National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
White Sands Test Facility
P.O. Box 20
Las Cruces, NM 88004-0020

March 8, 2022

Reply to Attn of: RE-22-028

New Mexico Environment Department
Attn: Mr. Rick Shean, Bureau Chief
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Subject: Response to Approval with Modifications of NASA WSTF Well Reconfiguration Work Plan for Well BW-4

On June 29, 2021, NASA submitted the *NASA WSTF Well Reconfiguration Work Plan for Well BW-4* to the NMED Hazardous Waste Bureau. The work plan provided details on NASA's recommendations for reconfiguring the borehole, which was previously equipped with a Westbay multiport groundwater sampling system with a dedicated low-flow bladder pump system. NMED approved the work plan with modifications on January 18, 2022 and directed NASA to submit a revised work plan no later than March 11, 2022.

Enclosure 1 provides the response table with cross-references where NMED modifications were addressed in the work plan. Enclosure 2 provides the required replacement pages that address NMED's modifications. Enclosure 3 provides electronic copies of the revised work plan, the redline-strikeout version of the work plan, and the response table on CD-ROM.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions or comments concerning this submittal, please contact Antonette Doherty of my staff at 575-202-5406.

TIMOTHY DAVIS
Digitally signed by TIMOTHY DAVIS
Date: 2022.03.08 07:34:29 -07'00'

Timothy J. Davis
Chief, Environmental Office

3 Enclosures

cc:
Mr. Gabriel Acevedo
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Well Reconfiguration Work Plan for Well BW-4

Revised March 2022

Purpose	The National Aeronautics and Space Administration (NASA) proposes to reconfigure monitoring Well BW-4 from a Westbay multiport monitoring well sampling system to a single-zone, low-flow bladder pump sampling system. Well BW-4 was not included in the Westbay wells identified for reconfiguration (NMED, 2016); however, after a failed attempt to remove downhole equipment, and the subsequent removal of the Westbay well casing, NASA initiated an evaluation of the borehole using several methods to determine if the borehole could be reconfigured for continued use as a groundwater monitoring well, or if it should be abandoned.
Well Background	Groundwater monitoring well BW-4 was completed with a Westbay®[1] multiport sampling system on February 23, 1993, with three sampling ports at 270, 355 and 455 feet (ft) below ground surface (bgs; Figure 1). The well was completed with nominal 5-inch steel surface casing set and cemented in place from 1.3 ft above ground surface (ags) to a depth of 244 ft bgs. The lower portion of the well is a 4.5-inch diameter open hole from 244 ft to 482 ft bgs. Well BW-4 is completed in Orejon Andesite bedrock. The well was sampled routinely until February 2016, in accordance with the then current WSTF Groundwater Monitoring Plan (GMP; NASA, 2015). Well BW-4 was last sampled using the originally installed Westbay system on February 19, 2016. In addition to its historical use for routine groundwater monitoring, the well was utilized as a monitoring location (Figure 2) for the 200/600 Areas and Mid-plume Constriction Area groundwater tracer test (NASA, 2012). In mid-2016, WSTF sample technicians installed a Solinst®[2] pump in the Westbay casing to purge the well during the dye tracer study. A depth probe was installed with the pump to monitor drawdown during pumping. Upon attempting to remove the downhole equipment, the pump and depth probe became lodged in the casing. The pump support tubing bundle separated, leaving the pump and depth probe lodged in the casing. Further attempts to recover the equipment were not successful, which prevented further use of the well for groundwater sampling. In February 2018, NASA contracted with a drilling company to remove the Westbay sampling system from the well. The contractor recovered approximately 185 ft (of 475 ft total) of Westbay casing, but the remainder had to be drilled out of the borehole. Following removal of the casing, a camera log was performed and revealed that numerous residual fragments of polyvinyl chloride (PVC) were trapped in fractures, on ledges and in cavities in the borehole walls. PVC

[1] Westbay is a registered trademark of Nova Metrix Ground Monitoring (Canada) Ltd.
[2] Solinst is a registered trademark of Solinst Canada Ltd.

	fragments and shards had also accumulated at the bottom of the borehole. The downhole video also showed the borehole was otherwise stable and in good condition. Well BW-4 occupies a large gap between wells BW-1-268 and BW-3-180 (Figure 2) and is an important groundwater monitoring location as discussed in Contaminant Data Review below.
Methods of Evaluation	NASA performed an evaluation of the BW-4 borehole using a variety of methods: • Acoustic and/or optical televiewer geophysical logs, • Flexible Underground Liner Technologies (FLUTe™) Activated Carbon Technique (FACT) profile to identify the presence and concentrations of volatile organic compounds (VOCs), • FLUTe liner transmissivity test to determine if and where groundwater is flowing into or out of the open portion of the borehole, and • Downhole flowmeter and temperature/water chemistry profiles.
Water Chemistry, Temperature and Flow-Meter Results	On July 17, 2019, a contractor geophysical service company logged the open portion of the borehole below the surface casing to identify fractures that could be potential pathways for groundwater flow. Resistivity, temperature, spontaneous potential, 3-arm caliper, acoustic borehole imaging (ABI), optical borehole imaging (OBI) and heat-pulse thermal flowmeter (TFM) logs were acquired. Fractures and fracture zones were evident on the imaging logs and correlate well with the caliper log (Figure 3). Additionally, the neutron and resistivity logs indicated the presence of water in fractures at 330, 350 and 360 ft below the top of casing (btoc). The Optical Borehole Imaging Log was used to distinguish between open and healed (filled) fractures. Fractures at 330 and 350 ft btoc were open; fractures at 360 and 435 ft btoc were tight and partially to mostly healed. Temperature logs were run prior to measuring flow rates with the TFM tool to pinpoint where water is entering or leaving the borehole. The temperature log run in well BW-4 showed a constant gradient. Changes in the temperature gradient, if any, could not be distinguished from background “noise” in the data. The TFM tool is capable of detecting as little as 0.01 gallon per minute (gpm) vertical flow in an open hole. Flow rate measurements were taken at 13 stations between 230 ft btoc (inside the casing) and 478 ft btoc. No vertical movement of water was detected in any portion of the borehole (Figure 3).
FLUTe Transmissivity and FACT Results	On January 7 and 8, 2020, FLUTe personnel installed a blank liner with the carbon activated felt strip to initiate an investigation of the borehole using the FACT. The liner was left in place for a period of two weeks for optimum absorption of contaminants and removed on

	January 21, 2020. The liner was taken to FLUTe's facility in Velarde, New Mexico, where the carbon activated strip was removed and cut into 2-ft strips for analysis by a contracted laboratory. SW-846 Method 8260C was used to analyze for VOCs. The only VOCs above detection limits (0.51 mg/kg) in the blank liner of well BW-4 were trichlorofluoromethane (Freon®[3] 11) and trichloroethene (TCE). The highest concentrations correlate well with fractures as documented by the geophysical logs and are associated with the open fracture at 330 ft btoc and the fracture zone from 358 to 363 ft btoc (Figure 4**)**. There are moderate contaminant levels present in samples from the fracture zone at 435 ft btoc. Low levels of contaminants from 289 to 330 ft bgs may be the result of numerous small fractures apparent on both the caliper and imaging logs. However, moderate levels of contamination between 389 and 413 ft btoc are more difficult to account for as they do not correlate with any noticeable fracturing of the bedrock, except for a single small fracture at 394 ft btoc. On January 23, 2019, FLUTe personnel attempted to conduct a transmissivity profile to identify transmissive fractures within the borehole. The objective was to use the advancing FLUTe liner to force water out of the borehole through transmissive fractures by applying a constant artificial head of 12 to 15 pounds per square inch (psi). The constant artificial head is maintained by adding water to the inside of the liner. During a FLUTe transmissivity test, the liner descends into the borehole and the rate of descent slows after passing and sealing each transmissive fracture. In evaluating well BW-4 however, once the liner reached the static water level, the rate of descent was so slow that the test had to be aborted. The test indicated that very little water was leaving the borehole through fractures in the bedrock, which is indicative of very low transmissivity.
Heat-Pulse Flowmeter and Downhole Conductivity/Temperature Logging Results	After the FLUTe transmissivity test was aborted, an additional geophysical investigation was performed to identify transmissive fractures in the well. On February 12, 2020, the same contractor geophysical service company conducted a second Heat-Pulse TFM log. During this test the borehole was filled with non-chlorinated water to the surface and the level was maintained to create approximately 86 psi hydrostatic head. After the borehole was filled with water, temperature and conductivity logs were run to pinpoint locations where water was leaving the borehole. The TFM tool, which collects flow data at predetermined stations, was used to bracket fractures and fracture zones, as well as changes in temperature or conductivity that showed potential movement of water out of the borehole. The first two TFM readings were taken inside the steel surface casing to establish an average rate of downward flow of approximately 1.24 gpm (Figure 5). Flow measurements were taken at 11 stations in the

[3] Freon is a registered trademark of The Chemours Company FC, LLC.

