding times for the requested analyses?		YES	NO
8.	Were all sample containers received intact? (not broken or leaking)		YES	NO
9.	Is there sufficient sample for the requested analyses?		YES	NO
10.	Are all samples in the proper containers for the requested analyses?		YES	NO
11.	Are all aqueous samples preserved correctly, if required? (excluding volatiles)	N/A	YES	NO
12.	Are all aqueous non-preserved samples pH 4-9?	N/A	YES	NO
13.	Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	N/A	YES	NO
14.	Were the samples shipped on ice?		YES	NO
15.	Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #1 #3 #4	RAD ONLY	YES	NO

Cooler #:	1							
Temperature (°C):	Amb							
No. of custody seals on cooler:	2							
External µR/hr reading:	10							
Background µR/hr reading:	10							

DOT Survey/ Acceptance Information

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / NA (If no, see Form 008.)

Additional Information: **Please provide details here for any NO responses to gray-shaded boxes above, or any other issues noted:**

Sample should be in a 250 ml poly but is in an 80 ml poly

If applicable, was the client contacted? YES / NO / NA　Contact: ______　Date/Time: ______

Project Manager Signature / Date: 9-18-18

Form 201r26.xls
(06/29/2018)

*IR Gun #1, VWR SN 170560549
*IR Gun #3, VWR SN 170647571
*IR Gun #4, Oakton, SN 2372220101-0002

1809297.

Must Deliver Next Business Day
Time and Tempature Sensitive!

ORIGIN ID:SGRA (281) 530-5656
SHIPPING DEPT
ALS LABORATORY GROUP
10450 STANCLIFF
SUITE 210
HOUSTON, TX 77099
UNITED STATES US

SHIP DATE: 14SEP18
ACTWGT: 9.20 LB
CAD: 300130/CAFE3211
DIMS: 19x16x13 IN
BILL THIRD PARTY

55IC1/F78C/104C

TO SAMPLE RECEIVING
ALS ENVIRONMENTAL
225 COMMERCE DRIVE

FORT COLLINS CO 80524
(970) 490-1511
REF: HS18090664/667 BF/RJ

10-2
Amb

FedEx
Express

E

J181118060501uv

MON - 17 SEP 3:00P
STANDARD OVERNIGHT

TRK# 0201 4380 9532 7032

BD FTCA

80524
CO-US DEN

Client:	ALS Environmental	**Date:**	*21-Sep-18*
Project:	HS18090667	**Work Order:**	1809297
Sample ID:	NBU-AW01 Upper	**Lab ID:**	1809297-1
Legal Location:		**Matrix:**	WATER
Collection Date:	9/13/2018 12:10	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Total Recoverable ICP Metals		**SW6010**		Prep Date: **9/19/2018**		PrepBy: **JML**
SILICON	7.5		0.046	MG/L	1	9/20/2018 14:44
SILICON AS SiO2	16		0.098	MG/L	1	9/20/2018 14:48

Client: ALS Environmental
Date: *21-Sep-18*
Project: HS18090667
Work Order: 1809297
Sample ID: NBU-AW01 Upper
Lab ID: 1809297-1
Legal Location:
Matrix: WATER
Collection Date: 9/13/2018 12:10
Percent Moisture:

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed

Explanation of Qualifiers

Radiochemistry:

- "Report Limit" is the MDC
U or ND - Result is less than the sample specific MDC.
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
Y2 - Chemical Yield outside default limits.
W - DER is greater than Warning Limit of 1.42
* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.
# - Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.
G - Sample density differs by more than 15% of LCS density.
D - DER is greater than Control Limit
M - Requested MDC not met.
LT - Result is less than requested MDC but greater than achieved MDC.
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
L - LCS Recovery below lower control limit.
H - LCS Recovery above upper control limit.
P - LCS, Matrix Spike Recovery within control limits.
N - Matrix Spike Recovery outside control limits
NC - Not Calculated for duplicate results less than 5 times MDC
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.

Inorganics:

B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).
U or ND - Indicates that the compound was analyzed for but not detected.
E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.
M - Duplicate injection precision was not met.
N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.
Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.
* - Duplicate analysis (relative percent difference) not within control limits.
S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

Organics:

U or ND - Indicates that the compound was analyzed for but not detected.
B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.
E - Analyte concentration exceeds the upper level of the calibration range.
J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).
A - A tentatively identified compound is a suspected aldol-condensation product.
X - The analyte was diluted below an accurate quantitation level.
* - The spike recovery is equal to or outside the control criteria used.
+ - The relative percent difference (RPD) equals or exceeds the control criteria.
G - A pattern resembling gasoline was detected in this sample.
D - A pattern resembling diesel was detected in this sample.
M - A pattern resembling motor oil was detected in this sample.
C - A pattern resembling crude oil was detected in this sample.
4 - A pattern resembling JP-4 was detected in this sample.
5 - A pattern resembling JP-5 was detected in this sample.
H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.
L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.
Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
- gasoline
- JP-8
- diesel
- mineral spirits
- motor oil
- Stoddard solvent
- bunker C

ALS -- Fort Collins

Client: ALS Environmental
Work Order: 1809297
Project: HS18090667

Date: *9/21/2018 1:28:*

QC BATCH REPORT

Batch ID: **IP180919-4-3** Instrument ID **ICPTrace2** Method: **SW6010**

LCS Sample ID: **IP180919-4** Units: **MG/L** Analysis Date: **9/20/2018 14:08**
Client ID: Run ID: **IT180920-1A8** Prep Date: **9/19/2018** DF: **1**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	RPD Ref	RPD	RPD Limit	Qual
SILICON	1.02	0.046	1		102	80-120				20	

MB Sample ID: **IP180919-4** Units: **MG/L** Analysis Date: **9/20/2018 14:07**
Client ID: Run ID: **IT180920-1A8** Prep Date: **9/19/2018** DF: **1**

Analyte	Result	ReportLimit	Qual
SILICON	ND	0.046	

The following samples were analyzed in this batch: 1809297-1

2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T: +1 805 526 7161
F: +1 805 526 7270
www.alsglobal.com

LABORATORY REPORT

September 24, 2018

RJ Modashia
ALS Laboratory Group
10450 Stancliff Road Suite 210
Houston, TX 77099-4338

RE: HS18090667

Dear RJ:

Enclosed are the results of the sample submitted to our laboratory on September 18, 2018. For your reference, these analyses have been assigned our service request number P1804870.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

ALS | Environmental

Kate Kaneko
By Kate Kaneko at 4:43 pm, 09/24/18
Kate Kaneko
Project Manager

RIGHT SOLUTIONS | RIGHT PARTNER

2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T: +1 805 526 7161
F: +1 805 526 7270
www.alsglobal.com

Client: ALS Laboratory Group
Project: HS18090667

Service Request No: P1804870

CASE NARRATIVE

The sample was received intact under chain of custody on September 18, 2018 and was stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the sample at the time of sample receipt.

Carbon Dioxide Analysis

The sample was analyzed for carbon dioxide using a gas chromatograph equipped with a thermal conductivity detector (TCD). A known amount of liquid was displaced by injecting 8.0 milliliters of helium creating a headspace in the sample vial. Each sample vial was agitated using a sonic disrupter for fifteen minutes and then allowed to equilibrate for at least four hours. A volume of the headspace was withdrawn using a gas-tight syringe and analyzed using a manual injection technique. The amount of dissolved gases (carbon dioxide) in the original sample was calculated using Henry's Law. This method was performed with guidance from RSK 175 as described in laboratory SOP VOA-DISGAS. This analyte is included on the laboratory's NELAP and DoD-ELAP scope of accreditation.

RIGHT SOLUTIONS | RIGHT PARTNER

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T: +1 805 526 7161
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ALS Environmental – Simi Valley

CERTIFICATIONS, ACCREDITATIONS, AND REGISTRATIONS

Agency	Web Site	Number
Alaska DEC	http://dec.alaska.gov/eh/lab.aspx	17-019
Arizona DHS	http://www.azdhs.gov/preparedness/state-laboratory/lab-licensure-certification/index.php#laboratory-licensure-home	AZ0694
Florida DOH (NELAP)	http://www.floridahealth.gov/licensing-and-regulation/environmental-laboratories/index.html	E871020
Louisiana DEQ (NELAP)	http://www.deq.louisiana.gov/page/la-lab-accreditation	05071
Maine DHHS	http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/labCert.shtml	2016036
Minnesota DOH (NELAP)	http://www.health.state.mn.us/accreditation	1347317
New Jersey DEP (NELAP)	http://www.nj.gov/dep/enforcement/oqa.html	CA009
New York DOH (NELAP)	http://www.wadsworth.org/labcert/elap/elap.html	11221
Oregon PHD (NELAP)	http://www.oregon.gov/oha/ph/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	4068-005
Pennsylvania DEP	http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx	68-03307 (Registration)
PJLA (DoD ELAP)	http://www.pjlabs.com/search-accredited-labs	65818 (Testing)
Texas CEQ (NELAP)	http://www.tceq.texas.gov/agency/qa/env_lab_accreditation.html	T104704413-18-9
Utah DOH (NELAP)	http://health.utah.gov/lab/lab_cert_env	CA016272018-9
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C946

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at www.alsglobal.com, or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

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ALS ENVIRONMENTAL

DETAIL SUMMARY REPORT

Client: ALS Laboratory Group

Service Request: P1804870

Project ID: HS18090667

Date Received: 9/18/2018

Time Received: 09:30

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	RSK 175 - CO2
NBU-AW01 Upper	P1804870-001	Water	9/13/2018	12:10	X

P1804870

10450 Stancliff Rd, Ste 210
Houston, TX 77099
T: +1 281 530 5656
F: +1 281 530 5887
www.alsglobal.com

Subcontract Chain of Custody

COC ID: 9822

SUBCONTRACT TO:

ALS Environmental
2655 Park Center Drive, Suite A
Simi Valley, CA 93065

Phone: +1 805 526 7161

CUSTOMER INFORMATION:

Company:	ALS Houston
Contact:	RJ Modashia
Address:	10450 Stancliff Rd, Ste 210
Phone:	+1 281 530 5656
Email:	RJ.Modashia@alsglobal.com
Alternate Contact:	Jumoke M. Lawal
Email:	jumoke.lawal@alsglobal.com

INVOICE INFORMATION:

Company:	ALS Houston
Contact:	Accounts Payable
Address:	10450 Stancliff Rd, Ste 210
Phone:	+1 281 530 5656
Reference:	HS18090667
TSR:	Jennifer Bell

	LAB SAMPLE ID / ANALYSIS REQUESTED	CLIENT SAMPLE ID	MATRIX	COLLECT DATE / DUE DATE
1.	**HS18090667-01**	**NBU-AW01 Upper**	**Water**	**13 Sep 2018 12:10**
	CO2 Analysis			24 Sep 2018

Comments: Please analyze for the analysis listed above.
Send report to the emails shown above.

QC Level: STD (Laboratory Standard QC: method blank and LCS required)

Relinquished By: [signature] Date/Time: 9/17/18 1800

Received By: [signature] Date/Time: 9/18/18 0930

Cooler ID(s): Temperature(s): 1° not ice

ALS Environmental
Sample Acceptance Check Form

Client: ALS Laboratory Group   Work order: P1804870

Project: HS18090667

Sample(s) received on: 9/18/18   Date opened: 9/18/18   by: ADAVID

Note: This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

		Yes	No	N/A
1	Were **sample containers** properly marked with client sample ID?	☒	☐	☐
2	Did **sample containers** arrive in good condition?	☒	☐	☐
3	Were **chain-of-custody** papers used and filled out?	☒	☐	☐
4	Did **sample container labels** and/or tags agree with custody papers?	☒	☐	☐
5	Was **sample volume** received adequate for analysis?	☒	☐	☐
6	Are samples within specified holding times?	☒	☐	☐
7	Was proper **temperature** (thermal preservation) of cooler at receipt adhered to?	☒	☐	☐
	Cooler Temperature: ° C Blank Temperature: 1° C Thermometer ID CO907034581	Wet Ice		
8	Were **custody seals** on outside of cooler/Box/Container?	☒	☐	☐
	Location of seal(s)? Cooler lid. Sealing Lid?	☒	☐	☐
	Were signature and date included?	☒	☐	☐
	Were seals intact?	☒	☐	☐
9	Do containers have appropriate **preservation**, according to method/SOP or Client specified information?	☒	☐	☐
	Is there a client indication that the submitted samples are **pH** preserved?	☐	☐	☒
	Were **VOA vials** checked for presence/absence of air bubbles?	☒	☐	☐
	Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it?	☐	☒	☐
10	**Tubes:** Are the tubes capped and intact?	☐	☐	☒
11	**Badges:** Are the badges properly capped and intact?	☐	☐	☒
	Are dual bed badges separated and individually capped and intact?	☐	☐	☒

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P1804870-001.01	40mL VOA NP		7		A	MR 09/24/18
P1804870-001.02	40mL VOA NP				A	
P1804870-001.03	40mL VOA NP				A	

Explain any discrepancies: (include lab sample ID numbers):

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

Client: **ALS Laboratory Group**
Client Project ID: **HS18090667**

ALS Project ID: P1804870

Carbon Dioxide

Test Code: RSK 175
Instrument ID: HP5890A/GC10/TCD
Analyst: Wade Henton
Matrix: Water
Test Notes:

Date(s) Collected: 9/13/18
Date Received: 9/18/18
Date Analyzed: 9/24/18

Client Sample ID	ALS Sample ID	Injection Volume ml(s)	**Result µg/L**	MRL µg/L	MDL µg/L	Data Qualifier
NBU-AW01 Upper	P1804870-001	0.10	**60,000**	1,000	370	
Method Control Sample	P180924-MB	0.10	ND	1,000	370	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

Client: **ALS Laboratory Group**
Client Sample ID: **Duplicate Lab Control Sample** ALS Project ID: P1804870
Client Project ID: **HS18090667** ALS Sample ID: P180924-DLCS

Test Code: RSK 175 Date Collected: NA
Instrument ID: HP5890A/GC10/TCD Date Received: NA
Analyst: Wade Henton Date Analyzed: 9/24/18
Matrix: Water Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

CAS #	**Compound**	Spike Amount LCS / DLCS ug/L	Result[1] LCS ug/L	DLCS ug/L	**% Recovery LCS**	**DLCS**	ALS Acceptance Limits	RPD	RPD Limit	Data Qualifier
124-38-9	Carbon Dioxide	22,900	16,400	16,100	**72**	**70**	62-123	3	15	

[1] = The concentration shown includes a subtraction of the Method Control Sample value, even if the result is less than the MRL.

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Corpus Christi
1733 N. Padre Island Drive
Corpus Christi, TX 78408
Tel: (361)289-2673

TestAmerica Job ID: 560-73887-1
Client Project/Site: EAA/NBU Water Quality Sampling Plan

For:
INTERA Inc
9600 Great Hills Trail
Suite 300W
Austin, Texas 78759

Attn: Frank Roecker

Nicole M. Boyken

Authorized for release by:
6/20/2018 3:55:35 PM
Nicole Boyken, Project Manager I
(361)800-5200
nicole.boyken@testamericainc.com

Designee for

Lindy Maingot, Project Manager I
(210)344-9751
lindy.maingot@testamericainc.com

Client: INTERA Inc TestAmerica Job ID: 560-73887-1
Project/Site: EAA/NBU Water Quality Sampling Plan

Qualifiers

Metals

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
F1	MS and/or MSD Recovery is outside acceptance limits.
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.

General Chemistry

Qualifier	Qualifier Description
F1	MS and/or MSD Recovery is outside acceptance limits.
H	Sample was prepped or analyzed beyond the specified holding time
HF	Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 560-73887-1

Laboratory: TestAmerica Corpus Christi

Narrative

Job Narrative
560-73887-1

Comments
No additional comments.

Receipt
The sample was received on 5/26/2018 10:26 AM; the sample arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 0.8º C.

Receipt Exceptions
The following sample was received outside of holding time: NBU-AW01 Upper (560-73887-1).

Metals
Method(s) 3010A: The following samples requested dissolved metals and were not filtered in the field: NBU-AW01 Upper (560-73887-1). These samples were filtered and preserved upon receipt to the laboratory.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
Method(s) 300.0: The following sample was received outside of holding time: NBU-AW01 Upper (560-73887-1).

Method(s) 365.3: The following sample was received outside of holding time: NBU-AW01 Upper (560-73887-1).

Method(s) 365.3: Sample turned a medium brown with addition of method reagents. The following sample was diluted to reduce any possible interference: NBU-AW01 Upper (560-73887-1)

Method(s) 9040C: This analysis is normally performed in the field and has a method-defined holding time of 15 minutes. The following samples has been qualified with the "HF" flag to indicate analysis was performed in the laboratory outside the 15 minute timeframe: NBU-AW01 Upper (560-73887-1) and (560-73877-B-1 DU).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: INTERA Inc TestAmerica Job ID: 560-73887-1
Project/Site: EAA/NBU Water Quality Sampling Plan

Client Sample ID: NBU-AW01 Upper Lab Sample ID: 560-73887-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
SiO2, Silica	12.4		1.10	0.152	mg/L	1		6010B	Total/NA
Arsenic	4.34	J	5.00	1.09	ug/L	1		6020	Total/NA
Calcium	762000		2500	990	ug/L	5		6020	Total/NA
Potassium	66100		1000	407	ug/L	1		6020	Total/NA
Magnesium	358000		500	113	ug/L	1		6020	Total/NA
Sodium	1370000		5000	3640	ug/L	5		6020	Total/NA
Strontium	17000		25.0	3.84	ug/L	5		6020	Total/NA
Chloride	1220		200	38.4	mg/L	200		300.0	Total/NA
Sulfate	691		200	75.4	mg/L	200		300.0	Total/NA
Fluoride	3.04		0.200	0.0400	mg/L	2		340.2	Total/NA
Nitrogen, Kjeldahl	4.81		0.200	0.100	mg/L	1		351.2	Total/NA
Orthophosphate as P	0.234	H	0.0300	0.0141	mg/L	1		365.3	Total/NA
pH	6.66	HF	0.100	0.100	SU	1		9040C	Total/NA
Total Organic Carbon	1.25		1.00	0.285	mg/L	1		9060	Total/NA
Total Alkalinity as CaCO3	269		5.00	5.00	mg/L	1		SM 2320B	Total/NA
Bicarbonate Alkalinity as CaCO3	269		5.00	5.00	mg/L	1		SM 2320B	Total/NA
Specific Conductivity	14500		1.00	1.00	umhos/cm	1		SM 2510B	Total/NA
Total Dissolved Solids	8490		100	100	mg/L	1		SM 2540C	Total/NA
Ammonia as N	3.94		0.200	0.0450	mg/L	1		SM 4500 NH3 G	Total/NA
Dissolved Inorganic Carbon	84.7		1.00	0.285	mg/L	1		SM 5310B	Dissolved

This Detection Summary does not include radiochemical test results.

Client Sample ID: NBU-AW01 Upper

Lab Sample ID: 560-73887-1

Date Collected: 05/23/18 21:40
Date Received: 05/26/18 10:26

Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
SiO2, Silica	12.4		1.10	0.152	mg/L		05/30/18 09:51	05/30/18 17:52	1

Method: 6020 - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	<0.941		5.00	0.941	ug/L		05/31/18 09:54	05/31/18 16:57	1
Arsenic	4.34	J	5.00	1.09	ug/L		05/31/18 09:54	05/31/18 16:57	1
Beryllium	<1.24		4.00	1.24	ug/L		05/31/18 09:54	05/31/18 16:57	1
Cadmium	<0.854		2.00	0.854	ug/L		05/31/18 09:54	05/31/18 16:57	1
Chromium	<1.40		5.00	1.40	ug/L		05/31/18 09:54	05/31/18 16:57	1
Copper	<2.00		10.0	2.00	ug/L		05/31/18 09:54	05/31/18 16:57	1
Manganese	<11.6		50.0	11.6	ug/L		05/31/18 09:54	05/31/18 16:57	1
Nickel	<2.17		5.00	2.17	ug/L		05/31/18 09:54	05/31/18 16:57	1
Lead	<0.733		5.00	0.733	ug/L		05/31/18 09:54	05/31/18 16:57	1
Selenium	<1.08	F1	5.00	1.08	ug/L		05/31/18 09:54	05/31/18 16:57	1
Thallium	<0.693		2.00	0.693	ug/L		05/31/18 09:54	05/31/18 16:57	1
Zinc	<3.55		25.0	3.55	ug/L		05/31/18 09:54	05/31/18 16:57	1
Antimony	<1.61		5.00	1.61	ug/L		05/31/18 09:54	05/31/18 16:57	1
Aluminum	<50.0		100	50.0	ug/L		05/31/18 09:54	06/01/18 15:17	1
Calcium	762000		2500	990	ug/L		05/31/18 09:54	06/01/18 15:34	5
Iron	<101		250	101	ug/L		05/31/18 09:54	05/31/18 16:57	1
Potassium	66100		1000	407	ug/L		05/31/18 09:54	05/31/18 16:57	1
Magnesium	358000		500	113	ug/L		05/31/18 09:54	05/31/18 16:57	1
Sodium	1370000		5000	3640	ug/L		05/31/18 09:54	06/01/18 15:34	5
Vanadium	<1.44		5.00	1.44	ug/L		05/31/18 09:54	05/31/18 16:57	1
Strontium	17000		25.0	3.84	ug/L		05/31/18 09:54	06/01/18 15:34	5

Method: 6020 - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Manganese, Dissolved	<11.6		50.0	11.6	ug/L		05/31/18 09:54	05/31/18 17:19	1
Iron, Dissolved	<101		250	101	ug/L		05/31/18 09:54	05/31/18 17:19	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Bromide	<63.0		200	63.0	mg/L			05/29/18 13:44	200
Chloride	1220		200	38.4	mg/L			05/29/18 13:44	200
Nitrate as N	<20.6	H	100	20.6	mg/L			05/29/18 13:44	200
Sulfate	691		200	75.4	mg/L			05/29/18 13:44	200
Fluoride	3.04		0.200	0.0400	mg/L			05/29/18 16:15	2
Nitrogen, Kjeldahl	4.81		0.200	0.100	mg/L		06/07/18 13:11	06/08/18 12:23	1
Orthophosphate as P	0.234	H	0.0300	0.0141	mg/L			05/31/18 09:10	1
Phosphates as P	<0.0410		0.100	0.0410	mg/L		06/07/18 13:11	06/08/18 12:23	1
pH	6.66	HF	0.100	0.100	SU			05/31/18 13:05	1
Total Organic Carbon	1.25		1.00	0.285	mg/L			06/20/18 08:26	1
Total Alkalinity as CaCO3	269		5.00	5.00	mg/L			06/04/18 11:20	1
Bicarbonate Alkalinity as CaCO3	269		5.00	5.00	mg/L			06/04/18 11:20	1
Carbonate Alkalinity as CaCO3	<5.00		5.00	5.00	mg/L			06/04/18 11:20	1
Specific Conductivity	14500		1.00	1.00	umhos/cm			06/05/18 14:25	1
Total Dissolved Solids	8490		100	100	mg/L			05/29/18 18:00	1
Ammonia as N	3.94		0.200	0.0450	mg/L			06/01/18 10:43	1

Client Sample ID: NBU-AW01 Upper — Lab Sample ID: 560-73887-1

Date Collected: 05/23/18 21:40 — **Matrix: Water**
Date Received: 05/26/18 10:26

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon	<0.285		1.00	0.285	mg/L			06/04/18 14:26	1
Dissolved Inorganic Carbon	**84.7**		1.00	0.285	mg/L			06/15/18 09:33	1

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 560-151416/1-A
Matrix: Water
Analysis Batch: 151462

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 151416

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
SiO2, Silica	<0.152		1.10	0.152	mg/L		05/30/18 09:51	05/30/18 16:57	1

Method: 6020 - Metals (ICP/MS)

Lab Sample ID: MB 560-151473/1-A
Matrix: Water
Analysis Batch: 151523

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 151473

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	<0.941		5.00	0.941	ug/L		05/31/18 09:54	05/31/18 16:52	1
Arsenic	<1.09		5.00	1.09	ug/L		05/31/18 09:54	05/31/18 16:52	1
Beryllium	<1.24		4.00	1.24	ug/L		05/31/18 09:54	05/31/18 16:52	1
Cadmium	<0.854		2.00	0.854	ug/L		05/31/18 09:54	05/31/18 16:52	1
Chromium	<1.40		5.00	1.40	ug/L		05/31/18 09:54	05/31/18 16:52	1
Copper	<2.00		10.0	2.00	ug/L		05/31/18 09:54	05/31/18 16:52	1
Manganese	<11.6		50.0	11.6	ug/L		05/31/18 09:54	05/31/18 16:52	1
Manganese, Dissolved	<11.6		50.0	11.6	ug/L		05/31/18 09:54	05/31/18 16:52	1
Nickel	<2.17		5.00	2.17	ug/L		05/31/18 09:54	05/31/18 16:52	1
Lead	<0.733		5.00	0.733	ug/L		05/31/18 09:54	05/31/18 16:52	1
Selenium	<1.08		5.00	1.08	ug/L		05/31/18 09:54	05/31/18 16:52	1
Thallium	<0.693		2.00	0.693	ug/L		05/31/18 09:54	05/31/18 16:52	1
Zinc	<3.55		25.0	3.55	ug/L		05/31/18 09:54	05/31/18 16:52	1
Antimony	<1.61		5.00	1.61	ug/L		05/31/18 09:54	05/31/18 16:52	1
Calcium	<198		500	198	ug/L		05/31/18 09:54	05/31/18 16:52	1
Iron	<101		250	101	ug/L		05/31/18 09:54	05/31/18 16:52	1
Iron, Dissolved	<101		250	101	ug/L		05/31/18 09:54	05/31/18 16:52	1
Potassium	<407		1000	407	ug/L		05/31/18 09:54	05/31/18 16:52	1
Magnesium	<113		500	113	ug/L		05/31/18 09:54	05/31/18 16:52	1
Vanadium	<1.44		5.00	1.44	ug/L		05/31/18 09:54	05/31/18 16:52	1
Strontium	<0.768		5.00	0.768	ug/L		05/31/18 09:54	05/31/18 16:52	1

Lab Sample ID: MB 560-151473/1-A
Matrix: Water
Analysis Batch: 151559

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 151473

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	<50.0		100	50.0	ug/L		05/31/18 09:54	06/01/18 15:12	1
Calcium	<198		500	198	ug/L		05/31/18 09:54	06/01/18 15:12	1
Sodium	<727		1000	727	ug/L		05/31/18 09:54	06/01/18 15:12	1
Strontium	<0.768		5.00	0.768	ug/L		05/31/18 09:54	06/01/18 15:12	1

Lab Sample ID: LCS 560-151473/2-A
Matrix: Water
Analysis Batch: 151523

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 151473

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Silver	250	288.7		ug/L		115	80 - 120
Arsenic	250	276.7		ug/L		111	80 - 120

Method: 6020 - Metals (ICP/MS) (Continued)

Lab Sample ID: LCS 560-151473/2-A
Client Sample ID: Lab Control Sample
Matrix: Water
Prep Type: Total/NA
Analysis Batch: 151523
Prep Batch: 151473

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Beryllium	250	263.6		ug/L		105	80 - 120
Cadmium	250	259.4		ug/L		104	80 - 120
Chromium	250	258.5		ug/L		103	80 - 120
Copper	250	248.6		ug/L		99	80 - 120
Manganese	2500	2673		ug/L		107	80 - 120
Manganese, Dissolved	2500	2673		ug/L		107	80 - 120
Nickel	250	262.6		ug/L		105	80 - 120
Lead	250	253.9		ug/L		102	80 - 120
Selenium	250	262.3		ug/L		105	80 - 120
Thallium	100	102.3		ug/L		102	80 - 120
Zinc	250	250.6		ug/L		100	80 - 120
Antimony	250	272.9		ug/L		109	80 - 120
Calcium	25000	26840		ug/L		107	80 - 120
Iron	25000	25840		ug/L		103	80 - 120
Iron, Dissolved	25000	25840		ug/L		103	80 - 120
Potassium	25000	26650		ug/L		107	80 - 120
Magnesium	25000	25380		ug/L		102	80 - 120
Vanadium	250	262.4		ug/L		105	80 - 120
Strontium	250	264.0		ug/L		106	80 - 120

Lab Sample ID: LCS 560-151473/2-A
Client Sample ID: Lab Control Sample
Matrix: Water
Prep Type: Total/NA
Analysis Batch: 151559
Prep Batch: 151473

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	25000	24970		ug/L		100	80 - 120
Calcium	25000	26550		ug/L		106	80 - 120
Sodium	25000	26060		ug/L		104	80 - 120
Strontium	250	259.9		ug/L		104	80 - 120

Lab Sample ID: 560-73887-1 MS
Client Sample ID: NBU-AW01 Upper
Matrix: Water
Prep Type: Total/NA
Analysis Batch: 151523
Prep Batch: 151473

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Silver	<0.941		250	259.1		ug/L		104	80 - 120
Arsenic	4.34	J	250	290.0		ug/L		114	80 - 120
Beryllium	<1.24		250	241.6		ug/L		97	80 - 120
Cadmium	<0.854		250	239.8		ug/L		96	80 - 120
Chromium	<1.40		250	251.0		ug/L		100	80 - 120
Copper	<2.00		250	230.1		ug/L		92	80 - 120
Manganese	<11.6		2500	2542		ug/L		102	80 - 120
Manganese, Dissolved	<11.6		2500	2542		ug/L		102	80 - 120
Nickel	<2.17		250	248.1		ug/L		99	80 - 120
Lead	<0.733		250	236.6		ug/L		95	80 - 120
Selenium	<1.08	F1	250	163.2	F1	ug/L		65	80 - 120
Thallium	<0.693		100	94.21		ug/L		94	80 - 120
Zinc	<3.55		250	231.9		ug/L		93	80 - 120
Antimony	<1.61		250	270.1		ug/L		108	80 - 120

Method: 6020 - Metals (ICP/MS) (Continued)

Lab Sample ID: 560-73887-1 MS
Client Sample ID: NBU-AW01 Upper
Matrix: Water
Prep Type: Total/NA
Analysis Batch: 151523
Prep Batch: 151473

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Iron	<101		25000	25080		ug/L		100	80 - 120
Iron, Dissolved	<101		25000	25080		ug/L		100	80 - 120
Potassium	66100		25000	92940		ug/L		107	80 - 120
Magnesium	358000		25000	384800	4	ug/L		106	80 - 120
Vanadium	<1.44		250	267.4		ug/L		107	80 - 120

Lab Sample ID: 560-73887-1 MS
Client Sample ID: NBU-AW01 Upper
Matrix: Water
Prep Type: Total/NA
Analysis Batch: 151559
Prep Batch: 151473

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	<50.0		25000	24910		ug/L		100	80 - 120

Lab Sample ID: 560-73887-1 MSD
Client Sample ID: NBU-AW01 Upper
Matrix: Water
Prep Type: Total/NA
Analysis Batch: 151523
Prep Batch: 151473

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Silver	<0.941		250	252.8		ug/L		101	80 - 120	2	20
Arsenic	4.34	J	250	283.4		ug/L		112	80 - 120	2	20
Beryllium	<1.24		250	229.2		ug/L		92	80 - 120	5	20
Cadmium	<0.854		250	232.4		ug/L		93	80 - 120	3	20
Chromium	<1.40		250	231.1		ug/L		92	80 - 120	8	20
Copper	<2.00		250	224.5		ug/L		90	80 - 120	2	20
Manganese	<11.6		2500	2308		ug/L		92	80 - 120	10	20
Manganese, Dissolved	<11.6		2500	2308		ug/L		92	80 - 120	10	20
Nickel	<2.17		250	240.8		ug/L		96	80 - 120	3	20
Lead	<0.733		250	223.0		ug/L		89	80 - 120	6	20
Selenium	<1.08	F1	250	154.1	F1	ug/L		62	80 - 120	6	20
Thallium	<0.693		100	91.87		ug/L		92	80 - 120	3	20
Zinc	<3.55		250	222.7		ug/L		89	80 - 120	4	20
Antimony	<1.61		250	260.7		ug/L		104	80 - 120	4	20
Iron	<101		25000	24310		ug/L		97	80 - 120	3	20
Iron, Dissolved	<101		25000	24310		ug/L		97	80 - 120	3	20
Potassium	66100		25000	87920		ug/L		87	80 - 120	6	20
Magnesium	358000		25000	365300	4	ug/L		28	80 - 120	5	20
Vanadium	<1.44		250	247.5		ug/L		99	80 - 120	8	20

Lab Sample ID: 560-73887-1 MSD
Client Sample ID: NBU-AW01 Upper
Matrix: Water
Prep Type: Total/NA
Analysis Batch: 151559
Prep Batch: 151473

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	<50.0		25000	24300		ug/L		97	80 - 120	2	20

QC Sample Results

Client: INTERA Inc
Project/Site: EAA/NBU Water Quality Sampling Plan

TestAmerica Job ID: 560-73887-1

Method: 300.0 - Anions, Ion Chromatography

Lab Sample ID: MB 560-151391/3
Matrix: Water
Analysis Batch: 151391

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Bromide	<0.315		1.00	0.315	mg/L			05/29/18 10:57	1
Chloride	<0.192		1.00	0.192	mg/L			05/29/18 10:57	1
Nitrate as N	<0.103		0.500	0.103	mg/L			05/29/18 10:57	1
Sulfate	<0.377		1.00	0.377	mg/L			05/29/18 10:57	1

Lab Sample ID: LCS 560-151391/4
Matrix: Water
Analysis Batch: 151391

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromide	5.00	5.480		mg/L		110	90 - 110
Chloride	10.0	10.15		mg/L		102	90 - 110
Nitrate as N	5.00	5.234		mg/L		105	90 - 110
Sulfate	20.0	19.54		mg/L		98	90 - 110

Lab Sample ID: 560-73885-H-1 MS
Matrix: Water
Analysis Batch: 151391

Client Sample ID: Matrix Spike
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromide	221	J F1	2500	2011	F1	mg/L		72	80 - 120
Chloride	11100	F1	5000	26120	F1	mg/L		300	80 - 120
Nitrate as N	<51.5	F1	2500	1587	F1	mg/L		63	80 - 120
Sulfate	<189		10000	8744		mg/L		87	80 - 120

Lab Sample ID: 560-73885-H-1 MSD
Matrix: Water
Analysis Batch: 151391

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Bromide	221	J F1	2500	2067	F1	mg/L		74	80 - 120	3	20
Chloride	11100	F1	5000	24920	F1	mg/L		277	80 - 120	5	20
Nitrate as N	<51.5	F1	2500	1609	F1	mg/L		64	80 - 120	1	20
Sulfate	<189		10000	8361		mg/L		84	80 - 120	4	20

Method: 340.2 - Fluoride

Lab Sample ID: MB 560-151441/3
Matrix: Water
Analysis Batch: 151441

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	<0.0200		0.100	0.0200	mg/L			05/29/18 16:15	1

Method: 340.2 - Fluoride (Continued)

Lab Sample ID: LCS 560-151441/4 **Client Sample ID: Lab Control Sample**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 151441

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Fluoride			0.800	0.8430		mg/L		105	85 - 115		

Lab Sample ID: 560-73829-A-1 MS **Client Sample ID: Matrix Spike**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 151441

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits		
Fluoride	2.78		2.50	5.400		mg/L		105	75 - 125		

Lab Sample ID: 560-73829-A-1 MSD **Client Sample ID: Matrix Spike Duplicate**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 151441

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Fluoride	2.78		2.50	5.200		mg/L		97	75 - 125	4	20

Method: 351.2 - Nitrogen, Total Kjeldahl

Lab Sample ID: MB 680-526882/1-A **Client Sample ID: Method Blank**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 527127 **Prep Batch: 526882**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrogen, Kjeldahl	<0.100		0.200	0.100	mg/L		06/07/18 09:25	06/08/18 11:39	1

Lab Sample ID: LCS 680-526882/2-A **Client Sample ID: Lab Control Sample**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 527127 **Prep Batch: 526882**

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Nitrogen, Kjeldahl			2.00	2.330		mg/L		117	75 - 125		

Lab Sample ID: 680-153310-A-1-B MS ^10 **Client Sample ID: Matrix Spike**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 527127 **Prep Batch: 526882**

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits		
Nitrogen, Kjeldahl	7.05	F1	2.00	9.970	F1	mg/L		146	75 - 125		

Lab Sample ID: 680-153310-A-1-C MSD ^10 **Client Sample ID: Matrix Spike Duplicate**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 527127 **Prep Batch: 526882**

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Nitrogen, Kjeldahl	7.05	F1	2.00	9.510		mg/L		123	75 - 125	5	40

Method: 365.3 - Phosphorus, Orthophosphate

Lab Sample ID: MB 560-151471/3 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 151471

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Orthophosphate as P	<0.0141		0.0300	0.0141	mg/L			05/31/18 09:10	1

Lab Sample ID: LCS 560-151471/4 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 151471

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Orthophosphate as P	0.200	0.2080		mg/L		104	85 - 115

Lab Sample ID: 560-73915-C-1 MS — **Client Sample ID: Matrix Spike**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 151471

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Orthophosphate as P	0.0290	J	0.200	0.2030		mg/L		87	75 - 125

Lab Sample ID: 560-73915-C-1 MSD — **Client Sample ID: Matrix Spike Duplicate**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 151471

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Orthophosphate as P	0.0290	J	0.200	0.2030		mg/L		87	75 - 125	0	20

Method: 365.4 - Phosphorus, Total

Lab Sample ID: MB 680-526882/1-A — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 527126 — **Prep Batch: 526882**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Phosphates as P	<0.0410		0.100	0.0410	mg/L		06/07/18 09:25	06/08/18 11:39	1

Lab Sample ID: LCS 680-526882/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 527126 — **Prep Batch: 526882**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Phosphates as P	2.00	2.080		mg/L		104	60 - 140

Lab Sample ID: 680-153310-A-1-B MS — **Client Sample ID: Matrix Spike**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 527126 — **Prep Batch: 526882**

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Phosphates as P	<0.0410		2.00	1.990		mg/L		100	60 - 140

QC Sample Results

Client: INTERA Inc
Project/Site: EAA/NBU Water Quality Sampling Plan

TestAmerica Job ID: 560-73887-1

Method: 365.4 - Phosphorus, Total (Continued)

Lab Sample ID: 680-153310-A-1-C MSD
Matrix: Water
Analysis Batch: 527126

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA
Prep Batch: 526882

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Phosphates as P	<0.0410		2.00	2.060		mg/L		103	60 - 140	3	40

Method: 9040C - pH

Lab Sample ID: LCS 560-151492/2
Matrix: Water
Analysis Batch: 151492

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
pH	5.00	5.000		SU		100	98 - 102

Lab Sample ID: 560-73877-B-1 DU
Matrix: Water
Analysis Batch: 151492

Client Sample ID: Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
pH	6.66		6.650		SU		0.2	20

Method: 9060 - Organic Carbon, Total (TOC)

Lab Sample ID: MB 560-152112/3
Matrix: Water
Analysis Batch: 152112

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	<0.285		1.00	0.285	mg/L			06/20/18 08:26	1

Lab Sample ID: LCS 560-152112/4
Matrix: Water
Analysis Batch: 152112

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	25.0	22.80		mg/L		91	80 - 120

Lab Sample ID: 560-74197-G-18 MS
Matrix: Water
Analysis Batch: 152112

Client Sample ID: Matrix Spike
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	1.23	F1	10.0	7.317	F1	mg/L		61	75 - 125

Lab Sample ID: 560-74197-G-18 MSD
Matrix: Water
Analysis Batch: 152112

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon	1.23	F1	10.0	7.447	F1	mg/L		62	75 - 125	2	20

Method: SM 2320B - Alkalinity

Lab Sample ID: MB 560-151588/1
Matrix: Water
Analysis Batch: 151588

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Alkalinity as CaCO3	<5.00		5.00	5.00	mg/L			06/04/18 11:20	1
Bicarbonate Alkalinity as CaCO3	<5.00		5.00	5.00	mg/L			06/04/18 11:20	1
Carbonate Alkalinity as CaCO3	<5.00		5.00	5.00	mg/L			06/04/18 11:20	1

Lab Sample ID: LCS 560-151588/2
Matrix: Water
Analysis Batch: 151588

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Alkalinity as CaCO3	100	86.00		mg/L		86	85 - 115

Lab Sample ID: 560-73844-A-1 DU
Matrix: Water
Analysis Batch: 151588

Client Sample ID: Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Alkalinity as CaCO3	181		180.8		mg/L		0	20
Bicarbonate Alkalinity as CaCO3	181		180.8		mg/L		0	
Carbonate Alkalinity as CaCO3	<5.00		<5.00		mg/L		NC	

Method: SM 2510B - Conductivity, Specific Conductance

Lab Sample ID: MB 560-151646/3
Matrix: Water
Analysis Batch: 151646

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Specific Conductivity	<1.00		1.00	1.00	umhos/cm			06/05/18 14:25	1

Lab Sample ID: LCS 560-151646/4
Matrix: Water
Analysis Batch: 151646

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Specific Conductivity	1000	976.0		umhos/cm		98	90 - 110

Lab Sample ID: 560-73997-D-1 DU
Matrix: Water
Analysis Batch: 151646

Client Sample ID: Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Specific Conductivity	4800		4800		umhos/cm		0	20

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 560-151417/1 | **Client Sample ID: Method Blank**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 151417

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	<10.0		10.0	10.0	mg/L			05/29/18 18:00	1

Lab Sample ID: LCS 560-151417/2 | **Client Sample ID: Lab Control Sample**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 151417

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Dissolved Solids	2250	2096		mg/L		93	90 - 110

Lab Sample ID: 560-73877-D-1 DU | **Client Sample ID: Duplicate**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 151417

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Dissolved Solids	8460		8520		mg/L		0.7	20

Method: SM 4500 NH3 G - Ammonia

Lab Sample ID: MB 560-151528/11 | **Client Sample ID: Method Blank**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 151528

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ammonia as N	<0.0450		0.200	0.0450	mg/L			06/01/18 10:12	1

Lab Sample ID: LCS 560-151528/12 | **Client Sample ID: Lab Control Sample**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 151528

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Ammonia as N	2.50	2.436		mg/L		97	90 - 110

Lab Sample ID: 560-73923-C-1 MS | **Client Sample ID: Matrix Spike**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 151528

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Ammonia as N	<0.0450		2.50	2.510		mg/L		100	75 - 125

Lab Sample ID: 560-73923-C-1 MSD | **Client Sample ID: Matrix Spike Duplicate**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 151528

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Ammonia as N	<0.0450		2.50	2.581		mg/L		103	75 - 125	3	20

Method: SM 5310B - Organic Carbon, Dissolved (DOC)

Lab Sample ID: MB 560-151629/1-A
Client Sample ID: Method Blank
Matrix: Water
Prep Type: Dissolved
Analysis Batch: 151627

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon	<0.285		1.00	0.285	mg/L			06/04/18 14:26	1

Lab Sample ID: LCS 560-151629/2-A
Client Sample ID: Lab Control Sample
Matrix: Water
Prep Type: Dissolved
Analysis Batch: 151627

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dissolved Organic Carbon	25.0	28.18		mg/L		113	80 - 120

Lab Sample ID: MB 560-152012/1-A
Client Sample ID: Method Blank
Matrix: Water
Prep Type: Dissolved
Analysis Batch: 152011

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Inorganic Carbon	<0.285		1.00	0.285	mg/L			06/15/18 09:33	1

Lab Sample ID: LCS 560-152012/2-A
Client Sample ID: Lab Control Sample
Matrix: Water
Prep Type: Dissolved
Analysis Batch: 152011

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dissolved Inorganic Carbon	25.0	26.22		mg/L		105	80 - 120

Accreditation/Certification Summary

Client: INTERA Inc TestAmerica Job ID: 560-73887-1
Project/Site: EAA/NBU Water Quality Sampling Plan

Laboratory: TestAmerica Corpus Christi

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	EPA Region	Identification Number	Expiration Date
Texas	NELAP	6	T104704210-18-21	03-31-19

The following analytes are included in this report, but accreditation/certification is not offered by the governing authority:

Analysis Method	Prep Method	Matrix	Analyte
SM 2320B		Water	Bicarbonate Alkalinity as CaCO3
SM 2320B		Water	Carbonate Alkalinity as CaCO3
SM 2540C		Water	Total Dissolved Solids
SM 5310B		Water	Dissolved Inorganic Carbon
SM 5310B		Water	Dissolved Organic Carbon

Laboratory: TestAmerica Savannah

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
	AFCEE		SAVLAB	
Alabama	State Program	4	41450	06-30-18 *
Alaska	State Program	10		06-30-18 *
Alaska (UST)	State Program	10	UST-104	09-22-19
Arizona	State Program	9	AZ0808	12-14-18
Arkansas DEQ	State Program	6	88-0692	02-01-19
California	State Program	9	2939	06-30-18 *
Colorado	State Program	8	N/A	12-31-18
Connecticut	State Program	1	PH-0161	03-31-19
Florida	NELAP	4	E87052	06-30-18 *
GA Dept. of Agriculture	State Program	4	N/A	06-12-19
Georgia	State Program	4	N/A	06-30-18 *
Georgia	State Program	4	803	06-30-18 *
Guam	State Program	9	15-005r	04-17-19
Hawaii	State Program	9	N/A	06-30-18 *
Illinois	NELAP	5	200022	11-30-18
Indiana	State Program	5	N/A	06-30-18 *
Iowa	State Program	7	353	06-30-19
Kentucky (DW)	State Program	4	90084	12-31-18
Kentucky (UST)	State Program	4	18	06-30-18 *
Kentucky (WW)	State Program	4	90084	12-31-18 *
L-A-B	DoD ELAP		L2463	09-22-19
L-A-B	ISO/IEC 17025		L2463.01	09-22-19
Louisiana	NELAP	6	30690	06-30-18 *
Louisiana (DW)	NELAP	6	LA160019	12-31-18
Maine	State Program	1	GA00006	09-24-18
Maryland	State Program	3	250	12-31-18
Massachusetts	State Program	1	M-GA006	06-30-18 *
Michigan	State Program	5	9925	06-30-18 *
Mississippi	State Program	4	N/A	06-30-18 *
Nebraska	State Program	7	TestAmerica-Savannah	06-30-18 *
New Jersey	NELAP	2	GA769	06-30-18 *
New Mexico	State Program	6	N/A	06-30-18 *
New York	NELAP	2	10842	03-31-19
North Carolina (DW)	State Program	4	13701	07-31-18
North Carolina (WW/SW)	State Program	4	269	12-31-18
Oklahoma	State Program	6	9984	08-31-18 *

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Accreditation/Certification Summary

Client: INTERA Inc
TestAmerica Job ID: 560-73887-1
Project/Site: EAA/NBU Water Quality Sampling Plan

Laboratory: TestAmerica Savannah (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Pennsylvania	NELAP	3	68-00474	06-30-18 *
Puerto Rico	State Program	2	GA00006	12-31-18
South Carolina	State Program	4	98001	06-30-18 *
Tennessee	State Program	4	TN02961	06-30-18 *
Texas	NELAP	6	T104704185-16-9	11-30-18
Texas	State Program	6	T104704185	06-30-18 *
US Fish & Wildlife	Federal		LE058448-0	07-31-18
USDA	Federal		P330-17-00213	06-14-20 *
Virginia	NELAP	3	460161	06-14-18
Washington	State Program	10	C805	06-10-18
West Virginia (DW)	State Program	3	9950C	12-31-18
West Virginia DEP	State Program	3	094	06-30-18 *
Wisconsin	State Program	5	999819810	08-31-18
Wyoming	State Program	8	8TMS-L	06-30-16 *

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Client: INTERA Inc
Project/Site: EAA/NBU Water Quality Sampling Plan

TestAmerica Job ID: 560-73887-1

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL CC
6020	Metals (ICP/MS)	SW846	TAL CC
300.0	Anions, Ion Chromatography	MCAWW	TAL CC
340.2	Fluoride	MCAWW	TAL CC
351.2	Nitrogen, Total Kjeldahl	MCAWW	TAL SAV
365.3	Phosphorus, Orthophosphate	MCAWW	TAL CC
365.4	Phosphorus, Total	EPA	TAL SAV
9040C	pH	SW846	TAL CC
9060	Organic Carbon, Total (TOC)	SW846	TAL CC
SM 2320B	Alkalinity	SM	TAL CC
SM 2510B	Conductivity, Specific Conductance	SM	TAL CC
SM 2540C	Solids, Total Dissolved (TDS)	SM	TAL CC
SM 4500 NH3 G	Ammonia	SM	TAL CC
SM 5310B	Organic Carbon, Dissolved (DOC)	SM	TAL CC
3010A	Preparation, Total Metals	SW846	TAL CC
Digestion	Digestion, Hot Block	MCAWW	TAL SAV
FILTRATION	Sample Filtration	None	TAL CC

Protocol References:

EPA = US Environmental Protection Agency

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

None = None

SM = "Standard Methods For The Examination Of Water And Wastewater"

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CC = TestAmerica Corpus Christi, 1733 N. Padre Island Drive, Corpus Christi, TX 78408, TEL (361)289-2673

TAL SAV = TestAmerica Savannah, 5102 LaRoche Avenue, Savannah, GA 31404, TEL (912)354-7858

Sample Summary

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
560-73887-1	NBU-AW01 Upper	Water	05/23/18 21:40	05/26/18 10:26

TestAmerica Corpus Christi
1733 N. Padre Island Drive
Corpus Christi, TX 78408
Phone (361) 289-2673 Fax (361) 289-2471

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information	Sampler: F. Roecker	Lab PM: Maingot, Lindy	Carrier Tracking No(s):	COC No: 560-26233-3797.1
Client Contact: Frank Roecker	Phone: 678-485-4152	E-Mail: lindy.maingot@testamericainc.com		Page: Page 1 of 1
Company: INTERA Inc				Job #:
Address: 9600 Great Hills Trail Suite 300W	Due Date Requested:			
City: Austin	TAT Requested (days):			
State, Zip: TX, 78759				
Phone:	PO #: Purchase Order not required			
Email: froecker@intera.com	WO #:			
Project Name: Analytical Laboratory Services	Project #: 56006961			
Site: New Braunfels Utility	SSOW#:			

Loc: 560
73887

Preservation Codes:
A - HCL
B - NaC
C - Zn
D - Nitr
E - Nah
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)
Other:

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	SM5310_DOC_B - DIC and DOC SM5310_DOC_B Lab Filtered	SM4500NH3_G - Ammonia SM4500NH3_G	2320B Alkalinity, Bi-Carbonate, Carbonate, 300 Br, Cl, NO3, SO4, 340.2 Fluoride, 365.3_Ortho Phosphate, 9040C pH	6020 - (MOD) Dissolved Iron and Manganese 6020	6010B Silica, 6020 Special list of Metals	9060 TOC , SM5310_DOC and DIC_B	2510B Conductivity, 2540C_TDS	351.2 TKN (Savannah), 365.4 Total Phosphate (Savannah)	Total Number of containers	Special Instructions/Note:
				Preservation Code:			N	S	N	N	D	S	N	S		See Lab Project number 56006961
NBU-AW01 upper.	5/23/18	2140	G	Water			X	X	X	X	X	X	X	X		
				Water												

San Antonio
561

560-73887 Chain of Custody

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:	

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
[signature]	5/24/18 1000	INTERA	[signature]	5.26.18 10:26	

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks: .7 IR-10 .8

Ver: 08/04/2016

TestAmerica Corpus Christi
1733 N. Padre Island Drive
Corpus Christi, TX 78408
Phone (361) 289-2673 Fax (361) 289-2471

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Maingot, Lindy	Carrier Tracking No(s):	COC No: 560-17118.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: lindy.maingot@testamericainc.com	State of Origin: Texas	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Texas		Job #: 560-73887-1
Address: 5102 LaRoche Avenue, ,	Due Date Requested: 6/8/2018	**Analysis Requested**		**Preservation Codes:**
City: Savannah	TAT Requested (days):			
State, Zip: GA, 31404				
Phone: 912-354-7858(Tel) 912-352-0165(Fax)	PO #:			
Email:	WO #:			
Project Name: EAA/NBU Water Quality Sampling Plan	Project #: 56006987			
Site:	SSOW#:			Other:

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	351.2/Digest_P_HotBlk 351.2 - TKN (SAVANNAH)	365.4/Digest_P_HotBlk 365.4 - Total Phos (SAVANNAH)	Total Number of containers	Special Instructions/Note:
			Preservation Code:							
NBU-AW01 Upper (560-73887-1)	5/23/18	21:40 Central		Water			X	X	1	

Note: Since laboratory accreditations are subject to change, TestAmerica Laboratories, Inc. places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to TestAmerica Laboratories, Inc. attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to TestAmerica Laboratories, Inc.