	open portion of the borehole. While there are some limitations in the accuracy of the tool due to irregularities in the borehole walls, TFM stations at 270 and 284 ft btoc in the open hole were identical and matched the average rate of flow obtained inside the surface casing. These two readings provided a high degree of confidence in the data, which showed the greatest amount of water, approximately 1 gpm, was leaving the borehole through the open fracture at 330 ft btoc. A change in the temperature gradient and conductivity at that depth provided further confirmation that water was leaving the borehole at that depth (Figure 6). It is noteworthy that the previously installed Westbay sampling zones did not include the transmissive fracture at 330 ft btoc. Lesser amounts of water were observed leaving the borehole through fractures at 297 ft btoc (~0.2 gpm), 350 ft btoc (~0.07 gpm), and 435 ft (~0.05 gpm).
Contaminant Data Review and Comparison	WSTF contaminant data were reviewed for the last three years that well BW-4 was sampled, from 2014 through 2016. At that time, the Westbay sampling system was installed with sample ports at 270, 355 and 455 ft btoc. Historically, three contaminants have been detected in well BW-4 above clean-up levels (NASA, 2021): N-Nitrosodimethylamine (NDMA), tetrachloroethene (PCE), and trichloroethene (TCE). NDMA samples collected from the three Westbay zones ranged from 0.061 to 0.086 µg/L with little variation. TCE results from the upper zone at 270 ft btoc ranged from 76 to 100 µg/L, and the highest levels of TCE were collected from sample ports at 355 and 455 ft btoc ranging from 110 to 130 µg/L. Likewise, the highest results for PCE were from the zone at 355 ft btoc and ranged from 6.2 to 7.2 µg/L. The lower sampling port at 455 ft btoc had a range only slightly lower at 4.8 to 6.6 µg/L. Contaminant data was also compared to nearby wells using data and figures from the GMP 2021 update (NASA, 2021). Figure 7 through Figure 10 show relative concentration plots for NDMA, TCE, Trichlorofluoromethane (Freon 11) and 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113), respectively. Well BW-4 is near the center of the contaminant plumes for TCE and Freon 113 and is at the southern margin of the plume for NDMA and Freon 11. The time-concentration plots do not reflect current levels of these contaminants for well BW-4, but demonstrate the location is critical for plume boundary definition and to effectively monitor changes through time in these contaminant plumes.

Proposed Well Reconfiguration	Based on the results of the BW-4 geophysical evaluation, NASA proposes to install a single, dedicated low-flow bladder pump in the open portion of the borehole with the intake set at 330 ft btoc. Low-flow bladder pumps are proven to provide high quality chemical analytical data from groundwater samples collected at WSTF. NASA selected this sampling location due to the relatively high transmissivity of the fracture at 330 ft btoc. Sampling at locations lower in the borehole using a low-flow bladder pump is likely to induce downward vertical flow from the transmissive fracture at 330 ft btoc, resulting in the collection of groundwater samples that are not representative of aquifer conditions at that location. The lower portion of the borehole from current total depth up to 340 ft btoc will be filled with neat cement grout containing 5 to 10 percent bentonite powder to reduce shrinkage. The upper portion of the borehole from 340 ft btoc to the bottom of the casing at 244 ft btoc will remain open. The sampling interval will extend to the static water level at 197 ft btoc; however, all testing indicates there is little to no water movement into or out of the borehole except at the open fracture at 330 ft btoc. This method of well completion in is accordance with the NASA WSTF Hazardous Waste Permit Attachment 19, Section 19.3.2.c (NMED, 2019), for bedrock wells which states "When the drilling is complete, the finished well will consist of an open borehole from the ground surface to the bottom of the well."
Groundwater Sampling	Groundwater sampling will be conducted in accordance with the GMP (NASA, 2021). Well BW-4 will be allowed to equilibrate for up to 30 days prior to initial groundwater sampling, which is typically performed between 10 and 30 days after installation of the sampling system. Reconfigured groundwater monitoring wells/zones are sampled quarterly for at least one year for VOC, nitrosamines, metals, semi-volatile organic compounds, and inorganic compounds. After one year, groundwater sampling at well BW-4 will be conducted in accordance with the schedule identified for the well in the GMP, which is updated annually and approved by NMED. Data collected from the initial year of quarterly sampling will be compared to historical data collected from the zones of former Westbay monitoring well BW-4, as well as data from surrounding groundwater monitoring wells. The results of the evaluation of these data will be summarized in the annual GMP update provided to NMED after completing the evaluation of analytical data from reconfigured well BW-4.
Investigation-Derived Waste and Waste Characterization	Information related to the characterization, management, and disposition of waste generated during this project is provided in this section. Waste characterization will be conducted in accordance with Section II.C.2 (Waste Characterization) and Attachment 12 (Waste Analysis Plan) of the WSTF Hazardous Waste Permit (NMED, 2019).

	All waste will be properly managed and disposed of in accordance with NASA procedures and state and federal regulations. The Environmental Protection Agency (EPA) has established through the "contained-in policy" that groundwater and other environmental media is not solid waste but is subject to regulation as if it were hazardous waste when it contains listed waste (EPA, 1996). Available historical analytical data from well BW-4 indicate that the well is located in the WSTF contaminant plume and contains WSTF contaminants of concern (NDMA, PCE, Freon 113, and TCE). Therefore, F001 and F002 hazardous waste codes will apply to groundwater actively managed from these wells. As a result of this determination, groundwater and materials that contact groundwater at these locations are subject to regulation as listed hazardous waste. Anticipated waste streams that may be generated during this project include: • **Groundwater.** Groundwater produced from the aquifer within the WSTF groundwater plume boundaries contains listed hazardous waste. Activities that produce groundwater may include cementing the bottom of the borehole, purging, and groundwater sampling. Waste groundwater is characterized as hazardous waste. • **Decontamination fluids.** Decontamination fluids such as water and soap solutions used to wash and decontaminate equipment during this project will be managed as a listed hazardous waste. • **Contact waste.** Waste, or debris, such as used disposable sampling equipment, personal protective equipment, plastic sheeting, and other debris generated during reconfiguration activities at well BW-4 contacted by contaminated groundwater will be managed as a listed hazardous waste. • **Petroleum Contaminated Debris.** Debris such as rags and wipes that may be contaminated with petroleum products during routine equipment maintenance. This debris is characterized as hazardous waste with the D018 hazardous waste code. Groundwater and decontamination fluids generated during cementing, purging, and sampling activities will be accumulated in appropriately sized containers. All containers containing hazardous waste generated will be managed in accordance with 20.4.1.300 NMAC and 40 CFR 262.17 in a Central Accumulation Area. Within permissible accumulation time limits, hazardous groundwater and decontamination fluids will be transferred to the Mid-plume Interception and Treatment System (MPITS) for treatment and discharge in accordance with Discharge Permit (DP)-1255 (NMED, 2017).

	Hazardous debris, that contacts contaminated groundwater will be collected at the end of each working shift and transferred to an appropriate container. Similarly, debris that may have come into contact with petroleum-based oils or fuels will be accumulated separately as hazardous waste. Hazardous waste debris will be managed in accordance with 20.4.1.300 NMAC and 40 CFR 262.17 at a Central Accumulation Area. Hazardous debris will be disposed at a RCRA permitted treatment, storage, and disposal facility (TSDF) within permissible time limits. For waste that is characterized as hazardous waste, land disposal restriction notifications, disposal facility profiles, and hazardous waste manifests will be completed as required. Hazardous waste manifested off-site will be transported for treatment and disposal at a permitted RCRA TSDF. Contaminated groundwater and decontamination water generated during the project will be managed at the MPITS. If that system is not capable of receiving the waste, it will be disposed of at a permitted RCRA TSDF.
Schedule	Following NMED approval of this work plan, NASA will implement the following well reconfiguration activities: • Project planning and procurement activities: 2 months • Fieldwork activities (well sample system installation, well equilibration, initial groundwater sampling): 2 months • Groundwater data management and evaluation: 2 months • Final well reconfiguration summary report: 3 months The total project duration will be approximately 9 months. As directed by NMED in the January 18, 2022 Approval with Modifications, NASA will submit a well reconfiguration report for well BW-4 no later than March 30, 2023.
References	Adoption of 40 CFR Part 262, Environmental Improvement Board, 20.4.1.300 NMAC (12-1-18). EPA. (April 29, 1996). Requirements for Management of Hazardous Contaminated Media (HWIR-Media). *Federal Register* 61, No. 83: 18780.https://www.govinfo.gov/content/pkg/FR-1996-04-29/pdf/96-10096.pdf Hazardous Waste Management, Environmental Improvement Board, 20.4.1 NMAC (12-1-18). NASA Johnson Space Center White Sands Test Facility. (2012, May 10). *Work Plan for Tracer Testing in the 200/600 Areas and Mid-Plume Constriction Area*. Las Cruces, NM.

	NASA Johnson Space Center White Sands Test Facility. (2015, April 29). *Groundwater Monitoring Plan Update for 2015*. Las Cruces, NM. NASA Johnson Space Center White Sands Test Facility. (2021, April 19). *NASA White Sands Test Facility (WSTF) Groundwater Monitoring Plan (GMP) Update for 2021*. Las Cruces, NM. NMED Hazardous Waste Bureau. (2016, March 29). *Approval NASA WSTF Periodic Monitoring Report Fourth Quarter 2015*. Santa Fe, NM. NMED Ground Water Quality Bureau. (2017, July 14). Discharge Permit Renewal and Modification, DP-1255, NASA White Sands Testing Facility. Santa Fe, NM. NMED Hazardous Waste Bureau. (2019, December 11). *Fee Assessment Administrative Completeness and Fee Assessment Transmittal of Class I Permit Modification Without Prior Approval*. Santa Fe, NM. NMED Hazardous Waste Bureau. (2022, January 18). *Approval with Modifications Well Reconfiguration Work Plan for Well BW-4*. Santa Fe, NM.

Figures

Figure 1 **BW-4 Well Completion Diagram**

(SEE NEXT PAGE)

WELL COMPLETION DIAGRAM

WESTBAY® MONITORING WELL

Location ID: **BW-4** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 SE 1/4 SE 1/4 Sec. 34, T20S, R3E**
NM State Plane Coordinates (NAD 83 in meters): **168325.61N 465802.60E**
Elevation (Brass Cap): **1448.64 m AMSL**
Elevation (Top of Casing): **1449.04 m AMSL**
Drilling Contractor: **Larjon Drilling Company**
Driller: **J. Gower**
Total Depth of Borehole (bgs): **482' (146.9 m)**
Borehole Diameter: **8 3/4" 0-244'; 4 1/2" 244-482'**
Depth to Bedrock (bgs): **230' (70.1 m); Andesite**
Depth to Groundwater: **194.26' (59.2 m) TOSC (2/18/93)**
Total Depth Surface Casing (bgs): **244' (74.4 m)**
Diameter and Type Surface Casing: **Nominal 5" Steel**
Date(s) Well Installed: **2/19/93 - 2/23/93**

Date(s) Well Developed: **BH = 2/17/93 (air-lift); WB = unknown**
Field Representative(s): **P. Egan, D. Menzie, K. Summers**
Total Depth Well Casing (bgs): **475' (144.8 m)**
Type of Casing: **Westbay® MP 38 PVC (SCD 80)**
Diameter Well Casing: **1.5" ID; 1.9" OD**
WB Sampling Zone(s)(bgs): **270' (82.79 m); 355' (108.71 m); and 455' (139.20 m)**
WB Packer Zone(s)(bgs): **260-285' (79.74-87.36 m); 345-365' (105.66 m-111.76 m); and 455-475' (TD) (139.20-144.8 m)**
Comments: **Depths (meters) for Westbay components and zones are a calculated value based on piezometric levels at Meas. Ports. TOSC = Top of Surface Casing AMSL = Above Mean Sea Level BH = borehole WB = Westbay®**

Surface Casing
Nominal 5" Steel

1.5" ID Westbay® MP38 Casing

Casing Explanation:

1.5" ID Westbay® MP38 End Cap

Packer

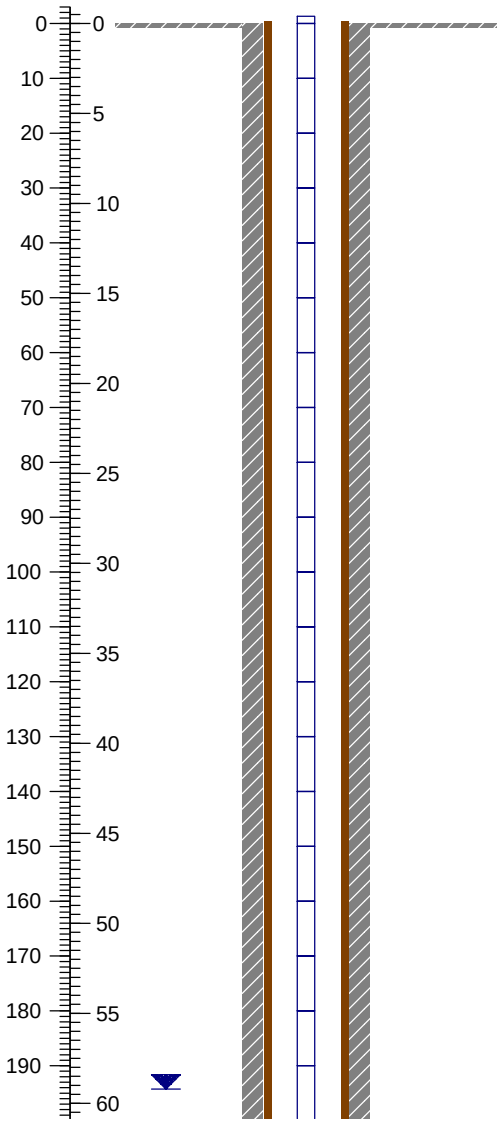
Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)

Magnetic Collar
Water Table

Cement
Slough

Feet/Meters

Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs



Westbay® Well Stick-Up = 1.3' (0.394 m)
Surface Casing Stick-Up = ~0.42' (0.1 m)
Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface.

Depth to Water = 194.26' (59.2 m)(Borehole; measured

Surface Casing
Nominal 5" Steel

1.5" ID Westbay® MP38 Casing

Casing Explanation:

1.5" ID Westbay® MP38 End Cap

Packer

Measurement Port (MP)

MP with Filter Sock

Mechanical Pumping Port (PP)

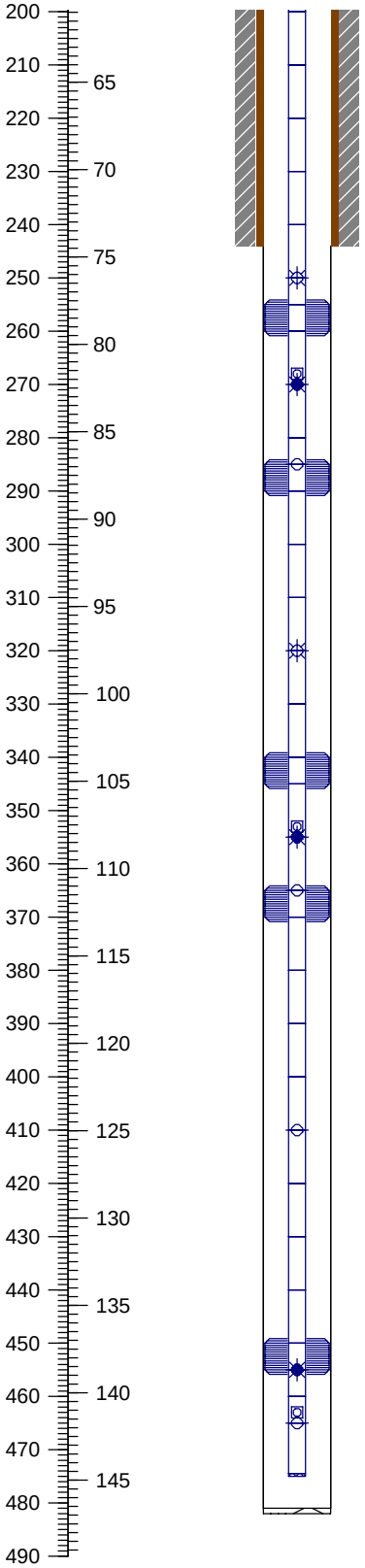
Magnetic Collar

Water Table

Cement

Slough

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs
2/18/93 (TOSC) just before Westbay® well casing installation)	
	Andesite (Orejon Andesite) Bedrock Depth = 230' (70.1 m)
Nominal 5" Steel Surface Casing Depth = 244' (74.4 m)	8 3/4" Borehole cemented to 244' (74.4 m)
MP Depth = 250' (76.69 m) Packer Depth = 255'-260' (78.21-79.74 m)	
Magnetic Collar Depth = 269.6' (82.67 m) Sampling MP Depth (with Filter Sock) = 270' (82.79 m)	
PP Depth = 285' (87.36 m) Packer Depth = 285'-290' (87.36-88.87 m)	
MP Depth = 320' (98.04 m)	
Packer Depth = 340'-345' (104.14-105.66 m)	
Magnetic Collar Depth = 354.6' (108.59 m) Sampling MP Depth (with Filter Sock) = 355' (108.71 m)	
PP Depth = 365' (111.76 m) Packer Depth = 365'-370' (111.76-113.28 m)	
PP Depth = 410' (125.0 m)	
Packer Depth = 450'-455' (137.68-139.20 m) Sampling MP Depth (with Filter Sock) = 455' (139.20 m) Magnetic Collar Depth = 464.6' (142.13 m) PP Depth = 465' (142.25 m)	
Westbay® MP 38 Casing TD = 475' (144.8 m)	
4 1/2" Borehole TD = 482' (146.9 m)	Top of Slough = ~481' (146.6 m). Borehole total depth with slough per

Figure 2 **BW-4 Well Location Map**

(SEE NEXT PAGE)

Work Location for BW-4

Multiport
Perched Well
Hardscrabble Hill Fault Zone
Conventional Well
MSVGM Well

Feet
0 750 1,500

N
W E
S

June 2021

Figure 3 BW-4 Geophysical Logs 7/17/2019 OBI/ABI/Temperature/Caliper/TFM

(SEE NEXT PAGE)

JET WEST
GEOPHYSICAL SERVICES, LLC.