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
J. Allen	5/29/18 1700		VM	5/30/18 0925	TASAV
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks: 4.6 (4.0) CUTAK -0.6

Ver: 09/20/2016

Login Sample Receipt Checklist

Client: INTERA Inc

Job Number: 560-73887-1

Login Number: 73887
List Number: 1
Creator: Van Joolen, Nickolas L

List Source: TestAmerica Corpus Christi

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	False	Refer to Job Narrative for details.
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: INTERA Inc

Job Number: 560-73887-1

Login Number: 73887
List Number: 2
Creator: Latta, Reginald L

List Source: TestAmerica Savannah
List Creation: 05/30/18 12:01 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	Received project as a subcontract.
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	N/A	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

10.8 Appendix H. Lower Edwards aquifer lab water quality report and field data

(Pending lab report)

Table 10-3: Table H-1 Field parameters from Lower interval sampling event #1

Date	Time	Temperature (°C)	pH (Su)	Specific Conductivity (uS/cm)	DO (mg/L)	Turbidity (NTU)
6/12/2018	14:50	27.70	6.64	11510	0.06	13.60
6/12/2018	14:55	27.76	6.64	11570	0.06	9.56
6/12/2018	15:00	27.79	6.64	11590	0.06	5.79
6/12/2018	15:05	27.63	6.64	11630	0.06	4.43
6/12/2018	15:10	27.74	6.63	11640	0.06	3.10

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

1 2 3 4 5 6 7 8 9 10 11

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Corpus Christi
1733 N. Padre Island Drive
Corpus Christi, TX 78408
Tel: (361)289-2673

TestAmerica Job ID: 560-74183-1
Client Project/Site: NBU AW01 6-12-18

For:
INTERA Inc
9600 Great Hills Trail
Suite 300W
Austin, Texas 78759

Attn: Frank Roecker

Authorized for release by:
7/2/2018 12:18:20 PM

Lindy Maingot, Project Manager I
(210)344-9751
lindy.maingot@testamericainc.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

1 2 3 4 5 6 7 8 9 10 11

Qualifiers

Metals

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
F1	MS and/or MSD Recovery is outside acceptance limits.
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.

General Chemistry

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
F1	MS and/or MSD Recovery is outside acceptance limits.
B	Compound was found in the blank and sample.
HF	Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

1 2 3 4 5 6 7 8 9 10 11

Job ID: 560-74183-1

Laboratory: TestAmerica Corpus Christi

Narrative

Job Narrative
560-74183-1

Comments
No additional comments.

Receipt
The sample was received on 6/14/2018 9:30 AM; the sample arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 0.7° C.

Metals
Method 3010A: The following samples requested dissolved metals and were not filtered in the field: NBU AW01 Lower (560-74183-1). These samples were filtered and preserved upon receipt to the laboratory.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
Method 300.0: The following sample was diluted due to the nature of the sample matrix: NBU AW01 Lower (560-74183-1). Elevated reporting limits (RLs) are provided.

Method 9060: The method blank for preparation batch 560-152019 and analytical batch 560-152016 contained DIC above the method detection limit. This target analyte concentration was less than half the reporting limit (1/2RL); therefore, re-analysis of samples was not performed.

Method 9040C: This analysis is normally performed in the field and has a method-defined holding time of 15 minutes. The following samples has been qualified with the "HF" flag to indicate analysis was performed in the laboratory outside the 15 minute timeframe: NBU AW01 Lower (560-74183-1), (CCV 560-152039/14), (CCV 560-152039/3), (ICV 560-152039/1), (LCS 560-152039/2), (560-74171-C-1) and (560-74171-C-1 DU).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: INTERA Inc
Project/Site: NBU AW01 6-12-18

TestAmerica Job ID: 560-74183-1

Client Sample ID: NBU AW01 Lower

Lab Sample ID: 560-74183-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
SiO2, Silica	15.5		1.10	0.152	mg/L	1		6010B	Total/NA
Arsenic	5.08		5.00	1.09	ug/L	1		6020	Total/NA
Chromium	2.74	J	5.00	1.40	ug/L	1		6020	Total/NA
Manganese	49.7	J	50.0	11.6	ug/L	1		6020	Total/NA
Selenium	1.16	J F1	5.00	1.08	ug/L	1		6020	Total/NA
Zinc	133		25.0	3.55	ug/L	1		6020	Total/NA
Calcium	1220000		50000	19800	ug/L	100		6020	Total/NA
Iron	576		250	101	ug/L	1		6020	Total/NA
Potassium	64400		1000	407	ug/L	1		6020	Total/NA
Magnesium	353000		500	113	ug/L	1		6020	Total/NA
Sodium	2180000		100000	72700	ug/L	100		6020	Total/NA
Vanadium	1.54	J	5.00	1.44	ug/L	1		6020	Total/NA
Strontium	28700		500	76.8	ug/L	100		6020	Total/NA
Manganese, Dissolved	49.0	J	50.0	11.6	ug/L	1		6020	Dissolved
Iron, Dissolved	131	J	250	101	ug/L	1		6020	Dissolved
Bromide	39.7	J	100	31.5	mg/L	100		300.0	Total/NA
Chloride	1790	F1	100	19.2	mg/L	100		300.0	Total/NA
Sulfate	1450	F1	100	37.7	mg/L	100		300.0	Total/NA
Fluoride	2.93		0.250	0.0500	mg/L	2.5		340.2	Total/NA
Nitrogen, Kjeldahl	5.01		0.200	0.100	mg/L	1		351.2	Total/NA
Orthophosphate as P	0.564		0.0300	0.0141	mg/L	1		365.3	Total/NA
Phosphates as P	1.16		0.100	0.0410	mg/L	1		365.4	Total/NA
pH	6.86	HF	0.100	0.100	SU	1		9040C	Total/NA
Total Organic Carbon	0.461	J	1.00	0.285	mg/L	1		9060	Total/NA
Total Alkalinity as CaCO3	281		5.00	5.00	mg/L	1		SM 2320B	Total/NA
Bicarbonate Alkalinity as CaCO3	281		5.00	5.00	mg/L	1		SM 2320B	Total/NA
Specific Conductivity	12100		1.00	1.00	umhos/cm	1		SM 2510B	Total/NA
Total Dissolved Solids	8520		100	100	mg/L	1		SM 2540C	Total/NA
Dissolved Organic Carbon	0.543	J	1.00	0.285	mg/L	1		SM 5310B	Dissolved
Dissolved Inorganic Carbon	87.6	B	1.00	0.285	mg/L	1		SM 5310B	Dissolved

This Detection Summary does not include radiochemical test results.

Client Sample ID: NBU AW01 Lower

Lab Sample ID: 560-74183-1

Date Collected: 06/12/18 15:40
Matrix: Water
Date Received: 06/14/18 09:30

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
SiO2, Silica	**15.5**		1.10	0.152	mg/L		06/18/18 09:03	06/19/18 14:19	1

Method: 6020 - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	<0.941		5.00	0.941	ug/L		06/18/18 09:03	06/20/18 14:13	1
Arsenic	**5.08**		5.00	1.09	ug/L		06/18/18 09:03	06/20/18 14:13	1
Beryllium	<1.24		4.00	1.24	ug/L		06/18/18 09:03	06/20/18 14:13	1
Cadmium	<0.854		2.00	0.854	ug/L		06/18/18 09:03	06/20/18 14:13	1
Chromium	**2.74**	**J**	5.00	1.40	ug/L		06/18/18 09:03	06/20/18 14:13	1
Copper	<2.00		10.0	2.00	ug/L		06/18/18 09:03	06/20/18 14:13	1
Manganese	**49.7**	**J**	50.0	11.6	ug/L		06/18/18 09:03	06/20/18 14:13	1
Nickel	<2.17		5.00	2.17	ug/L		06/18/18 09:03	06/20/18 14:13	1
Lead	<0.733		5.00	0.733	ug/L		06/18/18 09:03	06/20/18 14:13	1
Selenium	**1.16**	**J F1**	5.00	1.08	ug/L		06/18/18 09:03	06/20/18 14:13	1
Thallium	<0.693		2.00	0.693	ug/L		06/18/18 09:03	06/20/18 14:13	1
Zinc	**133**		25.0	3.55	ug/L		06/18/18 09:03	06/20/18 14:13	1
Antimony	<1.61		5.00	1.61	ug/L		06/18/18 09:03	06/20/18 14:13	1
Aluminum	<50.0		100	50.0	ug/L		06/18/18 09:03	06/20/18 14:13	1
Calcium	**1220000**		50000	19800	ug/L		06/18/18 09:03	06/20/18 18:18	100
Iron	**576**		250	101	ug/L		06/18/18 09:03	06/20/18 14:13	1
Potassium	**64400**		1000	407	ug/L		06/18/18 09:03	06/20/18 14:13	1
Magnesium	**353000**		500	113	ug/L		06/18/18 09:03	06/20/18 14:13	1
Sodium	**2180000**		100000	72700	ug/L		06/18/18 09:03	06/20/18 18:18	100
Vanadium	**1.54**	**J**	5.00	1.44	ug/L		06/18/18 09:03	06/20/18 14:13	1
Strontium	**28700**		500	76.8	ug/L		06/18/18 09:03	06/20/18 18:18	100

Method: 6020 - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Manganese, Dissolved	**49.0**	**J**	50.0	11.6	ug/L		06/18/18 09:03	06/20/18 14:37	1
Iron, Dissolved	**131**	**J**	250	101	ug/L		06/18/18 09:03	06/20/18 14:37	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Bromide	**39.7**	**J**	100	31.5	mg/L			06/14/18 12:33	100
Chloride	**1790**	**F1**	100	19.2	mg/L			06/14/18 12:33	100
Nitrate as N	<10.3	F1	50.0	10.3	mg/L			06/14/18 12:33	100
Sulfate	**1450**	**F1**	100	37.7	mg/L			06/14/18 12:33	100
Fluoride	**2.93**		0.250	0.0500	mg/L			06/19/18 16:30	2.5
Nitrogen, Kjeldahl	**5.01**		0.200	0.100	mg/L		06/21/18 10:11	06/22/18 12:31	1
Orthophosphate as P	**0.564**		0.0300	0.0141	mg/L			06/14/18 14:05	1
Phosphates as P	**1.16**		0.100	0.0410	mg/L		06/21/18 10:11	06/22/18 13:04	1
pH	**6.86**	**HF**	0.100	0.100	SU			06/18/18 10:05	1
Total Organic Carbon	**0.461**	**J**	1.00	0.285	mg/L			06/20/18 08:26	1
Total Alkalinity as CaCO3	**281**		5.00	5.00	mg/L			06/15/18 14:30	1
Bicarbonate Alkalinity as CaCO3	**281**		5.00	5.00	mg/L			06/15/18 14:30	1
Carbonate Alkalinity as CaCO3	<5.00		5.00	5.00	mg/L			06/15/18 14:30	1
Specific Conductivity	**12100**		1.00	1.00	umhos/cm			06/15/18 12:10	1
Total Dissolved Solids	**8520**		100	100	mg/L			06/18/18 09:13	1
Ammonia as N	<0.0450		0.200	0.0450	mg/L			06/22/18 14:24	1

Client Sample ID: NBU AW01 Lower
Lab Sample ID: 560-74183-1
Date Collected: 06/12/18 15:40
Matrix: Water
Date Received: 06/14/18 09:30

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon	0.543	J	1.00	0.285	mg/L			06/20/18 15:37	1
Dissolved Inorganic Carbon	87.6	B	1.00	0.285	mg/L			06/16/18 14:52	1

Method: 6020 - Metals (ICP/MS)

Lab Sample ID: MB 560-152024/1-A
Matrix: Water
Analysis Batch: 152149

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 152024

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	<0.941		5.00	0.941	ug/L		06/18/18 09:03	06/20/18 13:58	1
Arsenic	<1.09		5.00	1.09	ug/L		06/18/18 09:03	06/20/18 13:58	1
Beryllium	<1.24		4.00	1.24	ug/L		06/18/18 09:03	06/20/18 13:58	1
Cadmium	<0.854		2.00	0.854	ug/L		06/18/18 09:03	06/20/18 13:58	1
Chromium	<1.40		5.00	1.40	ug/L		06/18/18 09:03	06/20/18 13:58	1
Copper	<2.00		10.0	2.00	ug/L		06/18/18 09:03	06/20/18 13:58	1
Nickel	<2.17		5.00	2.17	ug/L		06/18/18 09:03	06/20/18 13:58	1
Lead	<0.733		5.00	0.733	ug/L		06/18/18 09:03	06/20/18 13:58	1
Selenium	<1.08		5.00	1.08	ug/L		06/18/18 09:03	06/20/18 13:58	1
Thallium	<0.693		2.00	0.693	ug/L		06/18/18 09:03	06/20/18 13:58	1
Zinc	<3.55		25.0	3.55	ug/L		06/18/18 09:03	06/20/18 13:58	1
Antimony	<1.61		5.00	1.61	ug/L		06/18/18 09:03	06/20/18 13:58	1
Aluminum	<50.0		100	50.0	ug/L		06/18/18 09:03	06/20/18 13:58	1
Calcium	<198		500	198	ug/L		06/18/18 09:03	06/20/18 13:58	1
Iron	<101		250	101	ug/L		06/18/18 09:03	06/20/18 13:58	1
Iron, Dissolved	<101		250	101	ug/L		06/18/18 09:03	06/20/18 13:58	1
Potassium	<407		1000	407	ug/L		06/18/18 09:03	06/20/18 13:58	1
Magnesium	<113		500	113	ug/L		06/18/18 09:03	06/20/18 13:58	1
Sodium	<727		1000	727	ug/L		06/18/18 09:03	06/20/18 13:58	1
Vanadium	<1.44		5.00	1.44	ug/L		06/18/18 09:03	06/20/18 13:58	1
Strontium	<0.768		5.00	0.768	ug/L		06/18/18 09:03	06/20/18 13:58	1

Lab Sample ID: MB 560-152024/1-A
Matrix: Water
Analysis Batch: 152183

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 152024

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	<0.941		5.00	0.941	ug/L		06/18/18 09:03	06/20/18 17:57	1
Arsenic	<1.09		5.00	1.09	ug/L		06/18/18 09:03	06/20/18 17:57	1
Beryllium	<1.24		4.00	1.24	ug/L		06/18/18 09:03	06/20/18 17:57	1
Cadmium	<0.854		2.00	0.854	ug/L		06/18/18 09:03	06/20/18 17:57	1
Chromium	<1.40		5.00	1.40	ug/L		06/18/18 09:03	06/20/18 17:57	1
Copper	<2.00		10.0	2.00	ug/L		06/18/18 09:03	06/20/18 17:57	1
Manganese	<11.6		50.0	11.6	ug/L		06/18/18 09:03	06/20/18 17:57	1
Manganese, Dissolved	<11.6		50.0	11.6	ug/L		06/18/18 09:03	06/20/18 17:57	1
Nickel	<2.17		5.00	2.17	ug/L		06/18/18 09:03	06/20/18 17:57	1
Lead	<0.733		5.00	0.733	ug/L		06/18/18 09:03	06/20/18 17:57	1
Selenium	<1.08		5.00	1.08	ug/L		06/18/18 09:03	06/20/18 17:57	1
Thallium	<0.693		2.00	0.693	ug/L		06/18/18 09:03	06/20/18 17:57	1
Zinc	<3.55		25.0	3.55	ug/L		06/18/18 09:03	06/20/18 17:57	1
Antimony	<1.61		5.00	1.61	ug/L		06/18/18 09:03	06/20/18 17:57	1
Aluminum	<50.0		100	50.0	ug/L		06/18/18 09:03	06/20/18 17:57	1
Calcium	<198		500	198	ug/L		06/18/18 09:03	06/20/18 17:57	1
Iron	<101		250	101	ug/L		06/18/18 09:03	06/20/18 17:57	1
Iron, Dissolved	<101		250	101	ug/L		06/18/18 09:03	06/20/18 17:57	1
Potassium	<407		1000	407	ug/L		06/18/18 09:03	06/20/18 17:57	1
Magnesium	<113		500	113	ug/L		06/18/18 09:03	06/20/18 17:57	1
Sodium	<727		1000	727	ug/L		06/18/18 09:03	06/20/18 17:57	1

1 2 3 4 5 6 7 8 9 10 11

Method: 6020 - Metals (ICP/MS) (Continued)

Lab Sample ID: MB 560-152024/1-A
Matrix: Water
Analysis Batch: 152183

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 152024

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Vanadium	<1.44		5.00	1.44	ug/L		06/18/18 09:03	06/20/18 17:57	1
Strontium	<0.768		5.00	0.768	ug/L		06/18/18 09:03	06/20/18 17:57	1

Lab Sample ID: LCS 560-152024/2-A
Matrix: Water
Analysis Batch: 152149

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 152024

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Silver	250	261.9		ug/L		105	80 - 120
Arsenic	250	247.2		ug/L		99	80 - 120
Beryllium	250	235.3		ug/L		94	80 - 120
Cadmium	250	234.4		ug/L		94	80 - 120
Chromium	250	230.6		ug/L		92	80 - 120
Copper	250	245.5		ug/L		98	80 - 120
Manganese	2500	2393		ug/L		96	80 - 120
Manganese, Dissolved	2500	2393		ug/L		96	80 - 120
Nickel	250	242.1		ug/L		97	80 - 120
Lead	250	232.0		ug/L		93	80 - 120
Selenium	250	248.9		ug/L		100	80 - 120
Thallium	100	90.00		ug/L		90	80 - 120
Zinc	250	250.5		ug/L		100	80 - 120
Antimony	250	233.3		ug/L		93	80 - 120
Aluminum	25000	26450		ug/L		106	80 - 120
Calcium	25000	23760		ug/L		95	80 - 120
Iron	25000	24220		ug/L		97	80 - 120
Iron, Dissolved	25000	24220		ug/L		97	80 - 120
Potassium	25000	23740		ug/L		95	80 - 120
Magnesium	25000	23390		ug/L		94	80 - 120
Sodium	25000	23730		ug/L		95	80 - 120
Vanadium	250	231.7		ug/L		93	80 - 120
Strontium	250	247.5		ug/L		99	80 - 120

Lab Sample ID: LCS 560-152024/2-A
Matrix: Water
Analysis Batch: 152183

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 152024

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Silver	250	260.1		ug/L		104	80 - 120
Arsenic	250	256.6		ug/L		103	80 - 120
Beryllium	250	228.8		ug/L		92	80 - 120
Cadmium	250	230.9		ug/L		92	80 - 120
Chromium	250	232.9		ug/L		93	80 - 120
Copper	250	253.7		ug/L		101	80 - 120
Manganese	2500	2450		ug/L		98	80 - 120
Manganese, Dissolved	2500	2450		ug/L		98	80 - 120
Nickel	250	252.6		ug/L		101	80 - 120
Lead	250	228.7		ug/L		91	80 - 120
Selenium	250	260.2		ug/L		104	80 - 120
Thallium	100	89.57		ug/L		90	80 - 120

QC Sample Results

Method: 6020 - Metals (ICP/MS) (Continued)

Lab Sample ID: LCS 560-152024/2-A
Matrix: Water
Analysis Batch: 152183

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 152024

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Zinc	250	262.4		ug/L		105	80 - 120
Antimony	250	230.4		ug/L		92	80 - 120
Aluminum	25000	27020		ug/L		108	80 - 120
Calcium	25000	23510		ug/L		94	80 - 120
Iron	25000	24750		ug/L		99	80 - 120
Iron, Dissolved	25000	24750		ug/L		99	80 - 120
Potassium	25000	23770		ug/L		95	80 - 120
Magnesium	25000	23360		ug/L		93	80 - 120
Sodium	25000	23660		ug/L		95	80 - 120
Vanadium	250	234.9		ug/L		94	80 - 120
Strontium	250	234.9		ug/L		94	80 - 120

Lab Sample ID: 560-74183-1 MS
Matrix: Water
Analysis Batch: 152149

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA
Prep Batch: 152024

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Silver	<0.941		250	257.8		ug/L		103	80 - 120
Arsenic	5.08		250	245.8		ug/L		96	80 - 120
Beryllium	<1.24		250	227.6		ug/L		91	80 - 120
Cadmium	<0.854		250	235.2		ug/L		94	80 - 120
Chromium	2.74	J	250	219.5		ug/L		87	80 - 120
Copper	<2.00		250	211.2		ug/L		84	80 - 120
Manganese	49.7	J	2500	2312		ug/L		90	80 - 120
Manganese, Dissolved	49.7	J	2500	2312		ug/L		90	80 - 120
Nickel	<2.17		250	211.8		ug/L		85	80 - 120
Lead	<0.733		250	211.6		ug/L		85	80 - 120
Selenium	1.16	J F1	250	141.3	F1	ug/L		56	80 - 120
Thallium	<0.693		100	84.10		ug/L		84	80 - 120
Zinc	133		250	342.6		ug/L		84	80 - 120
Antimony	<1.61		250	245.9		ug/L		98	80 - 120
Aluminum	<50.0		25000	26740		ug/L		107	80 - 120
Iron	576		25000	22810		ug/L		89	80 - 120
Iron, Dissolved	576		25000	22810		ug/L		89	80 - 120
Potassium	64400		25000	86570		ug/L		89	80 - 120
Magnesium	353000		25000	366200	4	ug/L		52	80 - 120
Vanadium	1.54	J	250	233.2		ug/L		93	80 - 120

Lab Sample ID: 560-74183-1 MSD
Matrix: Water
Analysis Batch: 152149

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA
Prep Batch: 152024

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Silver	<0.941		250	253.7		ug/L		101	80 - 120	2	20
Arsenic	5.08		250	252.0		ug/L		99	80 - 120	2	20
Beryllium	<1.24		250	223.4		ug/L		89	80 - 120	2	20
Cadmium	<0.854		250	235.2		ug/L		94	80 - 120	0	20
Chromium	2.74	J	250	223.9		ug/L		88	80 - 120	2	20
Copper	<2.00		250	214.8		ug/L		86	80 - 120	2	20

Method: 6020 - Metals (ICP/MS) (Continued)

Lab Sample ID: 560-74183-1 MSD
Matrix: Water
Analysis Batch: 152149

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA
Prep Batch: 152024

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Manganese	49.7	J	2500	2384		ug/L		93	80 - 120	3	20
Manganese, Dissolved	49.7	J	2500	2384		ug/L		93	80 - 120	3	20
Nickel	<2.17		250	217.5		ug/L		87	80 - 120	3	20
Lead	<0.733		250	213.3		ug/L		85	80 - 120	1	20
Selenium	1.16	J F1	250	142.1	F1	ug/L		56	80 - 120	1	20
Thallium	<0.693		100	85.60		ug/L		86	80 - 120	2	20
Zinc	133		250	371.5		ug/L		95	80 - 120	8	20
Antimony	<1.61		250	250.3		ug/L		100	80 - 120	2	20
Aluminum	<50.0		25000	27280		ug/L		109	80 - 120	2	20
Iron	576		25000	23500		ug/L		92	80 - 120	3	20
Iron, Dissolved	576		25000	23500		ug/L		92	80 - 120	3	20
Potassium	64400		25000	89150		ug/L		99	80 - 120	3	20
Magnesium	353000		25000	381900	4	ug/L		115	80 - 120	4	20
Vanadium	1.54	J	250	238.5		ug/L		95	80 - 120	2	20

Method: 300.0 - Anions, Ion Chromatography

Lab Sample ID: MB 560-151975/3
Matrix: Water
Analysis Batch: 151975

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Bromide	<0.315		1.00	0.315	mg/L			06/14/18 11:43	1
Chloride	<0.192		1.00	0.192	mg/L			06/14/18 11:43	1
Nitrate as N	<0.103		0.500	0.103	mg/L			06/14/18 11:43	1
Sulfate	<0.377		1.00	0.377	mg/L			06/14/18 11:43	1

Lab Sample ID: LCS 560-151975/4
Matrix: Water
Analysis Batch: 151975

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromide	5.00	4.945		mg/L		99	90 - 110
Chloride	10.0	10.06		mg/L		101	90 - 110
Nitrate as N	5.00	5.034		mg/L		101	90 - 110
Sulfate	20.0	20.93		mg/L		105	90 - 110

Lab Sample ID: 560-74183-1 MS
Matrix: Water
Analysis Batch: 151975

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Bromide	39.7	J	500	483.5		mg/L		89	80 - 120
Chloride	1790	F1	1000	3652	F1	mg/L		186	80 - 120
Nitrate as N	<10.3	F1	500	370.5	F1	mg/L		74	80 - 120
Sulfate	1450	F1	2000	4352	F1	mg/L		145	80 - 120

Method: 300.0 - Anions, Ion Chromatography (Continued)

Lab Sample ID: 560-74183-1 MSD
Matrix: Water
Analysis Batch: 151975

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Bromide	39.7	J	500	467.4		mg/L		86	80 - 120	3	20
Chloride	1790	F1	1000	3635	F1	mg/L		184	80 - 120	0	20
Nitrate as N	<10.3	F1	500	315.2	F1	mg/L		63	80 - 120	16	20
Sulfate	1450	F1	2000	4326	F1	mg/L		144	80 - 120	1	20

Method: 340.2 - Fluoride

Lab Sample ID: MB 560-152105/3
Matrix: Water
Analysis Batch: 152105

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	<0.0200		0.100	0.0200	mg/L			06/19/18 16:30	1

Lab Sample ID: LCS 560-152105/4
Matrix: Water
Analysis Batch: 152105

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Fluoride	0.800	0.8370		mg/L		105	85 - 115

Lab Sample ID: 560-74183-1 MS
Matrix: Water
Analysis Batch: 152105

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Fluoride	2.93		1.25	4.125		mg/L		96	75 - 125

Lab Sample ID: 560-74183-1 MSD
Matrix: Water
Analysis Batch: 152105

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Fluoride	2.93		1.25	4.175		mg/L		100	75 - 125	1	20

Method: 351.2 - Nitrogen, Total Kjeldahl

Lab Sample ID: MB 680-528764/10-A
Matrix: Water
Analysis Batch: 529007

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 528764

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrogen, Kjeldahl	<0.100		0.200	0.100	mg/L		06/21/18 10:11	06/22/18 12:09	1

Method: 351.2 - Nitrogen, Total Kjeldahl (Continued)

Lab Sample ID: LCS 680-528764/11-A
Matrix: Water
Analysis Batch: 529007

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 528764

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Nitrogen, Kjeldahl	2.00	2.230		mg/L		112	75 - 125

Lab Sample ID: 680-153992-A-1-B MS
Matrix: Water
Analysis Batch: 529007

Client Sample ID: Matrix Spike
Prep Type: Total/NA
Prep Batch: 528764

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Nitrogen, Kjeldahl	0.640		2.00	2.610		mg/L		99	75 - 125

Lab Sample ID: 680-153992-A-1-C MSD
Matrix: Water
Analysis Batch: 529007

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA
Prep Batch: 528764

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Nitrogen, Kjeldahl	0.640		2.00	2.920		mg/L		114	75 - 125	11	40

Method: 365.3 - Phosphorus, Orthophosphate

Lab Sample ID: MB 560-152316/3
Matrix: Water
Analysis Batch: 152316

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Orthophosphate as P	<0.0141		0.0300	0.0141	mg/L			06/14/18 14:05	1

Lab Sample ID: LCS 560-152316/4
Matrix: Water
Analysis Batch: 152316

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Orthophosphate as P	0.200	0.2060		mg/L		103	85 - 115

Lab Sample ID: 560-74183-1 MS
Matrix: Water
Analysis Batch: 152316

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Orthophosphate as P	0.564		0.200	0.7750		mg/L		106	75 - 125

Lab Sample ID: 560-74183-1 MSD
Matrix: Water
Analysis Batch: 152316

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Orthophosphate as P	0.564		0.200	0.7660		mg/L		101	75 - 125	1	20

Method: 365.4 - Phosphorus, Total

Lab Sample ID: MB 680-528764/10-A
Matrix: Water
Analysis Batch: 529006

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 528764

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Phosphates as P	<0.0410		0.100	0.0410	mg/L		06/21/18 10:11	06/22/18 12:09	1

Lab Sample ID: LCS 680-528764/11-A
Matrix: Water
Analysis Batch: 529006

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 528764

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Phosphates as P	2.00	2.220		mg/L		111	60 - 140

Lab Sample ID: 680-153992-A-1-B MS
Matrix: Water
Analysis Batch: 529006

Client Sample ID: Matrix Spike
Prep Type: Total/NA
Prep Batch: 528764

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Phosphates as P	0.152		2.00	2.560		mg/L		120	60 - 140

Lab Sample ID: 680-153992-A-1-C MSD
Matrix: Water
Analysis Batch: 529006

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA
Prep Batch: 528764

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Phosphates as P	0.152		2.00	2.340		mg/L		109	60 - 140	9	40

Method: 9040C - pH

Lab Sample ID: LCS 560-152039/2
Matrix: Water
Analysis Batch: 152039

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
pH	5.00	4.980		SU		100	98 - 102

Lab Sample ID: 560-74171-C-1 DU
Matrix: Water
Analysis Batch: 152039

Client Sample ID: Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
pH	7.76		7.770		SU		0.1	20

Method: 9060 - Organic Carbon, Total (TOC)

Lab Sample ID: MB 560-152112/3
Matrix: Water
Analysis Batch: 152112

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	<0.285		1.00	0.285	mg/L			06/20/18 08:26	1

Method: 9060 - Organic Carbon, Total (TOC) (Continued)

Lab Sample ID: LCS 560-152112/4
Matrix: Water
Analysis Batch: 152112

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	25.0	22.80		mg/L		91	80 - 120

Lab Sample ID: 560-74197-G-18 MS
Matrix: Water
Analysis Batch: 152112

Client Sample ID: Matrix Spike
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	1.23	F1	10.0	7.317	F1	mg/L		61	75 - 125

Lab Sample ID: 560-74197-G-18 MSD
Matrix: Water
Analysis Batch: 152112

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon	1.23	F1	10.0	7.447	F1	mg/L		62	75 - 125	2	20

Method: SM 2320B - Alkalinity

Lab Sample ID: MB 560-152006/1
Matrix: Water
Analysis Batch: 152006

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Alkalinity as CaCO3	<5.00		5.00	5.00	mg/L			06/15/18 14:30	1
Bicarbonate Alkalinity as CaCO3	<5.00		5.00	5.00	mg/L			06/15/18 14:30	1
Carbonate Alkalinity as CaCO3	<5.00		5.00	5.00	mg/L			06/15/18 14:30	1

Lab Sample ID: LCS 560-152006/2
Matrix: Water
Analysis Batch: 152006

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Alkalinity as CaCO3	100	85.00		mg/L		85	85 - 115

Lab Sample ID: 560-74104-E-1 DU
Matrix: Water
Analysis Batch: 152006

Client Sample ID: Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Alkalinity as CaCO3	119		118.0		mg/L		0.8	20
Bicarbonate Alkalinity as CaCO3	119		118.0		mg/L		0.8	
Carbonate Alkalinity as CaCO3	<5.00		<5.00		mg/L		NC	

Method: SM 2510B - Conductivity, Specific Conductance

Lab Sample ID: MB 560-151999/3
Matrix: Water
Analysis Batch: 151999

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Specific Conductivity	<1.00		1.00	1.00	umhos/cm			06/15/18 12:10	1

Lab Sample ID: LCS 560-151999/4
Matrix: Water
Analysis Batch: 151999

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Specific Conductivity	1000	961.0		umhos/cm		96	90 - 110

Lab Sample ID: 560-74121-A-1 DU
Matrix: Water
Analysis Batch: 151999

Client Sample ID: Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Specific Conductivity	67800		67800		umhos/cm		0	20

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 560-152075/1
Matrix: Water
Analysis Batch: 152075

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	<10.0		10.0	10.0	mg/L			06/18/18 09:13	1

Lab Sample ID: LCS 560-152075/2
Matrix: Water
Analysis Batch: 152075

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Dissolved Solids	2250	2068		mg/L		92	90 - 110

Lab Sample ID: 560-74183-1 DU
Matrix: Water
Analysis Batch: 152075

Client Sample ID: NBU AW01 Lower
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Dissolved Solids	8520		8670		mg/L		2	20

Method: SM 4500 NH3 G - Ammonia

Lab Sample ID: MB 560-152239/11
Matrix: Water
Analysis Batch: 152239

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ammonia as N	<0.0450		0.200	0.0450	mg/L			06/22/18 14:08	1

Method: SM 4500 NH3 G - Ammonia (Continued)

Lab Sample ID: LCS 560-152239/12
Matrix: Water
Analysis Batch: 152239

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Ammonia as N			2.50	2.565		mg/L		103	90 - 110		

Lab Sample ID: 560-74222-C-1 MS
Matrix: Water
Analysis Batch: 152239

Client Sample ID: Matrix Spike
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits		
Ammonia as N	<0.0450	F1	2.50	0.05700	J F1	mg/L		2	75 - 125		

Lab Sample ID: 560-74222-C-1 MSD
Matrix: Water
Analysis Batch: 152239

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Ammonia as N	<0.0450	F1	2.50	0.04700	J F1	mg/L		2	75 - 125	19	20

Method: SM 5310B - Organic Carbon, Dissolved (DOC)

Lab Sample ID: MB 560-152019/1-A
Matrix: Water
Analysis Batch: 152016

Client Sample ID: Method Blank
Prep Type: Dissolved

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Inorganic Carbon	0.3050	J	1.00	0.285	mg/L			06/16/18 14:52	1

Lab Sample ID: LCS 560-152019/2-A
Matrix: Water
Analysis Batch: 152016

Client Sample ID: Lab Control Sample
Prep Type: Dissolved

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Dissolved Inorganic Carbon			25.0	26.61		mg/L		106	80 - 120		

Lab Sample ID: MB 560-152019/1-A
Matrix: Water
Analysis Batch: 152150

Client Sample ID: Method Blank
Prep Type: Dissolved

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon	<0.285		1.00	0.285	mg/L			06/20/18 15:37	1

Lab Sample ID: LCS 560-152019/2-A
Matrix: Water
Analysis Batch: 152150

Client Sample ID: Lab Control Sample
Prep Type: Dissolved

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Dissolved Organic Carbon			25.0	24.41		mg/L		98	80 - 120		

Method: SM 5310B - Organic Carbon, Dissolved (DOC) (Continued)

Lab Sample ID: 560-73844-F-1 MS
Matrix: Water
Analysis Batch: 152150

Client Sample ID: Matrix Spike
Prep Type: Dissolved

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Dissolved Organic Carbon	1.07		10.0	10.79		mg/L		97	75 - 125

Lab Sample ID: 560-73844-F-1 MSD
Matrix: Water
Analysis Batch: 152150

Client Sample ID: Matrix Spike Duplicate
Prep Type: Dissolved

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Dissolved Organic Carbon	1.07		10.0	10.81		mg/L		97	75 - 125	0	20

Laboratory: TestAmerica Corpus Christi

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	EPA Region	Identification Number	Expiration Date
Texas	NELAP	6	T104704210-18-21	03-31-19

The following analytes are included in this report, but accreditation/certification is not offered by the governing authority:

Analysis Method	Prep Method	Matrix	Analyte
SM 2320B		Water	Bicarbonate Alkalinity as CaCO3
SM 2320B		Water	Carbonate Alkalinity as CaCO3
SM 2540C		Water	Total Dissolved Solids
SM 5310B		Water	Dissolved Inorganic Carbon
SM 5310B		Water	Dissolved Organic Carbon

Laboratory: TestAmerica Savannah

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
	AFCEE		SAVLAB	
Alabama	State Program	4	41450	06-30-18 *
Alaska	State Program	10		06-30-18 *
Alaska (UST)	State Program	10	UST-104	09-22-19
ANAB	DoD ELAP		L2463	09-22-19
Arizona	State Program	9	AZ0808	12-14-18
Arkansas DEQ	State Program	6	88-0692	02-01-19
California	State Program	9	2939	06-30-18 *
Colorado	State Program	8	N/A	12-31-18
Connecticut	State Program	1	PH-0161	03-31-19
Florida	NELAP	4	E87052	06-30-19
GA Dept. of Agriculture	State Program	4	N/A	06-12-19
Georgia	State Program	4	N/A	06-30-18 *
Georgia	State Program	4	803	06-30-18 *
Guam	State Program	9	15-005r	04-17-19
Hawaii	State Program	9	N/A	06-30-18 *
Illinois	NELAP	5	200022	11-30-18
Indiana	State Program	5	N/A	06-30-18 *
Iowa	State Program	7	353	06-30-19
Kentucky (DW)	State Program	4	90084	12-31-18
Kentucky (UST)	State Program	4	18	06-30-18 *
Kentucky (WW)	State Program	4	90084	12-31-18 *
L-A-B	ISO/IEC 17025		L2463.01	09-22-19
Louisiana	NELAP	6	30690	06-30-18 *
Louisiana (DW)	NELAP	6	LA160019	12-31-18
Maine	State Program	1	GA00006	09-24-18 *
Maryland	State Program	3	250	12-31-18
Massachusetts	State Program	1	M-GA006	06-30-18 *
Michigan	State Program	5	9925	06-30-18 *
Mississippi	State Program	4	N/A	06-30-18 *
Nebraska	State Program	7	TestAmerica-Savannah	06-30-18 *
New Jersey	NELAP	2	GA769	06-30-18 *
New Mexico	State Program	6	N/A	06-30-18 *
New York	NELAP	2	10842	03-31-19
North Carolina (DW)	State Program	4	13701	07-31-18 *
North Carolina (WW/SW)	State Program	4	269	12-31-18
Oklahoma	State Program	6	9984	08-31-18 *

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Laboratory: TestAmerica Savannah (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Pennsylvania	NELAP	3	68-00474	06-30-18 *
Puerto Rico	State Program	2	GA00006	12-31-18
South Carolina	State Program	4	98001	06-30-18 *
Tennessee	State Program	4	TN02961	06-30-18 *
Texas	NELAP	6	T104704185-16-9	11-30-18
Texas (DW)	State Program	1	T104704185	06-30-18 *
US Fish & Wildlife	Federal		LE058448-0	07-31-18 *
USDA	Federal		P330-17-00213	06-14-20 *
Washington	State Program	10	C805	06-10-19
West Virginia (DW)	State Program	3	9950C	12-31-18
West Virginia DEP	State Program	3	094	06-30-18 *
Wisconsin	State Program	5	999819810	08-31-18 *
Wyoming	State Program	8	8TMS-L	06-30-16 *

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Client: INTERA Inc
Project/Site: NBU AW01 6-12-18

TestAmerica Job ID: 560-74183-1

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL CC
6020	Metals (ICP/MS)	SW846	TAL CC
300.0	Anions, Ion Chromatography	MCAWW	TAL CC
340.2	Fluoride	MCAWW	TAL CC
351.2	Nitrogen, Total Kjeldahl	MCAWW	TAL SAV
365.3	Phosphorus, Orthophosphate	MCAWW	TAL CC
365.4	Phosphorus, Total	EPA	TAL SAV
9040C	pH	SW846	TAL CC
9060	Organic Carbon, Total (TOC)	SW846	TAL CC
SM 2320B	Alkalinity	SM	TAL CC
SM 2510B	Conductivity, Specific Conductance	SM	TAL CC
SM 2540C	Solids, Total Dissolved (TDS)	SM	TAL CC
SM 4500 NH3 G	Ammonia	SM	TAL CC
SM 5310B	Organic Carbon, Dissolved (DOC)	SM	TAL CC
3010A	Preparation, Total Metals	SW846	TAL CC
Digestion	Digestion, Hot Block	MCAWW	TAL SAV
FILTRATION	Sample Filtration	None	TAL CC

Protocol References:

EPA = US Environmental Protection Agency

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

None = None

SM = "Standard Methods For The Examination Of Water And Wastewater"

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CC = TestAmerica Corpus Christi, 1733 N. Padre Island Drive, Corpus Christi, TX 78408, TEL (361)289-2673

TAL SAV = TestAmerica Savannah, 5102 LaRoche Avenue, Savannah, GA 31404, TEL (912)354-7858

Sample Summary

Client: INTERA Inc
Project/Site: NBU AW01 6-12-18

TestAmerica Job ID: 560-74183-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
560-74183-1	NBU AW01 Lower	Water	06/12/18 15:40	06/14/18 09:30

TestAmerica Corpus Christi
1733 N. Padre Island Drive
Corpus Christi, TX 78408
Phone (361) 289-2673 Fax (361) 289-2471

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information	Sampler: F. Roecker / CG	Lab PM: Maingot, Lindy	Carrier Tracking No(s):	COC No: 560-26233-3797.1
Client Contact: Frank Roecker	Phone: (512) 425-2000	E-Mail: lindy.maingot@testamericainc.com		Page: Page 1 of 1
Company: INTERA Inc				Job #: Loc: 560 74183
Address: 9600 Great Hills Trail Suite 300W	Due Date Requested:			
City: Austin	TAT Requested (days):			
State, Zip: TX, 78759				
Phone: (512) 425-2000	PO #: Purchase Order not required			
Email: froecker@intera.com	WO #:			
Project Name: Analytical Laboratory Services	Project #: 56006961			
Site: NBU AW01	SSOW#:			

Analysis Requested

Preservation Codes: A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	SM5310_DOC_B - DIC and DOC SM5310_DOC_B Lab Filtered	SM4500NH3_G - Ammonia SM4500NH3_G	2320B Alkalinity, Bi-Carbonate, Carbonate, 300 Br, Cl, NO3, SO4, 340.2 Fluoride, 365.3_Ortho Phospahte, 9040C pH	6020 - (MOD) Dissolved Iron and Manganese 6020	6010B Silica, 6020 Special list of Metals	9060 TOC, SM5310_DOC and DIC_B	2510B Conductivity, 2540C_TDS	351.2 TKN (Savannah), 365.4 Total Phosphate (Savannah)	Total Number of containers	Special Instructions/Note:
				Preservation Code:			N	S	N	N	D	S	N	S		
NBU AW01 Lower (250mL plastic)	6/12/18	15:40	G	Water										X		S, I
NBU AW01 Lower (250mL plastic)	6/12/18	15:40	G	Water						X						I
NBU AW01 Lower (500mL plastic)	6/12/18	15:40	G	W				X								S, I
NBU AW01 Lower (500mL plastic)	6/12/18	15:40	G	W						X	X					D, I
NBU AW01 Lower (1L plastic)	6/12/18	15:40	G	W									X			I
NBU AW01 Lower (1L plastic)	6/12/18	15:40	G	W					X							I
NBU AW01 Lower (1L plastic	6/12/18	1540	G	W									X			I
NBU AW01 Lower (250mL amber)	6/12/18	1540	G	W			X									I
NBU AW01 Lower (250mL amber)	6/12/18	1540	G	W			X					X				S, I
NBU AW01 Lower (250mL amber)	6/12/18	1540	G	W			X					X				S, I

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For ______ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
[signature]	6/13/18 10:30	INTERA	[signature]	6/14/18 9:36	
Relinquished by:	Date/Time:			Date/Time:	Company
Relinquished by:	Date/Time:			Date/Time:	Company

Custody Seals Intact: ☑ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks: 0.6°C IR-10 0.7°C

560-74183 Chain of Custody

Ver: 08/04/2016

TestAmerica Corpus Christi
1733 N. Padre Island Drive
Corpus Christi, TX 78408
Phone (361) 289-2673 Fax (361) 289-2471

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Maingot, Lindy	Carrier Tracking No(s):	COC No: 560-17190.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: lindy.maingot@testamericainc.com	State of Origin: Texas	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Texas		Job #: 560-74183-1
Address: 5102 LaRoche Avenue,	Due Date Requested: 6/26/2018	**Analysis Requested**		Preservation Codes:
City: Savannah	TAT Requested (days):			
State, Zip: GA, 31404				
Phone: 912-354-7858(Tel) 912-352-0165(Fax)	PO #:			
Email:	WO #:			
Project Name: EAA/NBU Water Quality Sampling Plan	Project #: 56006987			
Site:	SSOW#:			

Preservation Codes:
A - HCL; B - NaOH; C - Zn Acetate; D - Nitric Acid; E - NaHSO4; F - MeOH; G - Amchlor; H - Ascorbic Acid; I - Ice; J - DI Water; K - EDTA; L - EDA
M - Hexane; N - None; O - AsNaO2; P - Na2O4S; Q - Na2SO3; R - Na2S2O3; S - H2SO4; T - TSP Dodecahydrate; U - Acetone; V - MCAA; W - pH 4-5; Z - other (specify)
Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	365.4/Digest_P_HotBlk 365.4 - Total Phos (SAVANNAH)	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
NBU AW01 Lower (560-74183-1)	6/12/18	15:40 Central		Water			X	1	

Note: Since laboratory accreditations are subject to change, TestAmerica Laboratories, Inc. places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to TestAmerica Laboratories, Inc. attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to TestAmerica Laboratories, Inc.

Possible Hazard Identification *Unconfirmed*	*Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)* ☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*
Deliverable Requested: I, II, III, IV, Other (specify) — Primary Deliverable Rank: 2	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Relinquished by: J. Tae	Date/Time: 6/15/18 1700	Company:	Received by: AW #4 TASAN	Date/Time: 6/16/18 1005	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks: 2.7 C2.6) CUTR22-01

Ver: 09/20/2016

TestAmerica Corpus Christi
1733 N. Padre Island Drive
Corpus Christi, TX 78408
Phone (361) 289-2673 Fax (361) 289-2471

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Boyken, Nicole M	Carrier Tracking No(s):	COC No: 560-17190.2
Client Contact: Shipping/Receiving	Phone:	E-Mail: nicole.boyken@testamericainc.com	State of Origin: Texas	Page: Page 2 of 2
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Texas		Job #: 560-74186-1
Address: 5102 LaRoche Avenue,	Due Date Requested: 6/20/2018			
City: Savannah	TAT Requested (days):			
State, Zip: GA, 31404				
Phone: 912-354-7858(Tel) 912-352-0165(Fax)	PO #:			
Email:	WO #:			
Project Name: Monthly Water Treatment	Project #: 56001289			
Site:	SSOW#:			

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	SM5910B/ UV254 (SAVANNAH)	SUVA_Calc/ SUVA (SAVANNAH)	SM5310_DOC_B/FILTRATION DOC (SAVANNAH)	524.2_Preserved/ TTHMs (SAVANNAH)	Total Number of containers	Special Instructions/Note:
			Preservation Code:									
Colombia Tap (560-74186-19)	6/13/18	14:00 Central		Water						X	3	
COL. SETTLED (560-74186-20)	6/13/18	13:50 Central		Water						X	3	

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Note: Since laboratory accreditations are subject to change, TestAmerica Laboratories, Inc. places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. I

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For ______ Months*

Deliverable Requested: I, II, III, IV, Other (specify) — Primary Deliverable Rank: 2

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:		
Relinquished by: [signature]	Date/Time: 6/15/18 1700	Company	Received by: [signature] TASH	Date/Time: 6/16/18 1005	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks: 2.7 (2.6) (UT122-0.)

Ver: 09/20/2016

Login Sample Receipt Checklist

Client: INTERA Inc | Job Number: 560-74183-1

Login Number: 74183 | **List Source: TestAmerica Corpus Christi**
List Number: 1
Creator: Adams, Juanita A

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: INTERA Inc

Job Number: 560-74183-1

Login Number: 74183
List Number: 2
Creator: Latta, Reginald L

List Source: TestAmerica Savannah
List Creation: 06/16/18 11:33 AM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	N/A	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

10.9 Appendix I. Drilling and completion report

STATE OF TEXAS WELL REPORT for Tracking #482564

Owner:	**New Braunfels Utilities**	Owner Well #:	**No Data**
Address:	**355 FM 306** **New Braunfels, TX 78130**	Grid #:	**68-24-5**
Well Location:	**1423 Saur Lane** **New Braunfels, TX 78130**	Latitude:	**29° 42' 17.1" N**
		Longitude:	**098° 03' 12.2" W**
Well County:	**Guadalupe**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **3/20/2018** Drilling End Date: **5/29/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
28	**0**	**59**
15	**59**	**545**
6.75	**545**	**945**

Drilling Method: **Air Rotary**

Borehole Completion: **Open Hole**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement 3 Yards**
0	**545**	**Cement 200 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Variance Number: **EAA**

Distance to Property Line (ft.): **12**

Distance to Septic Field or other concentrated contamination (ft.): **N/A**

Distance to Septic Tank (ft.): **N/A**

Method of Verification: **Tape**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **39 ft.** below land surface on **2018-05-29**

Packers: **Screen at 543 ft.**
Rubber at 544 ft.