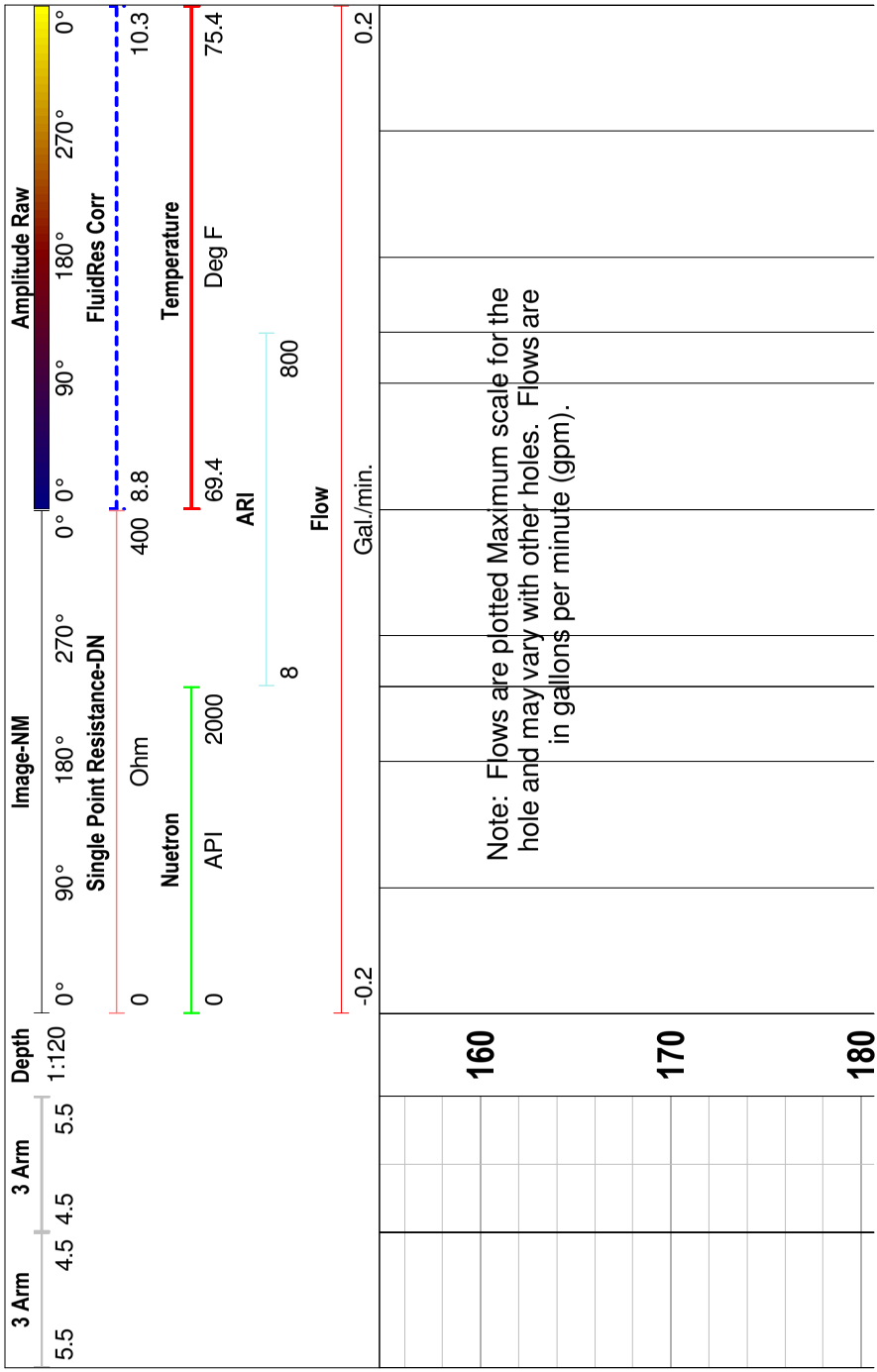
COMPANY	Navarro Research & Engineering
WELL ID	BW-4
FIELD	NASA/WSTF
COUNTY	Dona Ana STATE New Mexico
TYPE OF LOG:	**OBI, ABI, Caliper, Temp, Fluid Res, ARI**
OTHER SERVICES	Neutron Devitation Electrics
Northing:	
Easting:	
LOCATION	
SEC TWP RGE	
API No.	

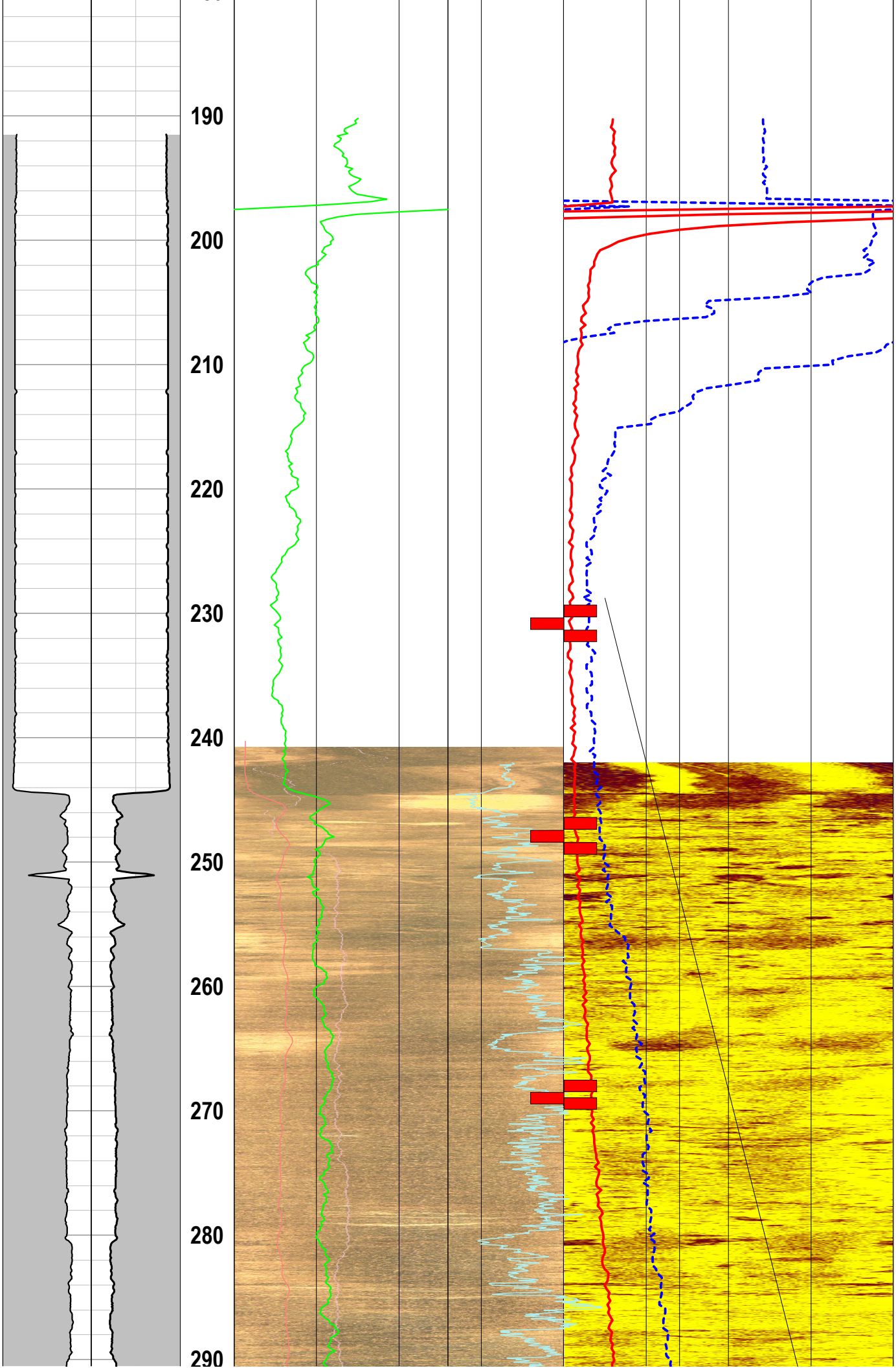
PERMANENT DATUM	Ground Level	ELEVATION	K.B.
LOG MEAS. FROM	Ground Level	ABOVE PERM. DATUM	T.O.C
DRILLING MEAS. FROM	Ground Level		G.L.

DATE	7-17-2019	TYPE FLUID IN HOLE	water
RUN No.	three, four	SALINITY	
TYPE LOG	OBI, ABI, 3Arm, Temp, FR	DENSITY	
DEPTH-DRILLER	482 ft.	LEVEL	197 ft.
DEPTH-LOGGER	483 ft.	MAX. REG. TEMP	
BTM LOGGED INTERVAL	483 ft.	DIGITIZE INTERVAL	0.4 - 0.1 - 0.01 ft.
TOP LOGGED INTERVAL	Surface		
OPERATING RIG TIME	09:50-13:15		
RECORDED BY	T.Staatz / A. Henderson		
WITNESSED BY	M. Pitterle		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE		FROM	TO
1				5 in. I.D.	Steel	-0.9 ft.	244 ft.
2	4.5 in.	244 ft.	483 ft.				
3							

REMARKS:

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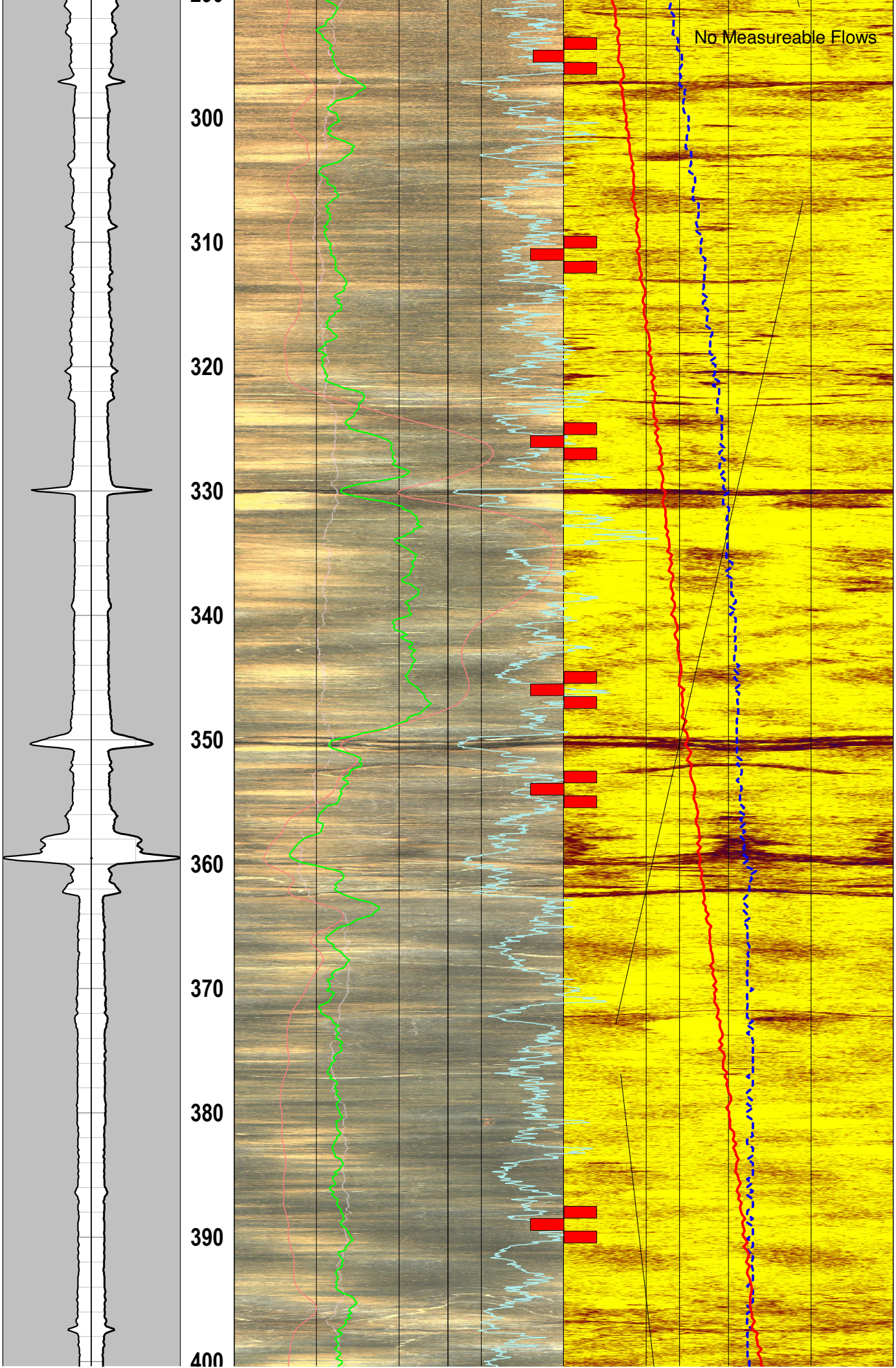

No Measureable Flows
300
310
320
330
340
350
360
370
380
390
400

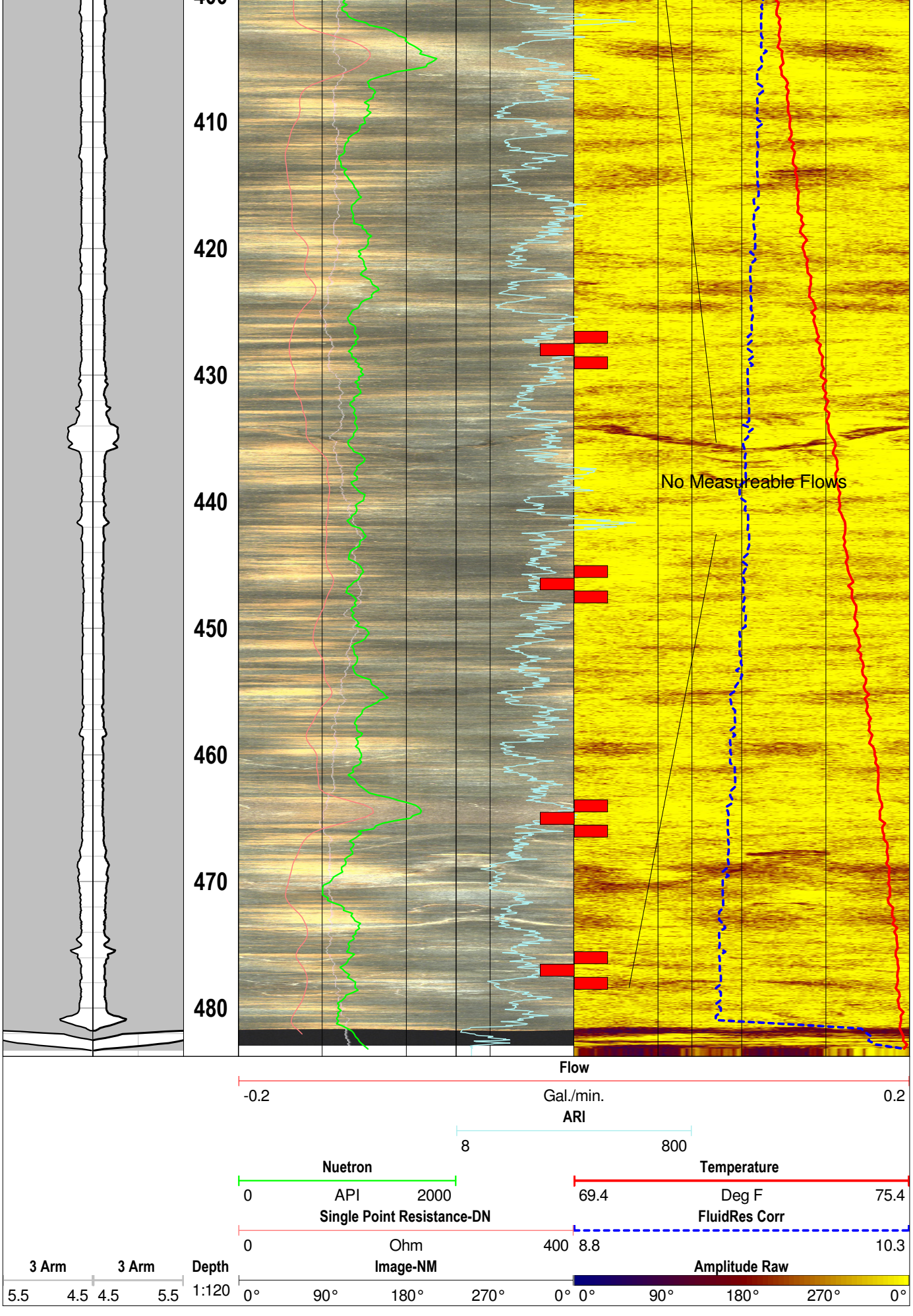

410
420
430
440
450
460
470
480
No Measureable Flows
Flow
-0.2
Gal./min.
0.2
ARI
8
800
Nuetron
0
API
2000
Temperature
69.4
Deg F
75.4
Single Point Resistance-DN
0
Ohm
400
FluidRes Corr
8.8
10.3
3 Arm
3 Arm
Depth
Image-NM
Amplitude Raw
5.5
4.5
4.5
5.5
1:120
0°
90°
180°
270°
0°
0°
90°
180°
270°
0°

Figure 4 FLUTe Activated Carbon Technique (FACT) Profile

(SEE NEXT PAGE)

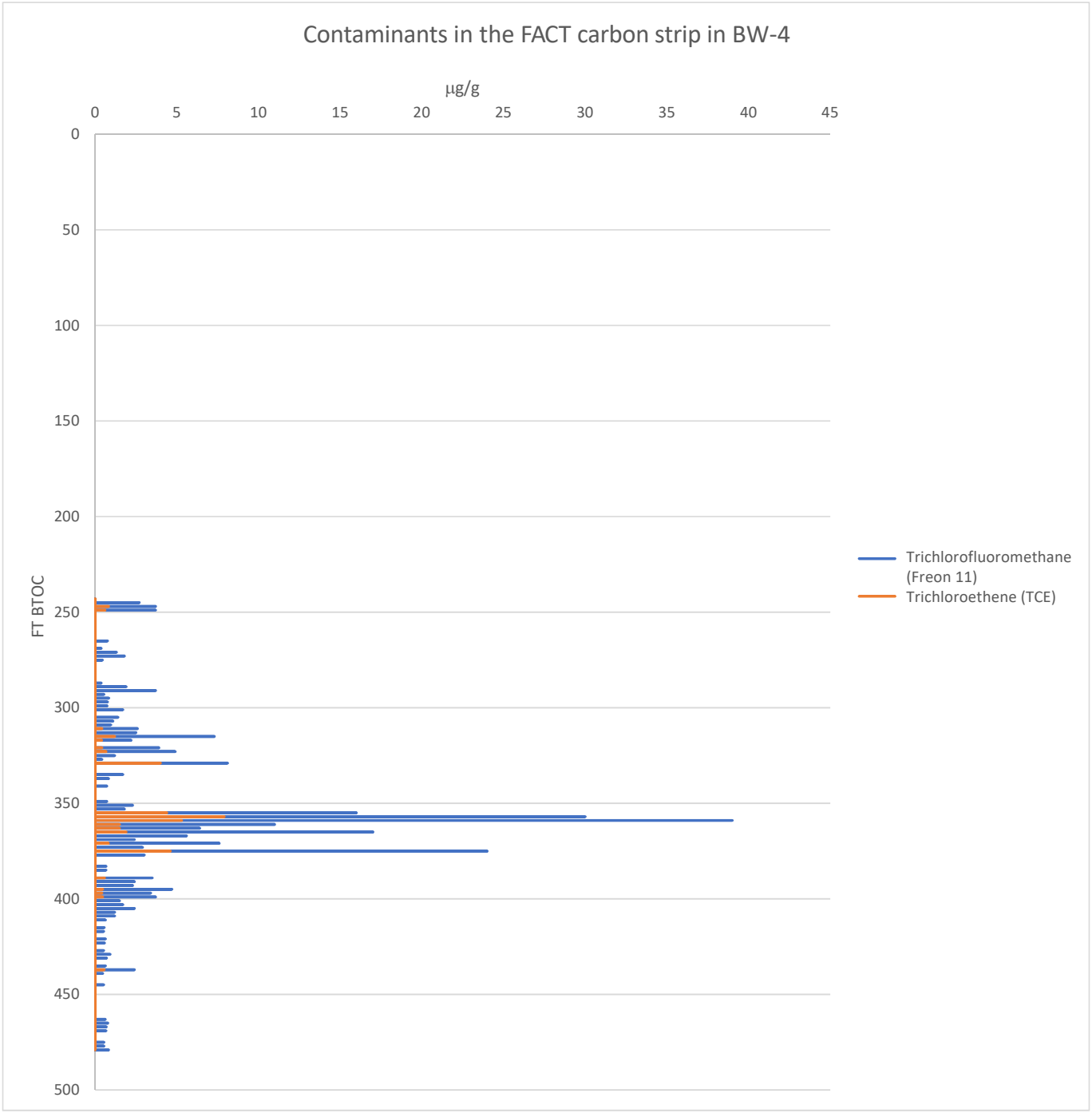
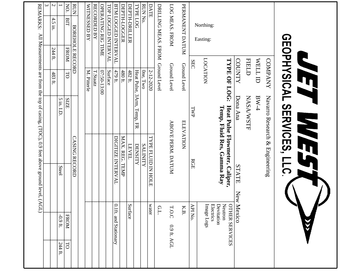

Contaminants in the FACT carbon strip in BW-4
µg/g
0
5
10
15
20
25
30
35
40
45
FT BTOC
0
50
100
150
200
250
300
350
400
450
500
Trichlorofluoromethane (Freon 11)
Trichloroethene (TCE)

Figure 5 BW-4 Geophysical Logs Run on 2/12/2020 Caliper/Temperature/Conductivity/TFM

(SEE NEXT PAGE)


JET WEST
GEOPHYSICAL SERVICES, LLC
COMPANY Stevens Research & Engineering
WELL ID BW-4
FIELD NASA/ANSTEF
COUNTY STATE Nye, Nevada
LOCATION
Other Services
Permanent Datum
Elevation
Log Measured From
Drilling Measured From
TYPE OF LOG: Dual Pulse Flowmeter, Caliper, Temp, Fluid Res, Gamma Ray
Run Number
Date
Depth-Driller
Depth-Logger
Bottom Logged Interval
Top Logged Interval
Type Fluid in Hole
Salinity, PPM Cl
Density / Viscosity
Max Rec. Temperature
Equipment Location
Recorded By
Witnessed By
Northing:
Easting:

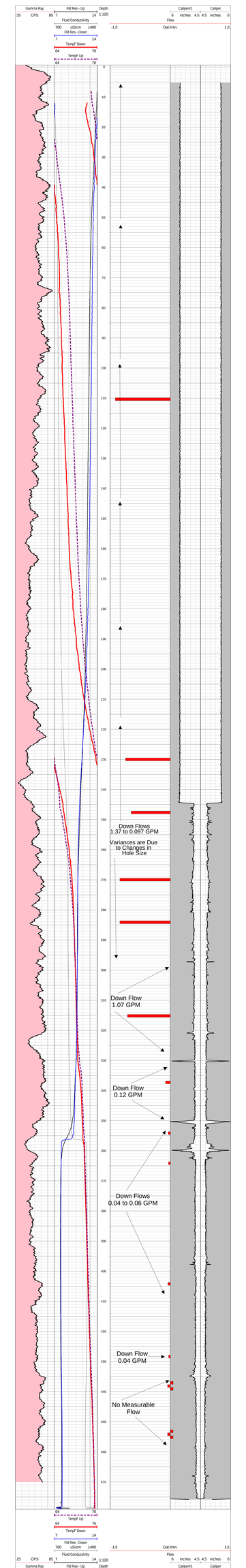

Gamma Ray
25 CPS 85
Fld Res - Up
Fld Res - Down
7 14
Depth
1:120
Caliper#1
Caliper
6 inches 4.5 4.5 inches 6
Fluid Conductivity
700 uS/cm 1400
Flow
-1.5 Gal./min. 1.5
Temp# Down
64 76
Temp# Up
64 76
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
Down Flows
1.37 to 0.097 GPM
Variances are Due
to Changes in
Hole Size
Down Flow
1.07 GPM
Down Flow
0.12 GPM
Down Flows
0.04 to 0.06 GPM
Down Flow
0.04 GPM
No Measurable
Flow

Figure 6 BW-4 Expanded Scale Temperature Logs Before (7/17/19) and after (2/12/20) Fresh Water Injection

(SEE NEXT PAGE)

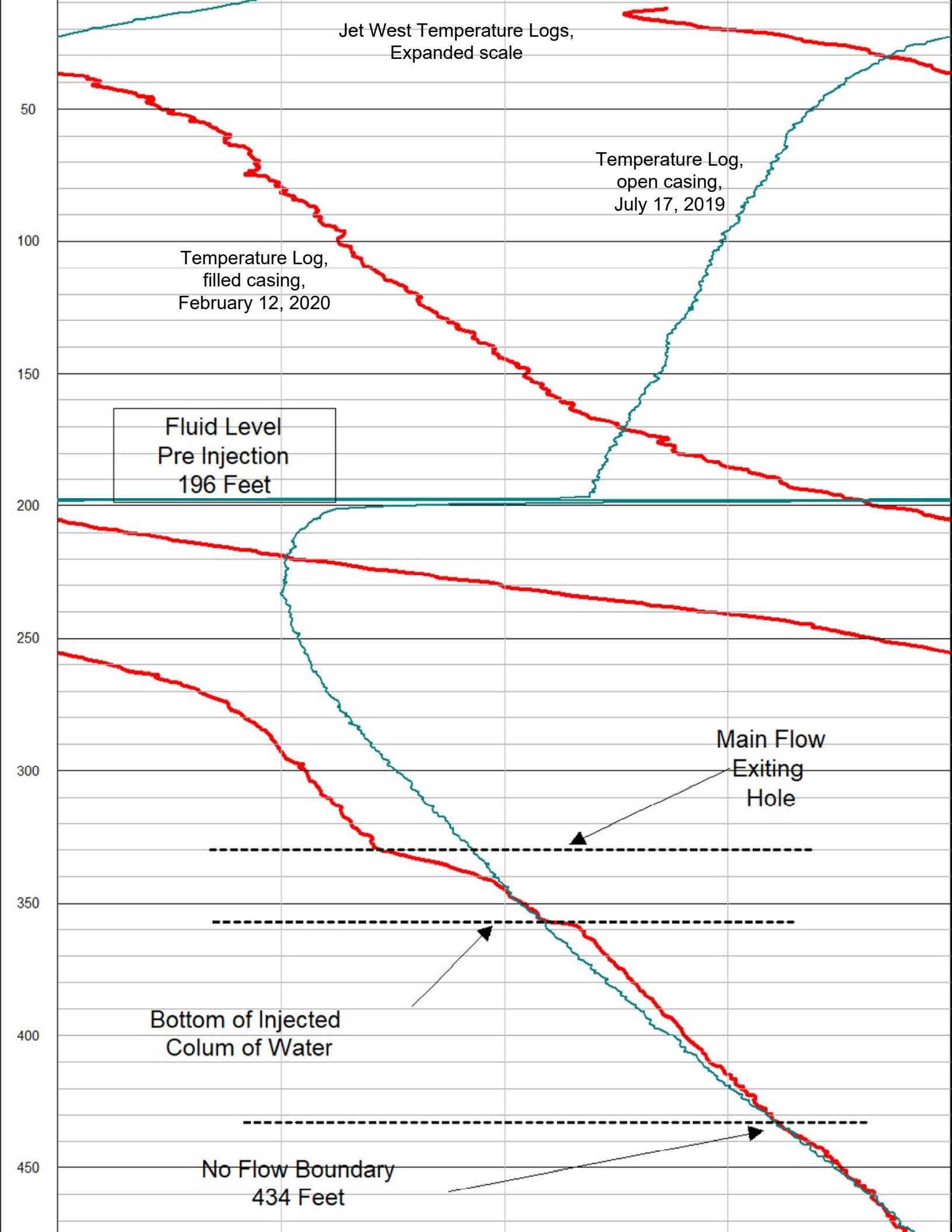
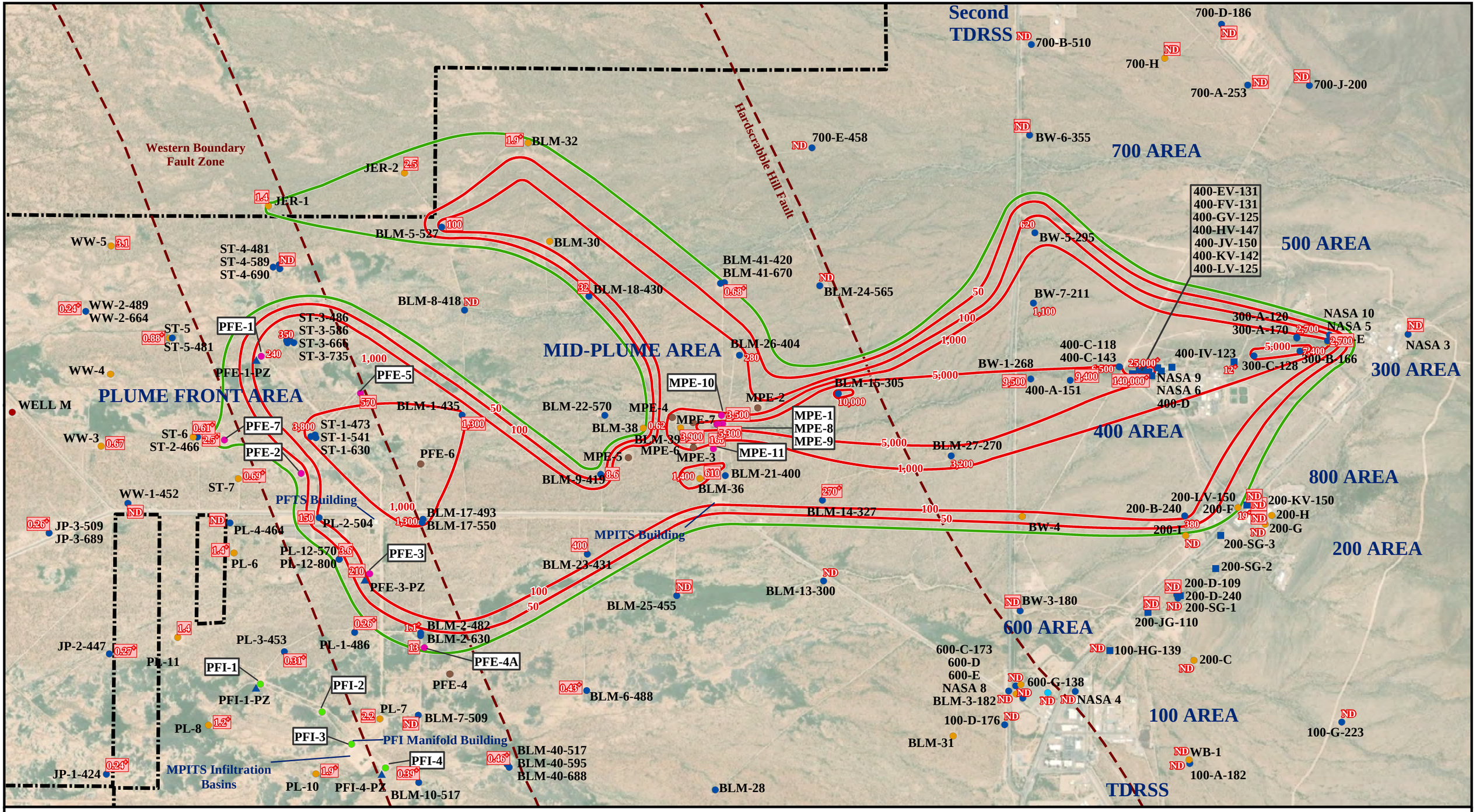