Type of Pump: **No Data**

Well Tests: **Estimated** **Yield: 500+ GPM**

Water Quality:

Strata Depth (ft.)	Water Type
610 - 660	**Brackish**
740 - 760	**BRackish**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **Yes**

Top Depth (ft.)	Bottom Depth (ft.)	Natural Injurious Constituents	Unnatural Injurious Constituents
610	**660**	**Saline/Brackish**	
740	**760**	**Saline/Brackish**	

The driller did certify that while drilling, deepening or otherwise altering the above described well, injurious water or constituents was encountered and the landowner or person having the well drilled was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Kutscher Drilling**

3810 Hunter Road
San Marcos, TX 78666

Driller Name: **Daniel Kutscher** License Number: **54746**

Apprentice Name: **Derek Scott** Apprentice Number: **59574**

Comments: **Brackish water with high levels of H2S and low Ph**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**Top Soil and Clay**
6	**33**	**Tan and White Clay**
33	**50**	**Gravel and Tan Clay**
50	**280**	**Blue Clay- Taylor**
280	**295**	**Austin Chalk**
295	**413**	**Harder Cream Austin Chalk**
413	**438**	**Eagle Ford Shale**
438	**533**	**Del Rio Caly**
533	**590**	**Georgetown- Light Grey Dolomite with Fossils**
590	**610**	**Dark Yellow Brown Shale**
610	**690**	**Brown Limestone- Edwards**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
20	**Blank**	**New Steel**	**STD WALL**	**0**	**59**
10	**Blank**	**New Plastic (PVC)**	**SDR 17**	**0**	**545**

690	**945**	**Edwards Limestone**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

10.10 Appendix J. Recharge water quality data and analysis summary

POLLUTION CONTROL SERVICES

NELAP ACCREDITED TNI LABORATORY

Report of Sample Analysis

Client Information	Sample Information	Laboratory Information
Trish Soechting New Braunfels Utilities P.O. Box 310289 New Braunfels, TX 78131-0289	Project Name: Surface Water Plant Sample ID: 06061885 Matrix: Drinking Water Date/Time Taken: 06/06/2018 1006	**PCS Sample #: 513998** **Page 1 of 4** Date/Time Received: 06/06/2018 12:23 Report Date: 06/21/2018 Approved by: Chuck Wallgren Chuck Wallgren, President

Test Description	Result	Units	RL	Analysis Date/Time	Method	Analyst
Phosphate, Ortho	<0.20	mg/L	0.1	06/06/2018 08:17	EPA 300.0	PLP
Ammonia-N (ISE)	0.7	mg/L	0.1	06/06/2018 12:30	SM 4500-NH3 D	CRM
Chloride	30	mg/L	1	06/06/2018 08:17	EPA 300.0	PLP
Nitrate-N	0.7	mg/L	0.1	06/06/2018 08:17	EPA 300.0	PLP
Phosphorus, Total	<0.1	mg/L	0.10	06/08/2018 07:00	SM 4500-P/B/E	JAS
Sulfate	30	mg/L	1	06/06/2018 08:17	EPA 300.0	PLP
Fluoride	0.23	mg/L	0.10	06/06/2018 08:17	EPA 300.0	PLP

Quality Assurance Summary

Test Description	Precision	Limit	LCL	MS	MSD	UCL	LCS	LCS Limit
Phosphate, Ortho	1	10	86	91	91	112	91	85 - 115
Ammonia-N (ISE)	<1	10	90	102	103	110	98	85 - 115
Chloride	<1	10	89	96	96	104	100	85 - 115
Nitrate-N	<1	20	70	98	98	130	101	85 - 115
Phosphorus, Total	1	10	95	99	100	104	99	85 - 115
Sulfate	<1	10	86	96	96	104	100	85 - 115
Fluoride	1	10	86	96	95	109	97	85 - 115

Quality Statement: *All supporting quality control data adhered to data quality objectives and test results meet the requirements of NELAC unless otherwise noted as flagged exceptions or in a case narrative attachment. Reports with full quality data deliverables are available on request. TCEQ Certificate No. T104704361-17-13*

These analytical results relate only to the sample tested.
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RL = Reporting Limits

QC Data Reported in %, Except BOD in mg/L

POLLUTION CONTROL SERVICES

Report of Sample Analysis

Client Information	Sample Information	Laboratory Information
Trish Soechting New Braunfels Utilities P.O. Box 310289 New Braunfels, TX 78131-0289	Project Name: Surface Water Plant Sample ID: 06061885 Matrix: Drinking Water Date/Time Taken: 06/06/2018 1006	**PCS Sample #: 513998** **Page 2 of 4** Date/Time Received: 06/06/2018 12:23 Report Date: 06/21/2018

Test Description	Flag	Result	Units	RL	Analysis Date/Time	Method	Analyst
Kjeldahl-N, Total		2	mg/L	1	06/13/2018 09:00	SM 4500-N B/E	CRM
Alkalinity, Bicarbonate	!	174	mg/L	10	06/08/2018 10:06	SM 2320 B	CRM
Phenolphthalein Alkalinity		<10	mg/L	10	06/08/2018 10:06	SM 2320 B	CRM
Alkalinity, Total	!	174	mg/L	10	06/08/2018 10:06	SM 2320 B	CRM
Cadmium/ICP (Total)		<0.005	mg/L	0.005	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Copper/ICP (Total)		0.100	mg/L	0.005	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Calcium/ICP (Total)		56.2	mg/L	1.00	06/14/2018 08:53	EPA 200.7 / 6010 B	DJL

Quality Assurance Summary

Test Description	Precision	Limit	LCL	MS	MSD	UCL	LCS	LCS Limit
Kjeldahl-N, Total	<1	10	93	101	101	108	106	85 - 115
Alkalinity, Bicarbonate	<1	10	95	100	100	107	102	85 - 115
Phenolphthalein Alkalinity	<1	10	95	100	100	107	102	85 - 115
Alkalinity, Total	<1	10	95	100	100	107	102	85 - 115
Cadmium/ICP (Total)	1	20	75	92	93	125	95	85 - 115
Copper/ICP (Total)	<1	20	75	91	91	125	95	85 - 115
Calcium/ICP (Total)	<1	20	75	*N/C	*N/C	125	90	85 - 115

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! *Not NELAP Certifiable Parameter*
* *Approved for release per QA Plan, Exception to Limits - QAM Section 13-4*

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RL = Reporting Limits

QC Data Reported in %, Except BOD in mg/L
N/C = Not Calculated, Sample Concentration Greater than 5 Times the Spike Level

POLLUTION CONTROL SERVICES

Report of Sample Analysis

Client Information	Sample Information	Laboratory Information
Trish Soechting New Braunfels Utilities P.O. Box 310289 New Braunfels, TX 78131-0289	Project Name: Surface Water Plant Sample ID: 06061885 Matrix: Drinking Water Date/Time Taken: 06/06/2018 1006	**PCS Sample #: 513998** Date/Time Received: 06/06/2018 12:23 Report Date: 06/21/2018

Test Description	Result	Units	RL	Analysis Date/Time	Method	Analyst
Aluminum/ICP (Total)	0.180	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Iron/ICP (Dissolved)	<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Iron/ICP (Total)	<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Magnesium/ICP (Total)	17.3	mg/L	1.00	06/14/2018 08:53	EPA 200.7 / 6010 B	DJL
Potassium/ICP (Total)	2.19	mg/L	1.00	06/14/2018 08:53	EPA 200.7 / 6010 B	DJL
Silica as SiO2	11.7	mg/L	2.14	06/14/2018 08:53	EPA 200.7 / 6010B	DJL
Sodium/ICP (Total)	12.6	mg/L	1.00	06/14/2018 08:53	EPA 200.7 / 6010 B	DJL

Quality Assurance Summary

Test Description	Precision	Limit	LCL	MS	MSD	UCL	LCS	LCS Limit
Aluminum/ICP (Total)	<1	20	75	93	93	125	95	85 - 115
Iron/ICP (Dissolved)	1	20	75	93	94	125	100	85 - 115
Iron/ICP (Total)	1	20	75	93	94	125	100	85 - 115
Magnesium/ICP (Total)	<1	20	75	*N/C	*N/C	125	93	85 - 115
Potassium/ICP (Total)	<1	20	75	97	97	125	96	85 - 115
Silica as SiO2	2	20	70	100	103	130	105	85 - 115
Sodium/ICP (Total)	<1	20	75	99	100	125	92	85 - 115

Quality Statement: ***All supporting quality control data adhered to data quality objectives and test results meet the requirements of NELAC unless otherwise noted as flagged exceptions or in a case narrative attachment. Reports with full quality data deliverables are available on request. TCEQ Certificate No. T104704361-17-13***

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RL = Reporting Limits

QC Data Reported in %, Except BOD in mg/L
N/C = Not Calculated, Sample Concentration Greater than 5 Times the Spike Level

Web Site: www.pcslab.net **Toll Free 800-880-4616** **1532 Universal City Blvd, Suite 100** **210-340-0343** **FAX # 210-658-7903**
e-mail: chuck@pcslab.net **Universal City, TX 78148-3318**

POLLUTION CONTROL SERVICES

Report of Sample Analysis

Client Information	Sample Information	Laboratory Information
Trish Soechting New Braunfels Utilities P.O. Box 310289 New Braunfels, TX 78131-0289	Project Name: Surface Water Plant Sample ID: 06061885 Matrix: Drinking Water Date/Time Taken: 06/06/2018 1006	**PCS Sample #: 513998** **Page 4 of 4** Date/Time Received: 06/06/2018 12:23 Report Date: 06/21/2018

Test Description	Flag	Result	Units	RL	Analysis Date/Time	Method	Analyst
Manganese/ICP (Dissolved)		<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Manganese/ICP (Total)		<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Zinc/ICP (Total)		<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Selenium/ICP (Total)		<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Dissolved Organic Carbon	!	2.54	mg/L	1	06/19/2018 12:31	SM 5310 C	DJL
Total Organic Carbon	!	2.59	mg/L	1	06/19/2018 12:31	SM 5310 C	DJL

Quality Assurance Summary

Test Description	Precision	Limit	LCL	MS	MSD	UCL	LCS	LCS Limit
Manganese/ICP (Dissolved)	1	20	75	90	91	125	95	85 - 115
Manganese/ICP (Total)	1	20	75	90	91	125	95	85 - 115
Zinc/ICP (Total)	1	20	75	88	89	125	95	85 - 115
Selenium/ICP (Total)	2	20	75	92	94	125	95	85 - 115
Dissolved Organic Carbon	<1	10	88	98	98	108	105	85 - 115
Total Organic Carbon	<1	10	88	98	98	108	105	85 - 115

Quality Statement: ***All supporting quality control data adhered to data quality objectives and test results meet the requirements of NELAC unless otherwise noted as flagged exceptions or in a case narrative attachment. Reports with full quality data deliverables are available on request. TCEQ Certificate No. T104704361-17-13***

! *Not NELAP Certifiable Parameter*

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RL = Reporting Limits

QC Data Reported in %, Except BOD in mg/L

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Universal City, TX 78148-3318
210-340-0343
FAX # 210-658-7903

Pollution Control Services
Mineral Analysis QA Check - Stabler Formula

PCS Sample#: **513998**

Cation Results

mg/L		me/L
<0.010	Iron/ICP (Total)	0.0000
12.6	Sodium/ICP (Total)	0.5481
56.2	Calcium/ICP (Total)	2.8044
17.3	Magnesium/ICP (Total)	1.4221
2.19	Potassium/ICP (Total)	0.0561
<0.010	Manganese/ICP (Total)	0.0000
	Sum Cations (me/L):	4.8307

Anion Results

mg/L		me/L
<10	Phenolphthalein Alkalinity	0.0000
0.7	Nitrate-N	0.0113
174	Alkalinity, Bicarbonate	3.4814
30	Sulfate	0.6240
30	Chloride	0.8460
0.23	Fluoride	0.0121
	Sum Anions (me/L):	4.9748

%Error: 1.4696

POLLUTION CONTROL SERVICES

Chain of Custody Number: 513998

MULTIPLE SAMPLE ANALYSIS REQUEST AND CHAIN OF CUSTODY FORM

Stamp 1st sample and COC as same number

CUSTOMER INFORMATION	REPORT INFORMATION		
Name: New Braunfels Utilities	Attention: Trish Soechting	Phone: (830) 608-8905	Fax: (830) 626-1361

SAMPLE INFORMATION

Project Information: Location 1 Surface water plant

Report "Soils" ☐ As Is ☐ Dry Wt.

Collected By: Dustin Lawrence

Requested Analysis: T-Alk, O-P, Cl, BiCarb | NO3N, F, SO4, DOC | NH3N, TKN, TP, TPO4P | TOC | metals | Dissolved metals

Instructions/Comments:

Client / Field Sample ID	Collected Date	Collected Time	Field Chlorine Residual mg/L	Composite or Grab	Matrix	Container Type	Number	Preservative	T-Alk, O-P, Cl, BiCarb	NO3N, F, SO4, DOC	NH3N, TKN, TP, TPO4P	TOC	metals	Dissolved metals			PCS Sample Number
Surface water plant 06061885	Start: 6-6-18 End: 6-6-18	Start: 1006 End: 1006		■ G	■ DW	■ P	1	■ ICE	X	X							513998 ☒S ☐B ☒N ☐HEM Other: P, N2
"	Start: " End: "	Start: " End: "		■ G	■ DW	■ P	1	■ H2SO4 ■ ICE			X	~~X~~ TS					☐S ☐B ☐N ☐HEM Other:
"	Start: " End: "	Start: " End: "		■ G	■ DW	■ P	1	■ H3PO4 ■ ICE				X					☐S ☐B ☐N ☐HEM Other:
"	Start: " End: "	Start: " End: "		■ G	■ DW	■ P	1	■ HNO3 ■ ICE					X				☐S ☐B ☐N ☐HEM Other:
"	Start: " End: "	Start: " End: "		■ G	■ DW	■ P	1	■ ICE						X			☐S ☐B ☐N ☐HEM Other:
	Start: End:	Start: End:		☐ C ☐ G	☐ DW ☐ NPW ☐ WW ☐ Soil ☐ Sludge ☐ LW ☐ Other	☐P ☐G ☐O		☐ H2SO4 ☐ HNO3 ☐ H3PO4 ☐ NaOH ☐ ICE ☐									☐S ☐B ☐N ☐HEM Other:
	Start: End:	Start: End:		☐ C ☐ G	☐ DW ☐ NPW ☐ WW ☐ Soil ☐ Sludge ☐ LW ☐ Other	☐P ☐G ☐O		☐ H2SO4 ☐ HNO3 ☐ H3PO4 ☐ NaOH ☐ ICE ☐									☐S ☐B ☐N ☐HEM Other:
	Start: End:	Start: End:		☐ C ☐ G	☐ DW ☐ NPW ☐ WW ☐ Soil ☐ Sludge ☐ LW ☐ Other	☐P ☐G ☐O		☐ H2SO4 ☐ HNO3 ☐ H3PO4 ☐ NaOH ☐ ICE ☐									☐S ☐B ☐N ☐HEM Other:

Matrix: DW-Drinking Water; NPW-Non-potable water; WW-Wastewater; LW-Liquid Waste

Required Turnaround: ☒ Routine (6-10 days) *EXPEDITE*: (See Surcharge Schedule) ☐ < 8 Hrs. ☐ < 16 Hrs. ☐ < 24 Hrs. ☐ 5 days ☐ Other: *Rush Charges Authorized by:*

Sample Archive/Disposal: ☐ Laboratory Standard ☐ Hold for client pick up

Container Type: P = Plastic, G = Glass, O = Other | Carrier ID:

Relinquished By:	Dustin [signature]	Date:	6-6-18	Time:	1126	Received By:	Trish Soechting	Date: 6-6-18	Time: 1126
Relinquished By:	Trish Soechting	Date:	6-6-18	Time:	1223	Received By:	[signature]	Date: 6-6-18	Time: 1223

Rev. Multiple Sample COC 20120201

1532 Universal City Blvd., Ste. 100, Universal City, Texas 78148
P (210) 340-0343 or (800) 880-4616 - F (210) 658-7903

* see attachment

Login at www.pcslab.net
TCEQ NELAP T104704361-TX

From: Trish Soechting [mailto:tsoechting@nbutexas.com]
Sent: Monday, June 04, 2018 10:40
To: Michael Klang
Subject: water test

Hi Michael, here is the list. There 27 at 2 locations.

Total Alkalinity	—
Chloride	
Fluoride	
Sulfate	
Carbonate Alkalinity	— <7.3
Bicarbonate Alkalinity	—
Silicon	
Calcium	
Magnesium	
Sodium	
Potassium	
Iron, Total	
Iron, Dissolved	
Aluminum	
Copper	
Manganese, Total	
Manganese, Dissolved	
Zinc	
Cadmium	
Selenium	
Nitrate	
Phosphorus, Total	
Phosphorus, Orthophosphate	
Ammonia	
Total Kjeldahl Nitrogen	
Total Organic Carbon	
Dissolved Organic Carbon	

NBU New Braunfels Utilities

Trish Soechting
Laboratory Supervisor
1922 Kuehler | New Braunfels, Texas 78130
tsoechting@nbutexas.com | 830.608.8905

Pollution Control Services

Sample Log-In Checklist

PCS Sample No(s) 513998 COC No. 513998

Client/Company Name: NBU Checklist Completed by: EV

Sample Delivery to Lab Via:

Client Drop Off ✓ Commercial Carrier: Bus ____ UPS ____ Lone Star ____ FedEx ____ USPS ____

PCS Field Services: Collection/Pick Up____ Other:________

Sample Kit/Coolers

Sample Kit/Cooler? Yes ✓ No____ Sample Kit/Cooler: Intact? Yes ✓ No___

Custody Seals on Sample Kit/Cooler: Not Present ✓ If Present, Intact ___ Broken ___

Sample Containers Intact; Unbroken and Not Leaking? Yes ✓ No ___

Custody Seals on Sample Bottles: Not Present ✓ If Present, Intact ___ Broken ___

COC Present with Shipment or Delivery or Completed at Drop Off? Yes ✓ No ___

Has COC sample date/time and other pertinent information been provided by client/sampler? Yes: ✓ No: ___

Has COC been properly Signed when Received/Relinquished? Yes ✓ No ___

Does COC agree with Sample Bottle Information, Bottle Types, Preservation, etc.? Yes ✓ No ___

All Samples Received before Hold Time Expiration? Yes ✓ No ___

Sufficient Sample Volumes for Analysis Requested? Yes ✓ No ___

Zero Headspace in VOA Vial if Present? Yes ___ No ___

Sample Preservation:

* *Cooling:* **Not Required** ______ or **Required** ✓

If cooling required, record temperature of submitted samples Observed/Corrected 14 / 11 °C

Is Ice Present in Sample Kit/Cooler? ✓ Yes ____ No Samples received same day as collected? ✓ Yes ____ No

Lab Thermometer Make and Serial Number: EX Tech 10093657 Other: ________

Acid Preserved Sample - If present, is pH <2? Yes ✓ No ___ ** ✓ H_2SO_4 ✓ HNO_3 ✓ H_3PO_4

Base Preserved Sample - If present, is pH >12? Yes ___ No ___ ____ NaOH

Other Preservation:________ If Present, Meets Requirements? Yes____ No____

Sample Preservations Checked by: EV Date 6-6-18 Time 12:30

pH paper used to check sample preservation (PCS log #): 18-028 (HEM pH checked at analysis).

Samples Preserved/Adjusted by Lab:	Lab #	Parameters Preserved	Preservative Used	Log #

Adjusted by Tech/Analyst:________ Date :________ Time:________

Client Notification/ Documentation for "No" Responses Above/ Discrepancies/ Revision Comments

Person Notified: ________ Contacted by:________

Notified Date: ________ Time: ________

Method of Contact: At Drop Off:____ Phone ___ Left Voice Mail ___ E-Mail ___ Fax ___

Unable to Contact____ Authorized Laboratory to Proceed :________(Lab Director)

Regarding / Comments:________

Actions taken to correct problems/discrepancies:________

Receiving qualifier needed (*requires client notification above*) Temp. ___ Holding Time ___ Initails: ________

Receiving qualifier entered into LIMS at login Initial/Date: ________

Revision Comments: ________

** Samples submitted for Metals Analysis (except Hex Cr) or Drinking Water for Coliform Bacteria Only are not required to be iced. Samples collected prior day to receipt at the laboratory must meet method specific thermal cooling requirements, "or will be flagged accordingly". Samples delivered the same day as collected may not meet thermal criteria, but shall be considered acceptable if evidence that the chilling process has begun, such as arrival on ice (EPA 815-F-08-006, June 2008). ** Water samples for metals analysis that are not acid preserved prior to shipment may be acceptably preserved by the laboratory on receipt – however, the sample digestion procedure must be delayed for at least 24 hours after preservation by the laboratory.*

POLLUTION CONTROL SERVICES

Report of Sample Analysis

Client Information	Sample Information	Laboratory Information
Trish Soechting New Braunfels Utilities P.O. Box 310289 New Braunfels, TX 78131-0289	Project Name: Well #5 Sample ID: 06061886 Matrix: Drinking Water Date/Time Taken: 06/06/2018 1034	**PCS Sample #: 513999** **Page 1 of 4** Date/Time Received: 06/06/2018 12:23 Report Date: 06/21/2018 Approved by: Chuck Wallgren Chuck Wallgren, President

Test Description	Result	Units	RL	Analysis Date/Time	Method	Analyst
Phosphate, Ortho	<0.20	mg/L	0.1	06/06/2018 08:17	EPA 300.0	PLP
Ammonia-N (ISE)	<0.1	mg/L	0.1	06/06/2018 12:30	SM 4500-NH3 D	CRM
Chloride	19	mg/L	1	06/06/2018 08:17	EPA 300.0	PLP
Nitrate-N	1.9	mg/L	0.1	06/06/2018 08:17	EPA 300.0	PLP
Phosphorus, Total	<0.1	mg/L	0.10	06/08/2018 07:00	SM 4500-P/B/E	JAS
Sulfate	31	mg/L	1	06/06/2018 08:17	EPA 300.0	PLP
Fluoride	0.25	mg/L	0.10	06/06/2018 08:17	EPA 300.0	PLP

Quality Assurance Summary

Test Description	Precision	Limit	LCL	MS	MSD	UCL	LCS	LCS Limit
Phosphate, Ortho	1	10	86	91	91	112	91	85 - 115
Ammonia-N (ISE)	<1	10	90	102	103	110	98	85 - 115
Chloride	<1	10	89	96	96	104	100	85 - 115
Nitrate-N	<1	20	70	98	98	130	101	85 - 115
Phosphorus, Total	1	10	95	99	100	104	99	85 - 115
Sulfate	<1	10	86	96	96	104	100	85 - 115
Fluoride	1	10	86	96	95	109	97	85 - 115

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Universal City, TX 78148-3318
210-340-0343
FAX # 210-658-7903

POLLUTION CONTROL SERVICES

NELAP ACCREDITED TNI LABORATORY

Report of Sample Analysis

Client Information	Sample Information	Laboratory Information
Trish Soechting New Braunfels Utilities P.O. Box 310289 New Braunfels, TX 78131-0289	Project Name: Well #5 Sample ID: 06061886 Matrix: Drinking Water Date/Time Taken: 06/06/2018 1034	**PCS Sample #: 513999** **Page 2 of 4** Date/Time Received: 06/06/2018 12:23 Report Date: 06/21/2018

Test Description	Flag	Result	Units	RL	Analysis Date/Time	Method	Analyst
Kjeldahl-N, Total		1	mg/L	1	06/13/2018 09:00	SM 4500-N B/E	CRM
Alkalinity, Bicarbonate	!	244	mg/L	10	06/08/2018 10:06	SM 2320 B	CRM
Phenolphthalein Alkalinity		<10	mg/L	10	06/08/2018 10:06	SM 2320 B	CRM
Alkalinity, Total	!	244	mg/L	10	06/08/2018 10:06	SM 2320 B	CRM
Cadmium/ICP (Total)		<0.005	mg/L	0.005	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Copper/ICP (Total)		0.006	mg/L	0.005	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Calcium/ICP (Total)		84.8	mg/L	1.00	06/14/2018 08:53	EPA 200.7 / 6010 B	DJL

Quality Assurance Summary

Test Description	Precision	Limit	LCL	MS	MSD	UCL	LCS	LCS Limit
Kjeldahl-N, Total	<1	10	93	101	101	108	106	85 - 115
Alkalinity, Bicarbonate	<1	10	95	100	100	107	102	85 - 115
Phenolphthalein Alkalinity	<1	10	95	100	100	107	102	85 - 115
Alkalinity, Total	<1	10	95	100	100	107	102	85 - 115
Cadmium/ICP (Total)	1	20	75	92	93	125	95	85 - 115
Copper/ICP (Total)	<1	20	75	91	91	125	95	85 - 115
Calcium/ICP (Total)	<1	20	75	*N/C	*N/C	125	90	85 - 115

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e-mail: chuck@pcslab.net **Universal City, TX 78148-3318**

POLLUTION CONTROL SERVICES

Report of Sample Analysis

Client Information	Sample Information	Laboratory Information
Trish Soechting New Braunfels Utilities P.O. Box 310289 New Braunfels, TX 78131-0289	Project Name: Well #5 Sample ID: 06061886 Matrix: Drinking Water Date/Time Taken: 06/06/2018 1034	**PCS Sample #: 513999** **Page 3 of 4** Date/Time Received: 06/06/2018 12:23 Report Date: 06/21/2018

Test Description	Result	Units	RL	Analysis Date/Time	Method	Analyst
Aluminum/ICP (Total)	<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Iron/ICP (Dissolved)	<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Iron/ICP (Total)	<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Magnesium/ICP (Total)	16.7	mg/L	1.00	06/14/2018 08:53	EPA 200.7 / 6010 B	DJL
Potassium/ICP (Total)	1.46	mg/L	1.00	06/14/2018 08:53	EPA 200.7 / 6010 B	DJL
Silica as SiO2	12.3	mg/L	2.14	06/14/2018 08:53	EPA 200.7 / 6010B	DJL
Sodium/ICP (Total)	11.3	mg/L	1.00	06/14/2018 08:53	EPA 200.7 / 6010 B	DJL

Quality Assurance Summary

Test Description	Precision	Limit	LCL	MS	MSD	UCL	LCS	LCS Limit
Aluminum/ICP (Total)	<1	20	75	93	93	125	95	85 - 115
Iron/ICP (Dissolved)	1	20	75	93	94	125	100	85 - 115
Iron/ICP (Total)	1	20	75	93	94	125	100	85 - 115
Magnesium/ICP (Total)	<1	20	75	*N/C	*N/C	125	93	85 - 115
Potassium/ICP (Total)	<1	20	75	97	97	125	96	85 - 115
Silica as SiO2	2	20	70	100	103	130	105	85 - 115
Sodium/ICP (Total)	<1	20	75	99	100	125	92	85 - 115

Quality Statement: ***All supporting quality control data adhered to data quality objectives and test results meet the requirements of NELAC unless otherwise noted as flagged exceptions or in a case narrative attachment. Reports with full quality data deliverables are available on request. TCEQ Certificate No. T104704361-17-13***

* *Approved for release per QA Plan, Exception to Limits - QAM Section 13-4*

These analytical results relate only to the sample tested.
All data is reported on an "As Is" basis unless designated as "Dry Wt."
RL = Reporting Limits

QC Data Reported in %, Except BOD in mg/L
N/C = Not Calculated, Sample Concentration Greater than 5 Times the Spike Level

Web Site: www.pcslab.net **Toll Free 800-880-4616** **1532 Universal City Blvd, Suite 100** **210-340-0343** **FAX # 210-658-7903**
e-mail: chuck@pcslab.net **Universal City, TX 78148-3318**

POLLUTION CONTROL SERVICES

Report of Sample Analysis

Client Information	Sample Information	Laboratory Information
Trish Soechting New Braunfels Utilities P.O. Box 310289 New Braunfels, TX 78131-0289	Project Name: Well #5 Sample ID: 06061886 Matrix: Drinking Water Date/Time Taken: 06/06/2018 1034	**PCS Sample #: 513999** **Page 4 of 4** Date/Time Received: 06/06/2018 12:23 Report Date: 06/21/2018

Test Description	Flag	Result	Units	RL	Analysis Date/Time	Method	Analyst
Manganese/ICP (Dissolved)		<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Manganese/ICP (Total)		<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Zinc/ICP (Total)		0.046	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Selenium/ICP (Total)		<0.010	mg/L	0.010	06/13/2018 12:39	EPA 200.7 / 6010 B	DJL
Dissolved Organic Carbon	!	<1.00	mg/L	1	06/19/2018 12:31	SM 5310 C	DJL
Total Organic Carbon	!	<1.00	mg/L	1	06/19/2018 12:31	SM 5310 C	DJL

Quality Assurance Summary

Test Description	Precision	Limit	LCL	MS	MSD	UCL	LCS	LCS Limit
Manganese/ICP (Dissolved)	1	20	75	90	91	125	95	85 - 115
Manganese/ICP (Total)	1	20	75	90	91	125	95	85 - 115
Zinc/ICP (Total)	1	20	75	88	89	125	95	85 - 115
Selenium/ICP (Total)	2	20	75	92	94	125	95	85 - 115
Dissolved Organic Carbon	<1	10	88	98	98	108	105	85 - 115
Total Organic Carbon	<1	10	88	98	98	108	105	85 - 115

Quality Statement: *All supporting quality control data adhered to data quality objectives and test results meet the requirements of NELAC unless otherwise noted as flagged exceptions or in a case narrative attachment. Reports with full quality data deliverables are available on request. TCEQ Certificate No. T104704361-17-13*

! *Not NELAP Certifiable Parameter*

These analytical results relate only to the sample tested.
All data is reported on an "As Is" basis unless designated as "Dry Wt."
RL = Reporting Limits

QC Data Reported in %, Except BOD in mg/L

Web Site: www.pcslab.net
e-mail: chuck@pcslab.net
Toll Free 800-880-4616
1532 Universal City Blvd, Suite 100
Universal City, TX 78148-3318
210-340-0343
FAX # 210-658-7903

Pollution Control Services
Mineral Analysis QA Check - Stabler Formula

PCS Sample#: **513999**

Cation Results

mg/L		me/L
<0.010	Iron/ICP (Total)	0.0000
11.3	Sodium/ICP (Total)	0.4915
84.8	Calcium/ICP (Total)	4.2315
16.7	Magnesium/ICP (Total)	1.3727
1.46	Potassium/ICP (Total)	0.0374
<0.010	Manganese/ICP (Total)	0.0000
	Sum Cations (me/L):	6.1331

Anion Results

mg/L		me/L
<10	Phenolphthalein Alkalinity	0.0000
1.9	Nitrate-N	0.0306
244	Alkalinity, Bicarbonate	4.8820
31	Sulfate	0.6448
19	Chloride	0.5358
0.25	Fluoride	0.0132
	Sum Anions (me/L):	6.1064

%Error: 0.2181

POLLUTION CONTROL SERVICES

Chain of Custody Number
513999

MULTIPLE SAMPLE ANALYSIS REQUEST AND CHAIN OF CUSTODY FORM

Stamp 1st sample and COC as same number

CUSTOMER INFORMATION	REPORT INFORMATION		
Name: New Braunfels Utilities	Attention: Trish Soechting	Phone: (830) 608-8905	Fax: (830) 626-1361

SAMPLE INFORMATION

Project Information: Well #5 Location 2

Report "Soils" ☐ As Is ☐ Dry Wt.

Collected By: Dustin Lawrence

Requested Analysis: (1) T-Alk, O-P, Cl, BiCarb; (2) NO3N, F, SO4, DOC; (3) NH3N, TKN, TPO4P; (4) TOC; (5) Metals; (6) Dissolved Metals

Matrix: DW-Drinking Water; NPW-Non-potable water; WW-Wastewater; LW-Liquid Waste

Client / Field Sample ID	Collected Date	Collected Time	Field Chlorine Residual mg/L	Composite or Grab	Matrix	Container Type	Number	Preservative	T-Alk, O-P, Cl, BiCarb	NO3N, F, SO4, DOC	NH3N, TKN, TPO4P	TOC	Metals	Dissolved Metals			Instructions/Comments: / PCS Sample Number
Well 5 06061886	Start: 6-6-18 End: "	Start: 1034 End: "		G	DW	P	1	ICE	X	X							513999 ☒S ☐B ☒N ☐HEM Other: P, N2
"	Start: " End: "	Start: " End: "		G	DW	P	1	H2SO4, ICE			X						☐S ☐B ☐N ☐HEM Other:
"	Start: " End: "	Start: " End: "		G	DW	P	1	H3PO4, ICE				X					☐S ☐B ☐N ☐HEM Other:
"	Start: " End: "	Start: " End: "		G	DW	P	1	HNO3, ICE					X				☐S ☐B ☐N ☐HEM Other:
"	Start: " End: "	Start: " End: "		G	DW	P	1	ICE						X			☐S ☐B ☐N ☐HEM Other:
	Start: End:	Start: End:		☐C ☐G	☐DW ☐NPW ☐WW ☐Soil ☐Sludge ☐LW ☐Other	☐P ☐G ☐O		☐H2SO4 ☐HNO3 ☐H3PO4 ☐NaOH ☐ICE ☐									☐S ☐B ☐N ☐HEM Other:
	Start: End:	Start: End:		☐C ☐G	☐DW ☐NPW ☐WW ☐Soil ☐Sludge ☐LW ☐Other	☐P ☐G ☐O		☐H2SO4 ☐HNO3 ☐H3PO4 ☐NaOH ☐ICE ☐									☐S ☐B ☐N ☐HEM Other:
	Start: End:	Start: End:		☐C ☐G	☐DW ☐NPW ☐WW ☐Soil ☐Sludge ☐LW ☐Other	☐P ☐G ☐O		☐H2SO4 ☐HNO3 ☐H3PO4 ☐NaOH ☐ICE ☐									☐S ☐B ☐N ☐HEM Other:

Required Turnaround: ☒ Routine (6-10 days) | ***EXPEDITE:*** (See Surcharge Schedule) ☐ < 8 Hrs. ☐ < 16 Hrs. ☐ < 24 Hrs. ☐ 5 days ☐ Other: ____ *Rush Charges Authorized by:*

Sample Archive/Disposal: ☐ Laboratory Standard ☐ Hold for client pick up | **Container Type:** P = Plastic, G = Glass, O = Other | Carrier ID:

Relinquished By:	[signature]	Date:	6-6-18	Time:	1126	Received By:	Trish Soechting	Date: 6-6-18	Time: 1126
Relinquished By:	Trish Soechting	Date:	6-6-18	Time:	1224	Received By:	[signature]	Date: 6-6-18	Time: 1224

Rev. Multiple Sample COC 20120201

* See attachment

1532 Universal City Blvd., Ste. 100, Universal City, Texas 78148
P (210) 340-0343 or (800) 880-4616 - F (210) 658-7903

Login at www.pcslab.net

TCEQ NELAP T104704361-TX

Michael Klang

From:	Trish Soechting <tsoechting@nbutexas.com>
Sent:	Monday, June 04, 2018 10:40
To:	Michael Klang
Subject:	water test

Hi Michael, here is the list. There 27 at 2 locations.

Total Alkalinity
Chloride
Fluoride
Sulfate
Carbonate Alkalinity
Bicarbonate Alkalinity
Silicon
Calcium
Magnesium
Sodium
Potassium
Iron, Total
Iron, Dissolved
Aluminum
Copper
Manganese, Total
Manganese, Dissolved
Zinc
Cadmium
Selenium
Nitrate
Phosphorus, Total
Phosphorus, Orthophosphate
Ammonia
Total Kjeldahl Nitrogen
Total Organic Carbon
Dissolved Organic Carbon

NBU
New Braunfels Utilities

Trish Soechting
Laboratory Supervisor
1922 Kuehler | New Braunfels, Texas 78130
tsoechting@nbutexas.com | 830.608.8905

Pollution Control Services
Sample Log-In Checklist

PCS Sample No(s) 513999 **COC No.** 513999

Client/Company Name: NBU **Checklist Completed by:** EV

Sample Delivery to Lab Via:
Client Drop Off ✓ Commercial Carrier: Bus ___ UPS ___ Lone Star ___ FedEx ___ USPS ___
PCS Field Services: Collection/Pick Up ___ Other: ___

Sample Kit/Coolers
Sample Kit/Cooler? Yes ✓ No ___ Sample Kit/Cooler: Intact? Yes ✓ No ___
Custody Seals on Sample Kit/Cooler: Not Present ✓ If Present, Intact ___ Broken ___
Sample Containers Intact; Unbroken and Not Leaking? Yes ✓ No ___
Custody Seals on Sample Bottles: Not Present ✓ If Present, Intact ___ Broken ___
COC Present with Shipment or Delivery or Completed at Drop Off? Yes ✓ No ___
Has COC sample date/time and other pertinent information been provided by client/sampler? Yes: ✓ No: ___
Has COC been properly Signed when Received/Relinquished? Yes ✓ No ___
Does COC agree with Sample Bottle Information, Bottle Types, Preservation, etc.? Yes ✓ No ___
All Samples Received before Hold Time Expiration? Yes ✓ No ___
Sufficient Sample Volumes for Analysis Requested? Yes ✓ No ___
Zero Headspace in VOA Vial if Present? Yes ___ No ___

Sample Preservation:
* ***Cooling:*** **Not Required** ___ or **Required** ✓
If cooling required, record temperature of submitted samples Observed/Corrected 14 / 11 °C
Is Ice Present in Sample Kit/Cooler? ✓ Yes ___ No Samples received same day as collected? ✓ Yes ___ No
Lab Thermometer Make and Serial Number: EX Tech 10093657 Other: ___

Acid Preserved Sample - If present, is pH <2? **Yes** ✓ **No** ___ ** ✓ H_2SO_4 ✓ HNO_3 ✓ H_3PO_4
Base Preserved Sample - If present, is pH >12? Yes ___ No ___ ___ NaOH
Other Preservation: ___ If Present, Meets Requirements? Yes ___ No ___
Sample Preservations Checked by: EV Date 6-6-18 Time 12:30
pH paper used to check sample preservation (PCS log #): 18-028 (HEM pH checked at analysis).
Samples Preserved/Adjusted by Lab:

Lab #	Parameters Preserved	Preservative Used	Log #

Adjusted by Tech/Analyst: ___ Date : ___ Time: ___

Client Notification/ Documentation for "No" Responses Above/ Discrepancies/ Revision Comments
Person Notified: ___ Contacted by: ___
Notified Date: ___ Time: ___
Method of Contact: At Drop Off: ___ Phone ___ Left Voice Mail ___ E-Mail ___ Fax ___
Unable to Contact ___ Authorized Laboratory to Proceed : ___ (Lab Director)
Regarding / Comments: ___

Actions taken to correct problems/discrepancies: ___

Receiving qualifier needed (*requires client notification above*) Temp. ___ Holding Time ___ Initails: ___
Receiving qualifier entered into LIMS at login Initial/Date: ___
Revision Comments: ___

** Samples submitted for Metals Analysis (except Hex Cr) or Drinking Water for Coliform Bacteria Only are not required to be iced. Samples collected prior day to receipt at the laboratory must meet method specific thermal cooling requirements. "or will be flagged accordingly". Samples delivered the same day as collected may not meet thermal criteria, but shall be considered acceptable if evidence that the chilling process has begun, such as arrival on ice (EPA 815-F-08-006, June 2008). ** Water samples for metals analysis that are not acid preserved prior to shipment may be acceptably preserved by the laboratory on receipt – however, the sample digestion procedure must be delayed for at least 24 hours after preservation by the laboratory.*

10.11 Appendix K. Geophysical logs

Digital logs as requested were provided to the TWDB.

GEO CAM

Water Well Logging & Video Recording Services

Geo Cam, Inc. 17118 Classen Rd. San Antonio, TX 78217 210-495-9121

Borehole: NBU ASR Core Well

Logs: GAMMA, RESISTIVITY, CALIPER, SPR, FTC

Project: NBU ASR Core Well Date: 03/26/2018

Client: **KUTSCHER DRILLING** County: COMAL

Location: N 29* 42' 16.2" W 98* 03' 13.0" State: TX

BOREHOLE DATA

Drilling Contractor: CASCADE DRILLING **Driller T.D. (ft) : 536.5'**

Elevation: 733' GPS Logger T.D. (ft) : 537.5'

Depth Ref: G.L. Date Drilled: 03/26/2018

BIT RECORD				CASING RECORD		
RUN	BIT SIZE (in)	FROM (ft)	TO (ft)	SIZE/WGT/THK	FROM (ft)	TO (ft)
1	NA			5" STEEL	+ .5'	59'
2	3.5"	60'	536.5'			
3						

Drill Method: CORE Weight: **Fluid Level (ft) :** 75'

Hole Medium: Mud Type: Time Since Circ:

Viscosity: Rm: at: Deg C

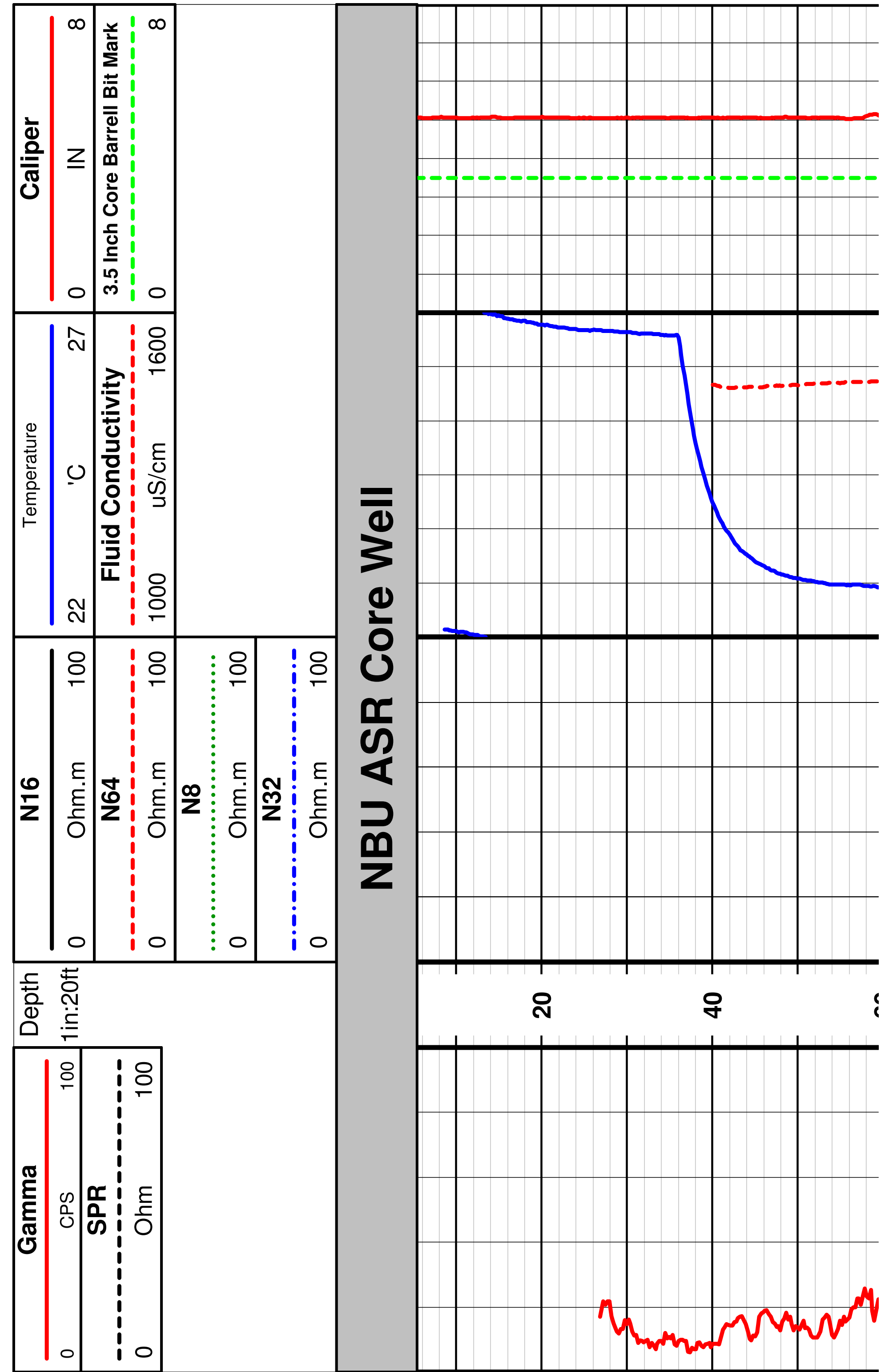
GENERAL DATA

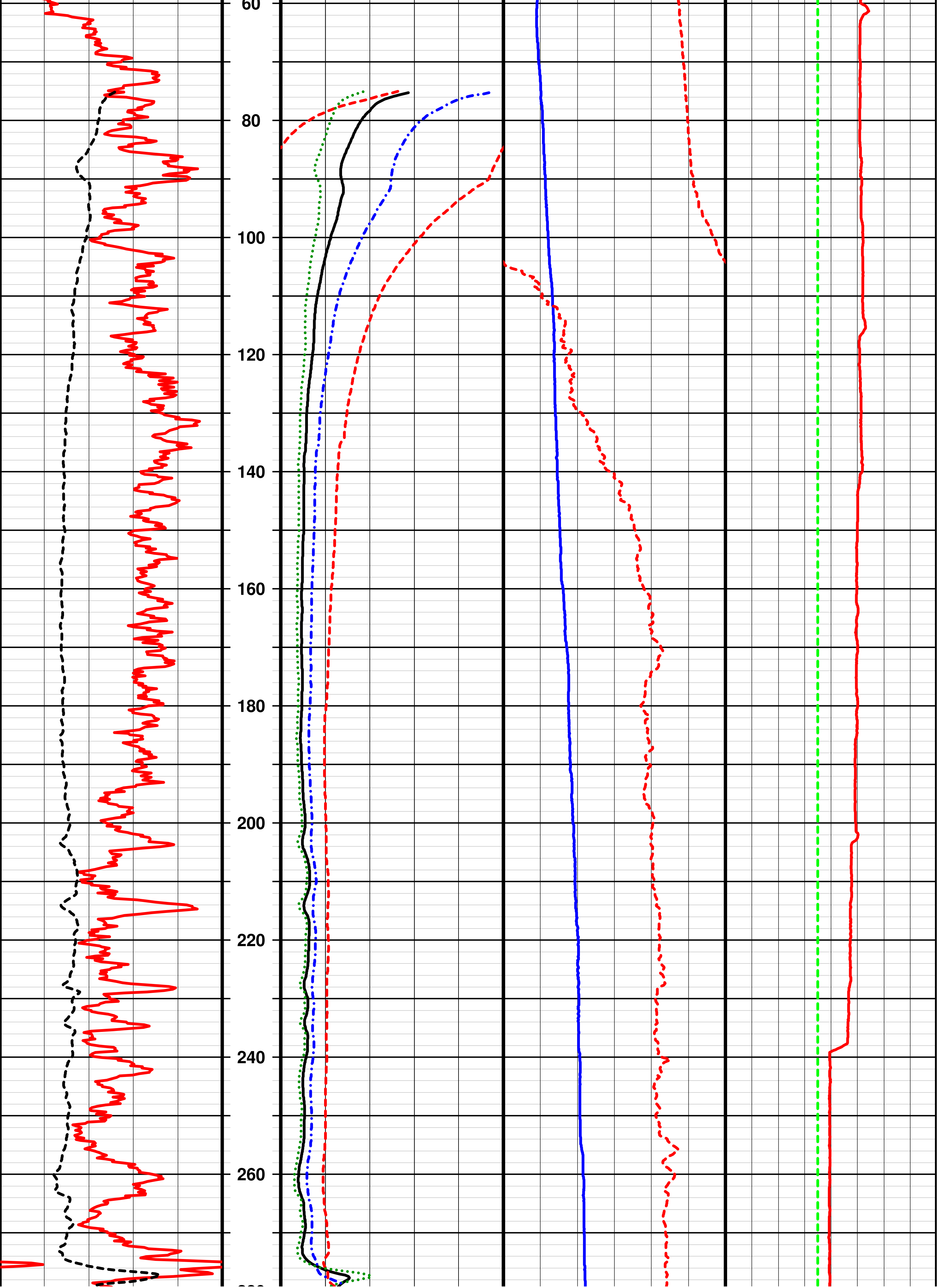
Logged by: Kelly Tuten Unit/Truck: 09

Witness:

LOG TYPE	RUN NO	SPEED (ft/min)	FROM (ft)	TO (ft)	FT./ IN.
GAMMA	2	35	528'	26'	20
RESISTIVITY, SPR	2	35	533'	75'	20
CALIPER	1	35	533'	5'	20

Comments:

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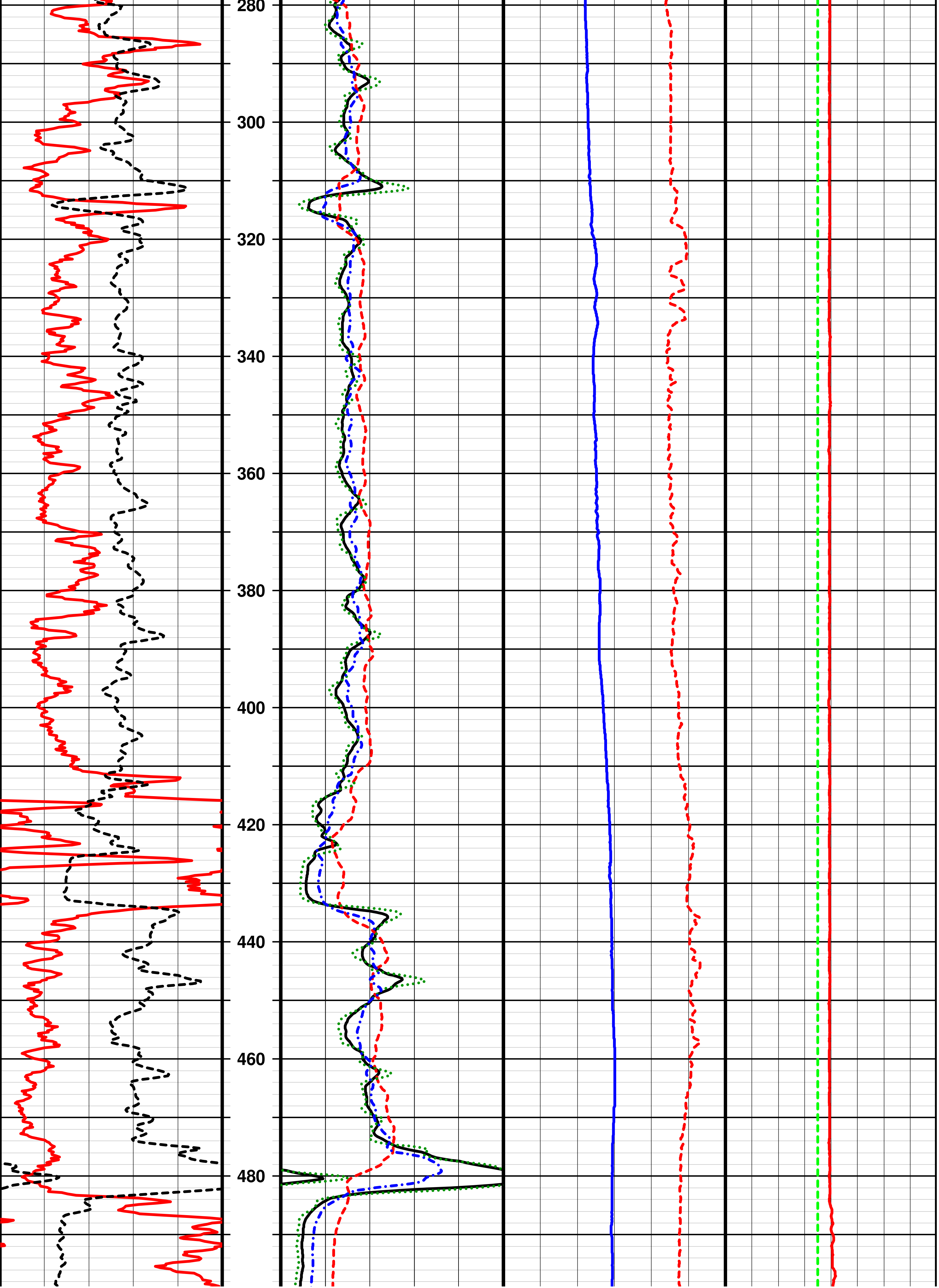
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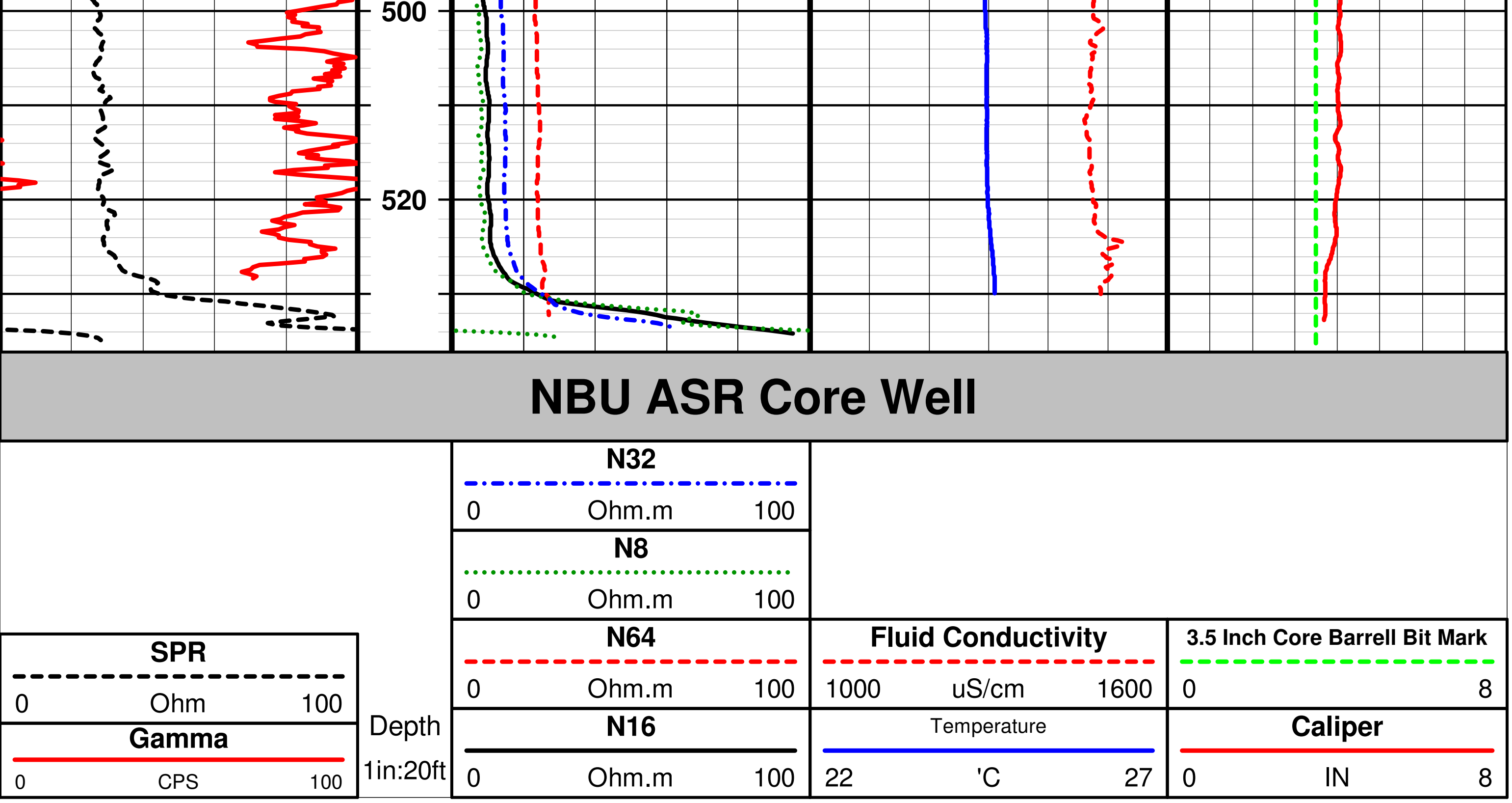