Jet West Temperature Logs,
Expanded scale
50
100
150
200
250
300
350
400
450
Temperature Log,
open casing,
July 17, 2019
Temperature Log,
filled casing,
February 12, 2020
Fluid Level
Pre Injection
196 Feet
Main Flow
Exiting
Hole
Bottom of Injected
Colum of Water
No Flow Boundary
434 Feet

Figure 7 NDMA Concentrations in Groundwater from GMP 2021 Update

(SEE NEXT PAGE)



NDMA Maximum Concentrations in Groundwater for Fourth Quarter 2020

- Equiconcentration Line (ng/L)
- NDMA Cleanup Level (1.1 ng/L)
- Multiport
- Conventional Well
- Perched Well
- MSVGM Well
- Extraction Well
- Injection Well
- Piezometer
- Exploration Well
- Production Well
- Fault
- WSTF Boundary

0 4,000 8,000 Feet

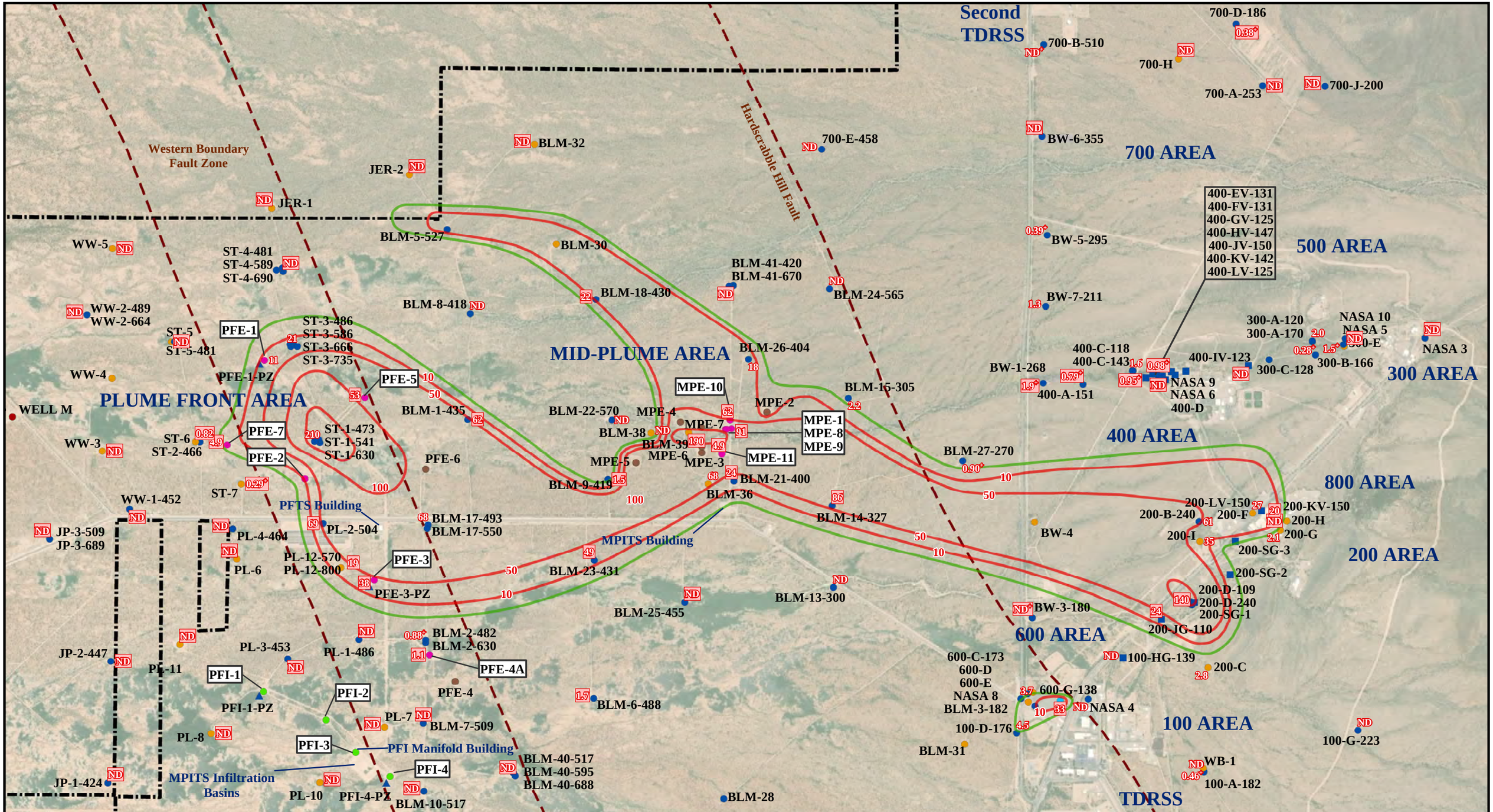
Note:
Method 607 NDMA results corrected for extraction efficiency.
+ - Data value has a QA flag. See Appendix A.2 for specific flags.
ND - Non-detect values <0.22 ng/L (NDMA-LL) or <4.7 ng/L (607)
50 - Sample event result was within the quarterly date range. No outline indicates an earlier sample event.
- No value indicates the well has not been sampled in the last year.