500
520
NBU ASR Core Well
N32
0 Ohm.m 100
N8
0 Ohm.m 100
N64
0 Ohm.m 100
N16
0 Ohm.m 100
SPR
0 Ohm 100
Gamma
0 CPS 100
Depth
1in:20ft
Fluid Conductivity
1000 uS/cm 1600
Temperature
22 'C 27
3.5 Inch Core Barrell Bit Mark
0 8
Caliper
0 IN 8

GEO CAM

Water Well Logging & Video Recording Services

Borehole: **NBU ASR Core Well**

Logs: **GAMMA, RESISTIVITY, CALIPER, SPR, FTC**

Geo Cam, Inc. 17118 Classen Rd. San Antonio, TX 78217 210-495-9121

Project: **NBU ASR Core Well** Date: 04/09/2018

Client: **KUTSCHER DRILLING** County: COMAL

Location: **N 29* 42' 16.2" W 98* 03' 13.0"** State: TX

BOREHOLE DATA

Drilling Contractor: CASCADE DRILLING **Driller T.D. (ft) : 1096.5'**

Elevation: 733' GPS Logger T.D. (ft) : 1097.5'

Depth Ref: G.L. Date Drilled: 04/09/2018

BIT RECORD				CASING RECORD		
RUN	BIT SIZE (in)	FROM (ft)	TO (ft)	SIZE/WGT/THK	FROM (ft)	TO (ft)
1	NA			5" STEEL	+ .5'	530'
2	3.5"	530'	1096.5'			
3						

Drill Method: CORE Weight: **Fluid Level (ft) :** 75'

Hole Medium: Mud Type: Time Since Circ:

Viscosity: Rm: at: Deg C

GENERAL DATA

Logged by: Kelly Tuten Unit/Truck: 09

Witness:

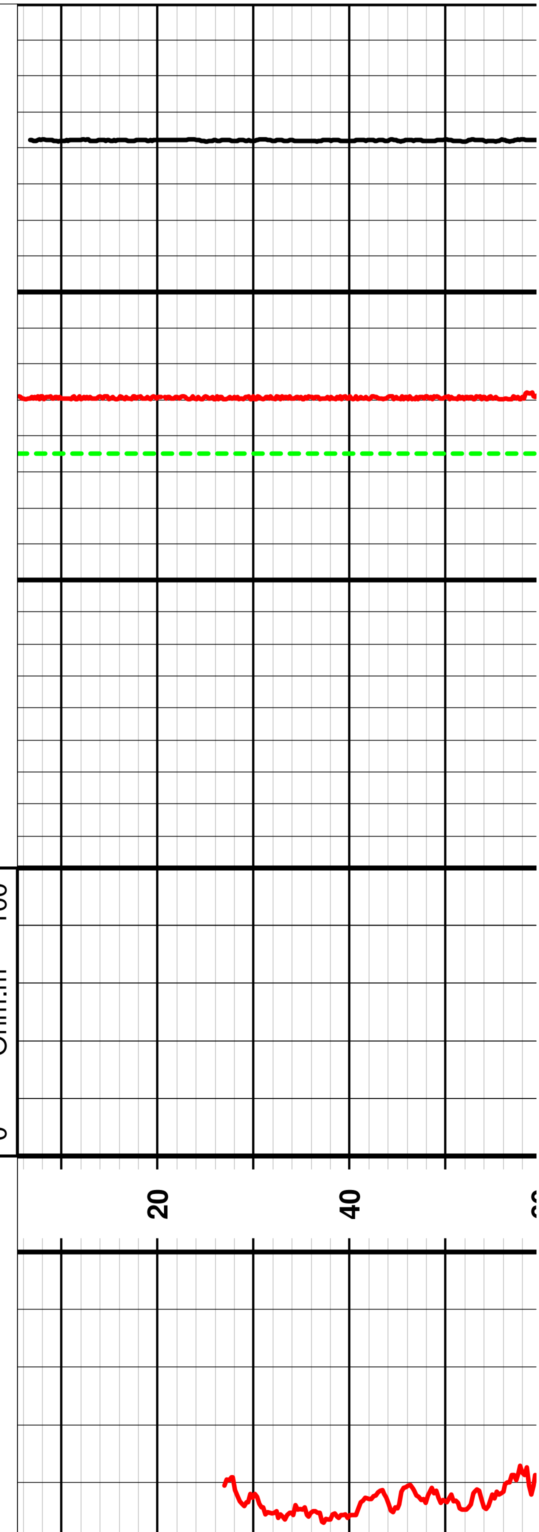
LOG TYPE	RUN NO	SPEED (ft/min)	FROM (ft)	TO (ft)	FT./ IN.
GAMMA	2	35	1090'	26'	20
RESISTIVITY, SPR	2	35	1095'	75'	20
CALIPER	1	35	533'	5'	20

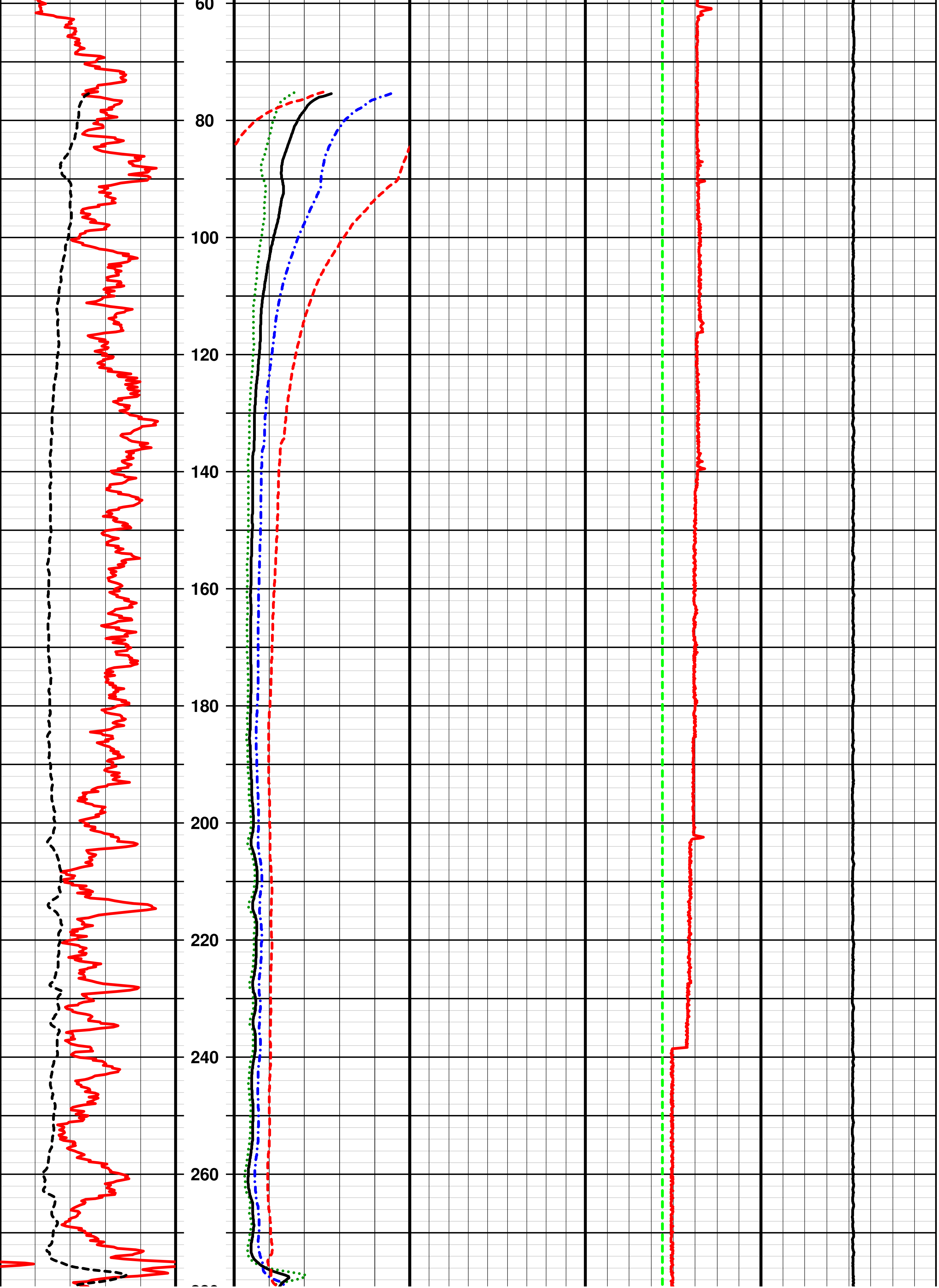
Open Hole log of top section of well run on 03-26-2018

Comments:

Gamma (0 Cps 100) / SPR (0 Ohm 100)	Depth 1in:20ft	N8 (0 Ohm.m 100) / N32 (0 Ohm.m 100) / N16 (0 Ohm.m 100) / N64 (0 Ohm.m 100)	Temperature (22 'C 29) / Cond (2000 uS/cm 11000)	3.5 Inch Core Barrel (0 8) / Open Hole Caliper (0 IN 8)	Cased Hole Caliper (0 IN 8)

NBU ASR Core Well

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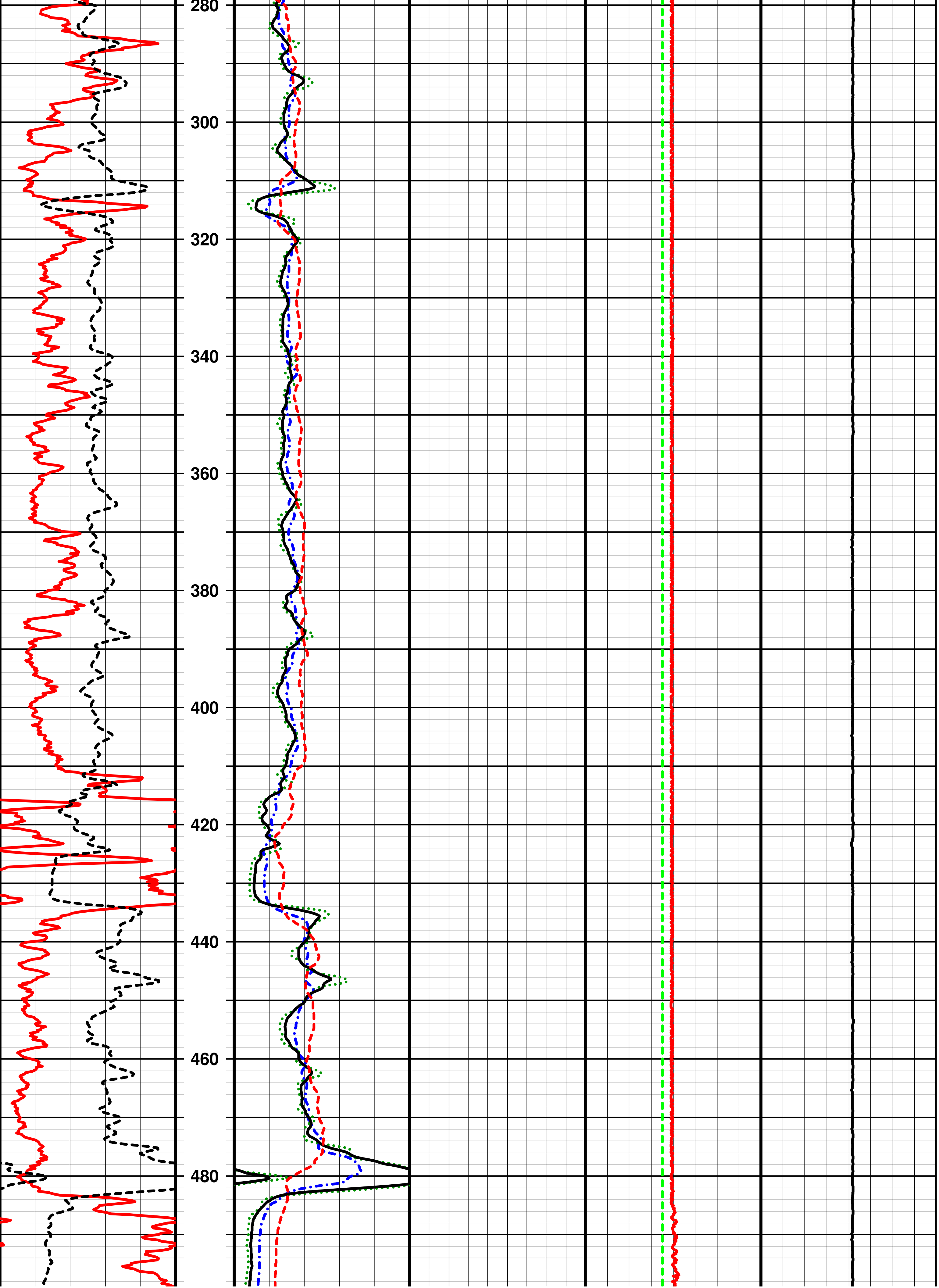
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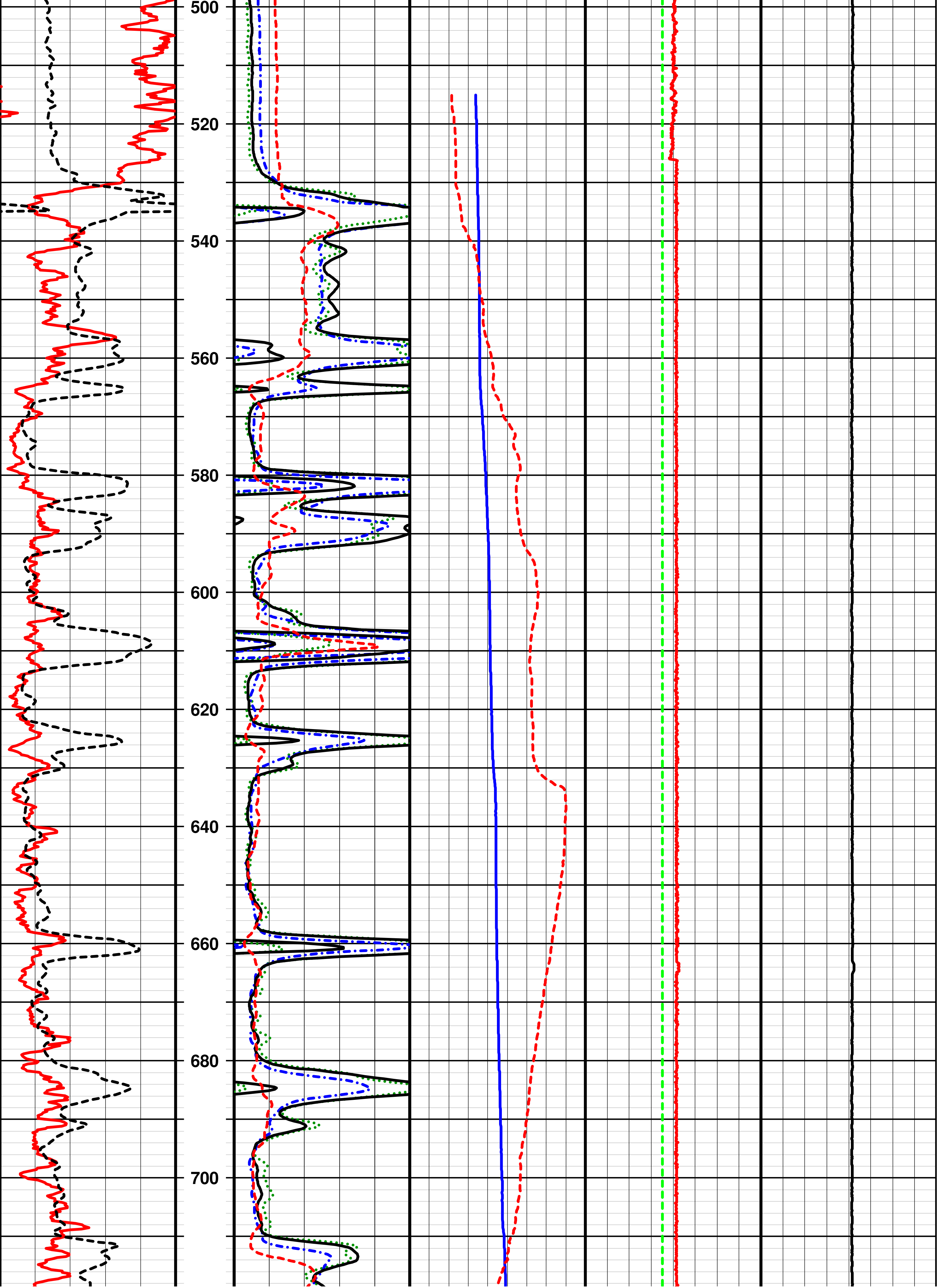
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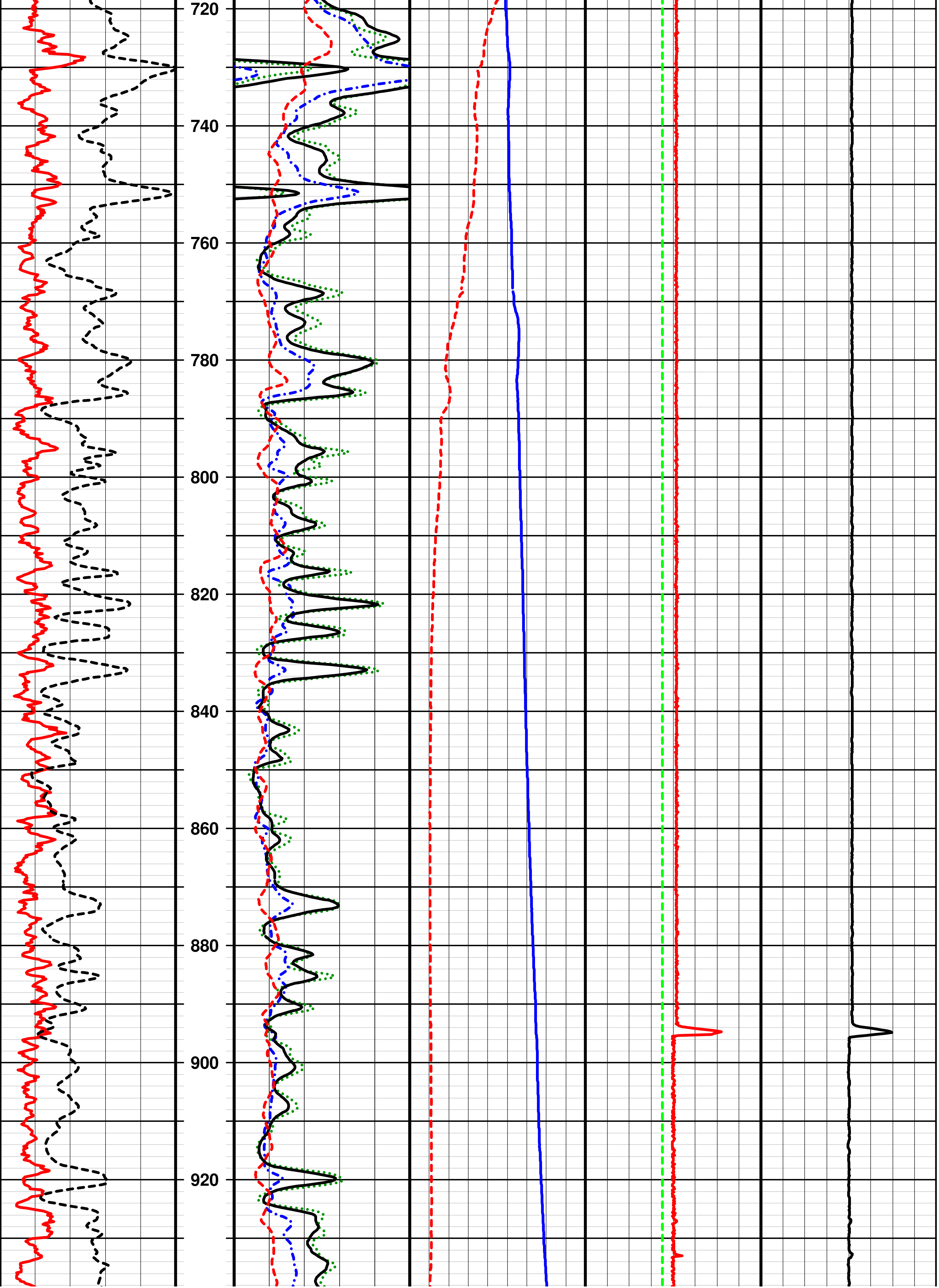
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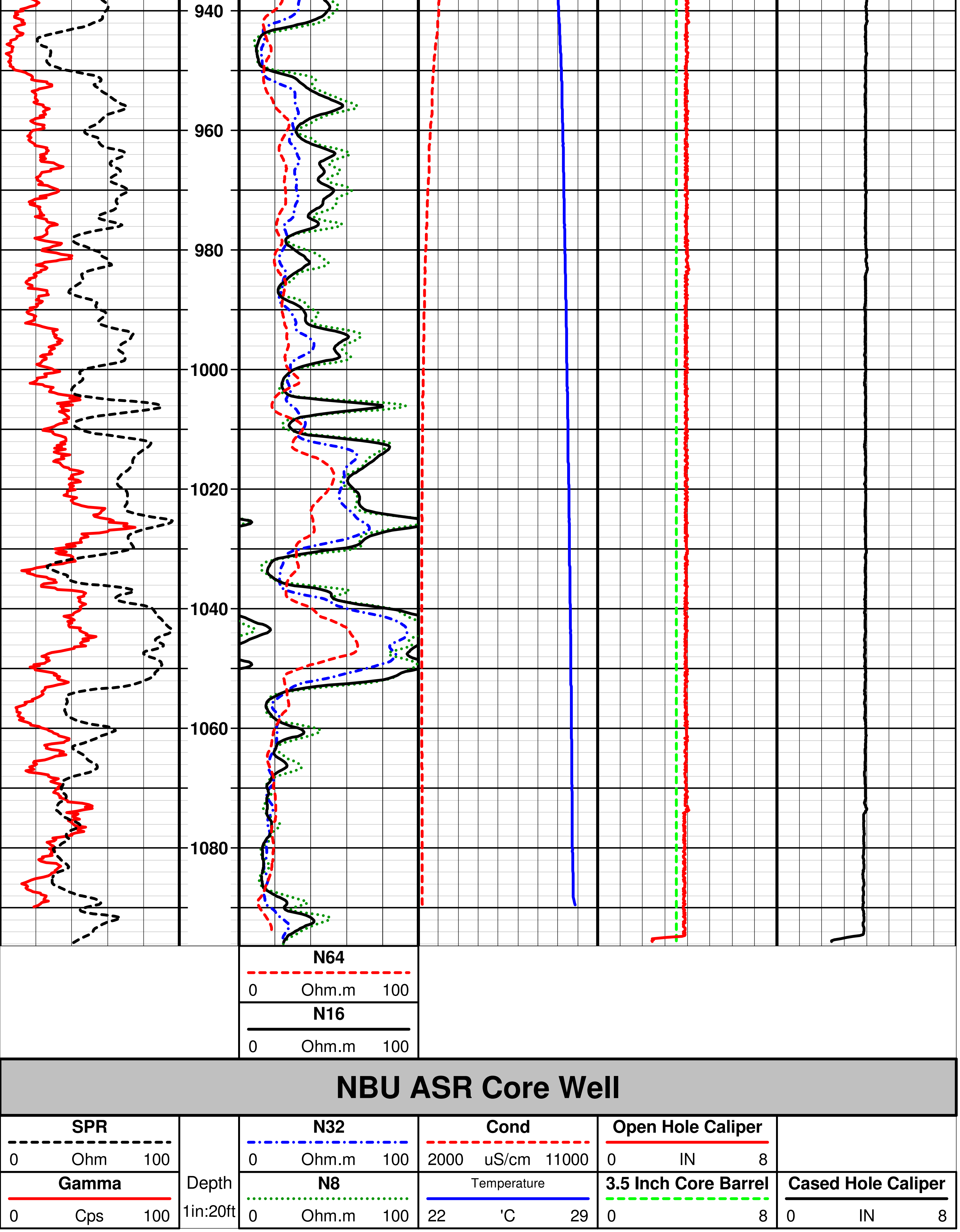
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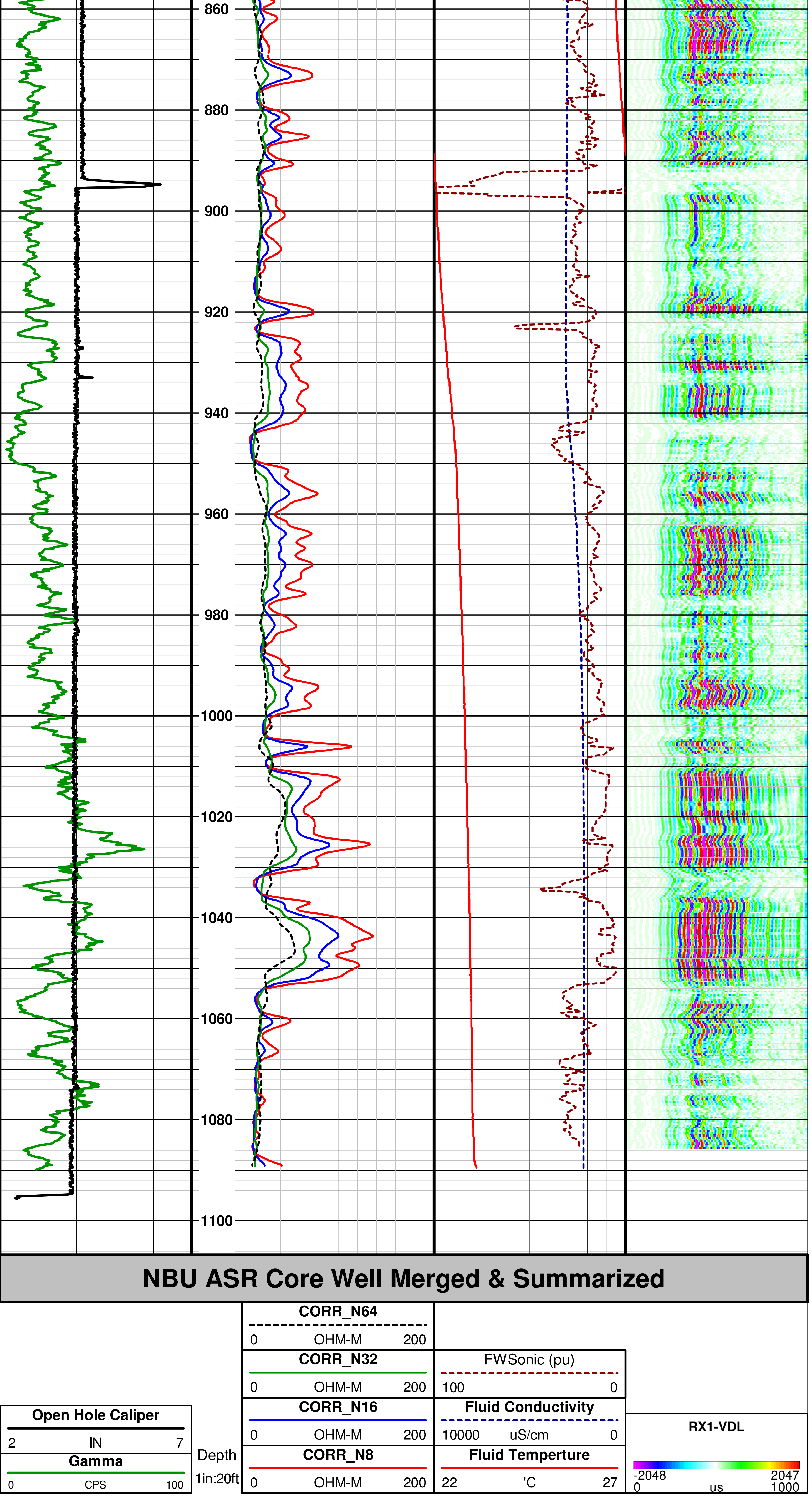
960
980
1000
1020
1040
1060
1080
N64
0 Ohm.m 100
N16
0 Ohm.m 100
NBU ASR Core Well
SPR
0 Ohm 100
Gamma
0 Cps 100
Depth
1in:20ft
N32
0 Ohm.m 100
N8
0 Ohm.m 100
Cond
2000 uS/cm 11000
Temperature
22 'C 29
Open Hole Caliper
0 IN 8
3.5 Inch Core Barrel
0 8
Cased Hole Caliper
0 IN 8