N W E S

April 2021

Figure 8 TCE Concentrations in Groundwater from GMP 2021 Update

(SEE NEXT PAGE)



TCE Maximum Concentrations in Groundwater for Fourth Quarter 2020

- Equiconcentration Line (ug/L)
- TCE Cleanup Level (4.9 ug/L)
- Multiport
- Conventional Well
- Perched Well
- MSVGM Well
- Extraction Well
- Injection Well
- Piezometer
- Exploration Well
- Production Well
- Fault
- WSTF Boundary

0 4,000 8,000 Feet

N W E S

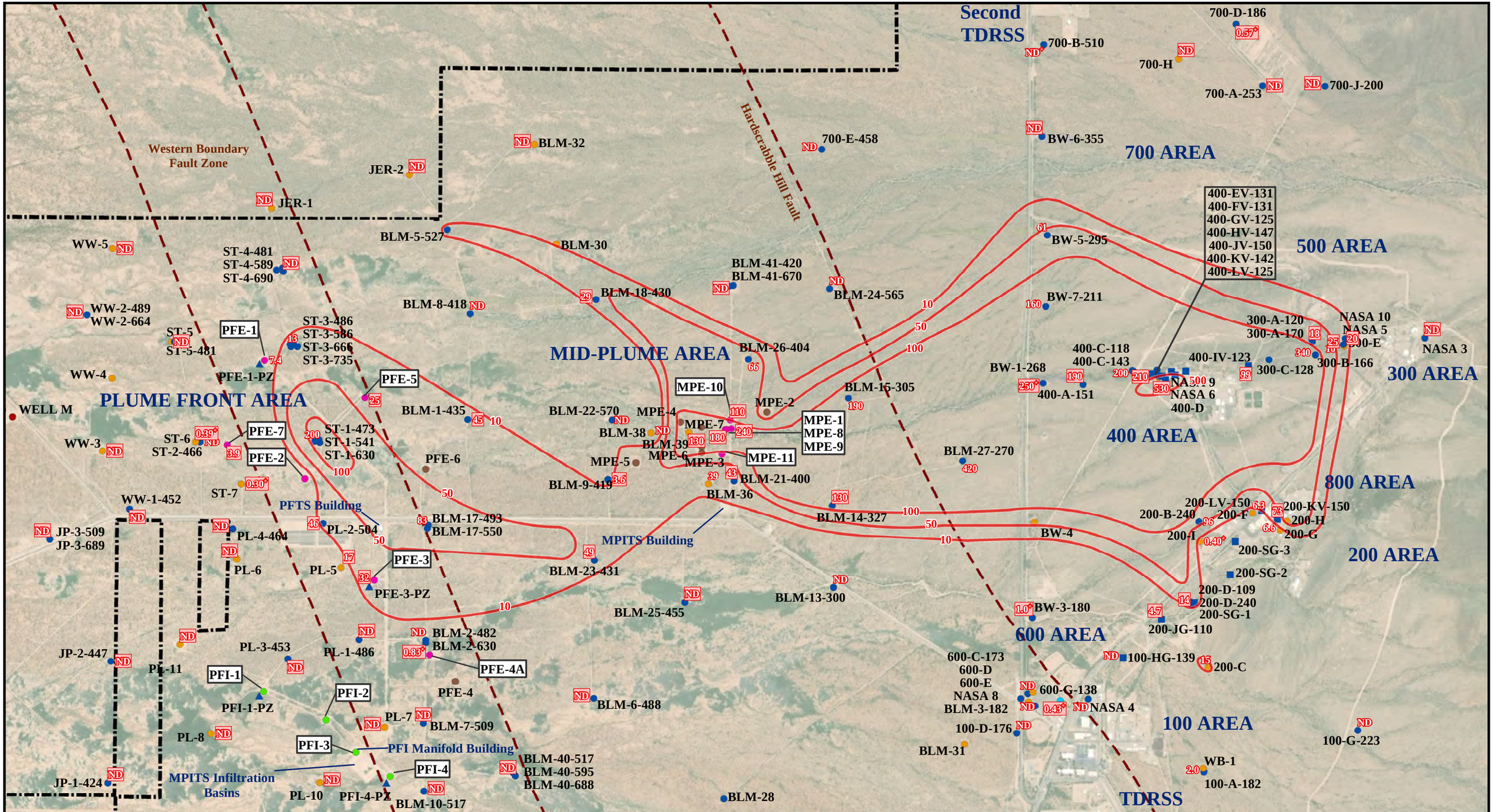
Note:
+ - Data value has a QA flag. See Appendix A.2 for specific flags.
ND - Non-detect values <0.20 ug/L
50 - Sample event result was within the quarterly date range. No outline indicates an earlier sample event.
- No value indicates the well has not been sampled in the last year.

April 2021

Figure 9 Freon 11 Concentrations in Groundwater from GMP 2021 Update

(SEE NEXT PAGE)

Freon 11 Maximum Concentrations in Groundwater for Fourth Quarter 2020



Multiport
Conventional Well
Perched Well
MSVGM Well
Extraction Well
Injection Well
Piezometer
Exploration Well
Production Well
Fault
WSTF Boundary
Equiconcentration Line (ug/L)

0 4,000 8,000 Feet

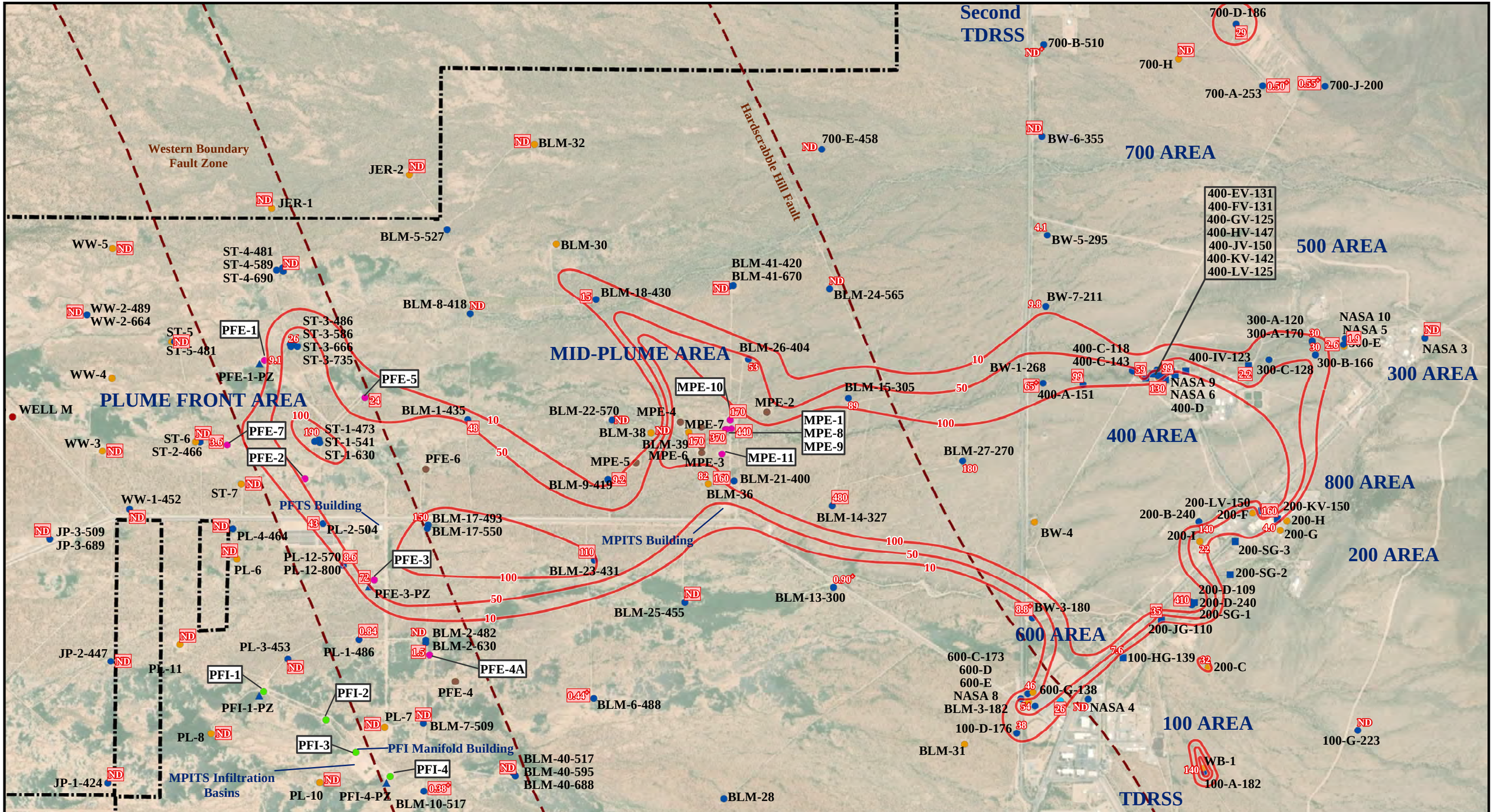
Note:
Freon 11 concentations are below the EPA RSL (5,200 ug/L).
+ - Data value has a QA flag. See Appendix A.2 for specific flags.
ND - Non-detect values <0.24 ug/L
8.0 - Sample event result was within the quarterly date range. No outline indicates an earlier sample event.
- No value indicates the well has not been sampled in the last year.

N
W E
S

April 2021

Figure 10 Freon 113 Concentrations in Groundwater from GMP 2021 Update

(SEE NEXT PAGE)



Freon 113 Maximum Concentrations in Groundwater for Fourth Quarter 2020

Multiport
Conventional Well
Perched Well
MSVGM Well
Extraction Well
Injection Well
Piezometer
Exploration Well
Production Well
Fault
WSTF Boundary
10 Equiconcentration Line (ug/L)

0 4,000 8,000 Feet

Note:
Freon 113 concentations are below the EPA RSL (10,000 ug/L).
+ Data value has a QA flag. See Appendix A.2 for specific flags.
ND Non-detect values <0.20 ug/L
80 - Sample event result was within the quarterly date range. No outline indicates an earlier sample event.
- No value indicates the well has not been sampled in the last year.

N W E S

April 2021