NBU ASR Core Well Merged & Summarized



860
880
900
920
940
960
980
1000
1020
1040
1060
1080
1100
NBU ASR Core Well Merged & Summarized
Open Hole Caliper
2 IN 7
Gamma
0 CPS 100
Depth
1in:20ft
CORR_N64
0 OHM-M 200
CORR_N32
0 OHM-M 200
CORR_N16
0 OHM-M 200
CORR_N8
0 OHM-M 200
FWSonic (pu)
100 0
Fluid Conductivity
10000 uS/cm 0
Fluid Temperture
22 °C 27
RX1-VDL
-2048 2047
0 us 1000

GEO CAM

Water Well Logging & Video Recording Services

Geo Cam, Inc. 17118 Classen Rd. San Antonio, TX 78247 877-495-9121

Borehole: NBU MONITOR WELL

Logs: GAMMA, CALIPER, SPR, FLUID CONDUCTIVITY, SPINNER

Project: NBU MONITOR WELL — Date: 05-23-2018

Client: KUTSCHER DRILLING — County: COMAL

Location: N 29° 42' 16.6" W 98° 03' 12.2" — State: TX

BOREHOLE DATA

Drilling Contractor: KUTSCHER DRILLING — **Driller T.D. (ft) : 710'**

Elevation: 651' GPS — Logger T.D. (ft) : 711'

Depth Ref: G.L. — Date Drilled: 05-22-2018

RUN	BIT RECORD: BIT SIZE (in)	FROM (ft)	TO (ft)	CASING RECORD: SIZE/WGT/THK	FROM (ft)	TO (ft)
1	15"	0'	545'	10" PVC	+ 2.4'	545'
2	6 3/4'	545'	710'			
3						

Drill Method: AIR ROTARY — Weight: — **Fluid Level (ft) :** 30.5'

Hole Medium: — Mud Type: — Time Since Circ:

Viscosity: — Rm: — at: — Deg C

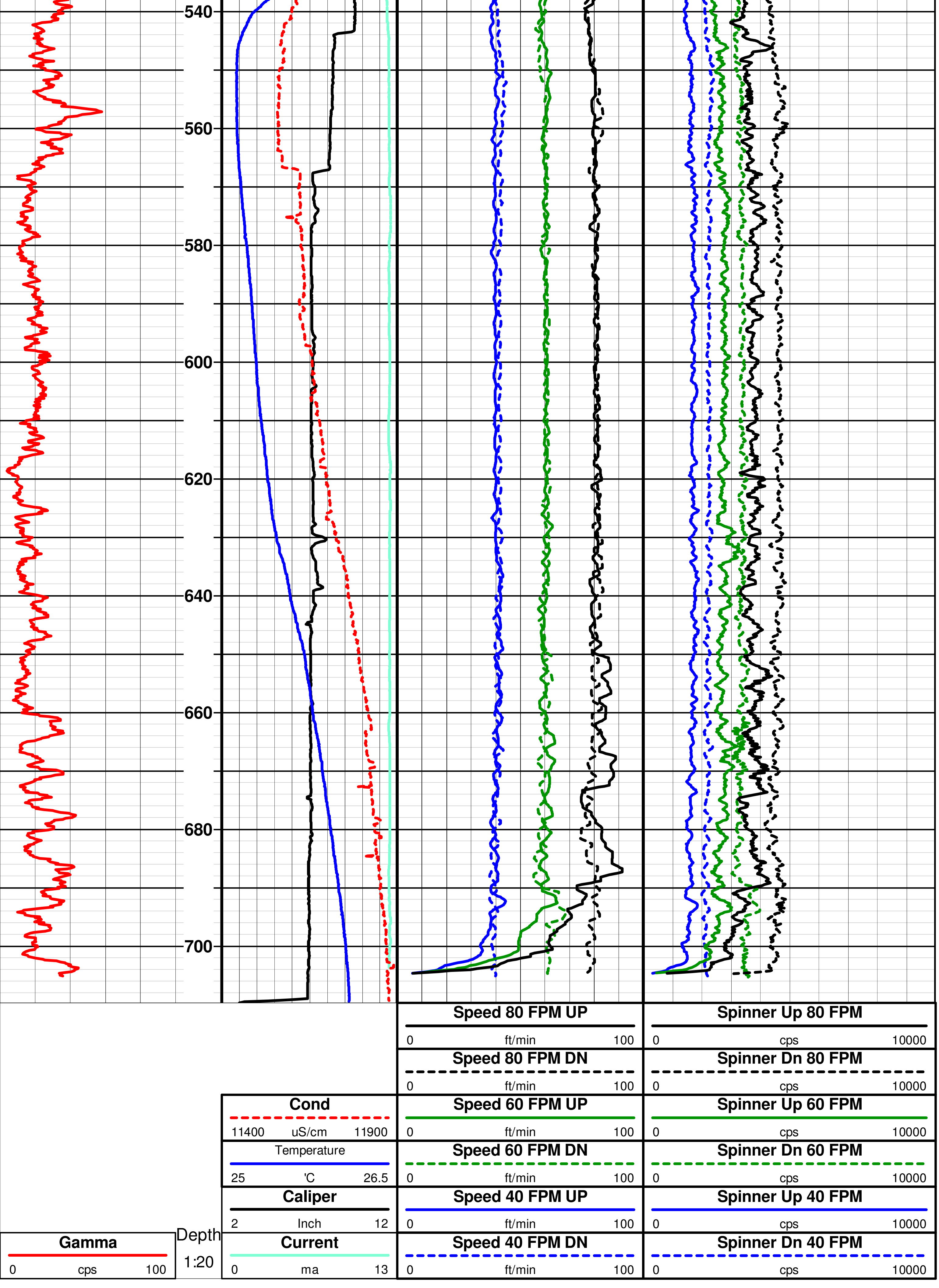
GENERAL DATA

Logged by: Kelly Tuten — Unit/Truck: 06

Witness:

LOG TYPE	RUN NO	SPEED (ft/min)	FROM (ft)	TO (ft)	FT./ IN.
GAMMA	1	25	706'	3.7'	20
CALIPER	1	25	710'	8.3'	20
SPINNER	6	40 - 80	450'	705'	20

Comments:



540
560
580
600
620
640
660
680
700
Speed 80 FPM UP
0 ft/min 100
Speed 80 FPM DN
0 ft/min 100
Speed 60 FPM UP
0 ft/min 100
Speed 60 FPM DN
0 ft/min 100
Speed 40 FPM UP
0 ft/min 100
Speed 40 FPM DN
0 ft/min 100
Spinner Up 80 FPM
0 cps 10000
Spinner Dn 80 FPM
0 cps 10000
Spinner Up 60 FPM
0 cps 10000
Spinner Dn 60 FPM
0 cps 10000
Spinner Up 40 FPM
0 cps 10000
Spinner Dn 40 FPM
0 cps 10000
Cond
11400 uS/cm 11900
Temperature
25 'C 26.5
Caliper
2 Inch 12
Current
0 ma 13
Gamma
0 cps 100
Depth
1:20

GEO CAM

Water Well Logging & Video Recording Services

Geo Cam, Inc. 17118 Classen Rd. San Antonio, TX 78247 877-495-9121

Borehole: NBU MONITOR WELL

Logs: GAMMA, CALIPER, SPR, FLUID CONDUCTIVITY, SPINNER

Project:	NBU MONITOR WELL	Date:	05-23-2018
Client:	KUTSCHER DRILLING	County:	COMAL
Location:	N 29* 42' 16.6" W 98* 03' 12.2"	State:	TX

BOREHOLE DATA

Drilling Contractor:	KUTSCHER DRILLING	**Driller T.D. (ft) :**	**710'**
Elevation:	651' GPS	Logger T.D. (ft) :	711'
Depth Ref:	G.L.	Date Drilled:	05-22-2018

BIT RECORD				CASING RECORD		
RUN	BIT SIZE (in)	FROM (ft)	TO (ft)	SIZE/WGT/THK	FROM (ft)	TO (ft)
1	15"	0'	545'	10" PVC	+ 2.4'	545'
2	6 3/4'	545'	710'			
3						

Drill Method:	AIR ROTARY	Weight:		**Fluid Level (ft) :**	30.5'
Hole Medium:		Mud Type:		Time Since Circ:	
Viscosity:		Rm:	at:	Deg C	

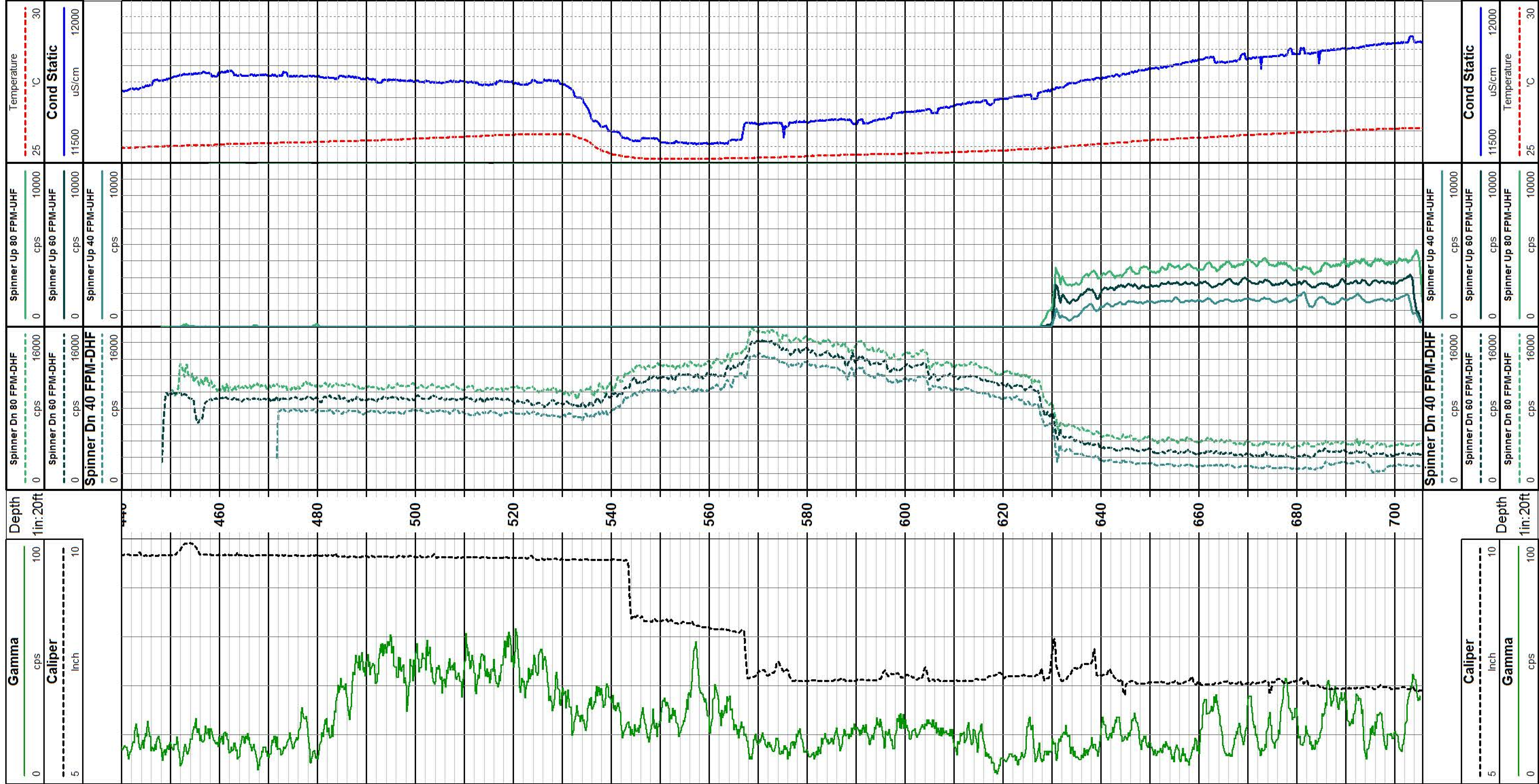
GENERAL DATA

Logged by: Kelly Tuten — Unit/Truck: 06

Witness:

LOG TYPE	RUN NO	SPEED (ft/min)	FROM (ft)	TO (ft)	FT./ IN.
GAMMA	1	25	706'	3.7'	20
CALIPER	1	25	710'	8.3'	20
SPINNER	6	40 - 80	450'	705'	20

Comments:



LEGACY LOGGING SERVICES
A Division of GEO CAM, Inc.

Gamma, SP
Dual Induction, LL3, Caliper
Compensated Neutron/Density

Company	Kutscher Drilling
Well	NBU Edwards Monitor Well
Field	Saur Lane, New Braunfels, TX
County	Comal
State	TX

Company Kutscher Drilling
Well NBU Edwards Monitor Well
Field Saur Lane, New Braunfels, TX
County Comal State TX

Location: API # :
N29 DEG. 42 MN. 16.6 SEC 98DEG. 03 MN. 12.2 SEC.
SEC TWP RGE

Other Services

			Elevation
Permanent Datum	G.L.	Elevation	K.B. 5 FT
Log Measured From	G.L.		D.F. NA
Drilling Measured From	G.L.		G.L. 0.00

Date	05/30/18
Run Number	4
Depth Driller	940 FT.
Depth Logger	941.2
Bottom Logged Interval	941
Top Log Interval	298
Casing Driller	545 FT.
Casing Logger	545
Bit Size	6.75 IN.
Type Fluid in Hole	BRACKISH
Density / Viscosity	
pH / Fluid Loss	
Source of Sample	
Rm @ Meas. Temp	1.225 @ 27.59
Rmf @ Meas. Temp	
Rmc @ Meas. Temp	
Source of Rmf / Rmc	
Rm @ BHT	
Time Circulation Stopped	05/29/18
Time Logger on Bottom	1345 HRS.
Maximum Recorded Temperature	
Equipment Number	L 1
Location	San Antonio
Recorded By	Mike Miller
Witnessed By	Derek Scott

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All interpretations are opinions based on inferences from electrical or other measurements and we cannot and do not guarantee the accuracy or correctness of any interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages, or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees. These interpretations are also subject to our general terms and conditions set out in our current Price Schedule.

Comments

Geo Cam, Inc. 17118 Classen Road, San Antonio TX 78247 877-495-9121

Database File	nbu edwards monitor well.db
Dataset Pathname	pass1.4
Presentation Format	nbu edwards monitor well
Dataset Creation	Wed May 30 14:07:27 2018
Charted by	Depth in Feet scaled 1:240

-0.9 Rcorr (g/cc) 0.1		0.2 Deep Resistivity (Ohm-m) 2000	60 CNLS (pu) 0
5 DCAL (in) 10		0.2 Medium Resistivity (Ohm-m) 2000	60 DPOR (pu) 0
0 Gamma Ray (GAPI) 150		0.2 Shallow Resistivity (Ohm-m) 2000	10000 LTEN (lb) 0
-150 SP (mV) 0			

-0.9 Rcorr (g/cc) 0.1		0.2 Deep Resistivity (Ohm-m) 2000	60 CNLS (pu) 0
5 DCAL (in) 10		0.2 Medium Resistivity (Ohm-m) 2000	60 DPOR (pu) 0
0 Gamma Ray (GAPI) 150		0.2 Shallow Resistivity (Ohm-m) 2000	10000 LTEN (lb) 0
-150 SP (mV) 0			

10.12 Appendix L. TWDB review of draft report 02/07/19

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

Mr. Brock Curry
Edwards Aquifer Authority
900 E. Quincy Street
San Antonio, TX 78215-1415

RE: Research Contract with Edwards Aquifer Authority, Contract No. 1600011957, Comments on Draft Report Entitled "New Braunfels Utilities: Aquifer Storage and Recovery Demonstration Project"

Dear Mr. Curry:

Staff members of the Texas Water Development Board (TWDB) have completed a review of the draft report prepared under the above-referenced contract. ATTACHMENT 1 provides the comments resulting from this review. As stated in the TWDB contract, Edwards Aquifer Authority will consider revising the final report in response to comments from the Executive Administrator and other reviewers. In addition, Edwards Aquifer Authority will include a copy of the Executive Administrator's draft report comments in the Final Report.

Please note: The TWDB logo should not be used in your Final Report.

The TWDB looks forward to receiving one (1) electronic copy of the entire Final Report in Portable Document Format (PDF) and five (5) bound double-sided copies. **Please further note, that in compliance with Texas Administrative Code Chapters 206 and 213 (related to Accessibility and Usability of State Web Sites), the digital copy of the final report must comply with the requirements and standards specified in statute. For more information, visit http://www.sos.state.tx.us/tac/index.shtml.** If you have any questions on accessibility, please contact David Carter with the Contract Administration Division at (512) 936-6079 or David.Carter@twdb.texas.gov.

Edwards Aquifer Authority shall also submit one (1) electronic copy of any computer programs or models, and, if applicable, an operations manual developed under the terms of this Contract.

Please feel free to contact Ms. Erika Mancha of TWDB's Conservation & Innovative Water Technologies staff at 512-463-7932 or erika.mancha@twdb.texas.gov if you have any questions or need any further information.

Sincerely,

John T. Dupnik, P.G.
Deputy Executive Administrator
Water Science and Conservation

Date: 2-7-19

Attachment

c w/o att.: Erika Mancha, Conservation & Innovative Water Technologies

Attachment 1
Edwards Aquifer Authority

Draft Final Report for New Braunfels Utilities Aquifer storage and Recovery Demonstration Project
TWDB Contract # 1600011957

TWDB Comments

General Comments

- Professional Geologists and Engineers **must** affix their seals and sign the final report on page ii.

- Professional Geologists James Holley and Kelley Smith **must** affix their seal for Appendix C.

- Please add the contract number 1600011957 to the cover page of the final report.

- Please remove TWDB logo placeholder from cover page, the Board no longer adds seals to contract reports.

- Please add an executive summary to the final report.

- Please enlarge all figures to cover the full page and make them legible. Figure 2-1 ad 4-1 were hard to read and should be redone.

- Please add a list of acronyms to the front of report.

Specific Comments

- Page 4. Section 2.1. Change "Rider 25" to "Demonstration Projects for Alternative Water Supplies".

- Page 5. Section 2.1, second paragraph: Please update language as necessary based on the information below.
    - *The 84th Texas Legislature appropriated $1,000,000 from General Revenue to the TWDB to fund grants for demonstration projects for alternative water supplies (House Bill 1, General Appropriations Act, 2015 Legislature, Regular Session, page VI-60, Rider 25). The grants will fund groundwater conservation districts for demonstration projects or feasibility studies that will prove up aquifer storage and recovery.*

- Page 7. First paragraph, last sentence: Please lower case the word "Being".

- Page 19. Figure 4-2: May need to remove and replace with general location map due to security risks.

- Page 27. Last paragraph, second to last sentence: Please add the missing words, "five percent to...".

- Page 35. Section 6.4. The ASR well design is planned to have the well annulus cemented in increments not exceeding 200 feet to minimize cement heat of hydration impact to PVC well casing. Please note that the TCEQ Public Drinking Water Rules and Regulation for Public Water Systems §290.41(c)3(C) indicates annular cement must be emplaced under pressure and staff have interpreted the rule to mean one continuous emplacement of annular cement. We suggest you coordinate with the TCEQ and request an exception to this rule (§290.39 L Exceptions) in advance of construction to avoid delays and unanticipated consequences.

- Appendix A: Please remove the sign-in sheet due to security risks.

- Appendix G. Please add the lab chemical data for the Upper Edwards Interval for sample event 2 on 9/13/18. Please incorporate data into the report as well.

- Appendix K. Please provide digital copies of the following geophysical well logs:

- NBU-CH-1 upper log run (surface to 540 feet)
- NBU-CH-1 lower log run (540 – 1096.8 feet)
- Any additional logging composites created including the sonic logging runs
- NBU-Monitor Well-1 logging run including gamma, caliper, spr, SP, dual induction, compensated neutron and density, and spinner tools.