



April 27, 2022

Mr. Randy Evans, Operator in Responsible Charge
Wellington Operating Company
1590 East County Road 70
Wellington, Colorado 80549

Subject: Annual Update – Groundwater Flow Direction
Wellington Muddy Sandstone Unit, Wellington, Colorado
Project No.: 1022.003

Dear Mr. Evans:

We understand that the Wellington Operating Company manages and runs the Wellington Muddy Sandstone Unit north of Wellington, Colorado. The company utilizes a water treatment system to handle portions of the produced water originating from the oil field. Part of the water handling process includes discharge of treated water to Rapid Infiltration Basins (RIBs) located north and south of CR 70 approximately $\frac{3}{4}$ mile west of County Road 9. The site location and related features are shown on Figure 1.

A discharge permit is required for the RIBs and is updated as necessary to meet state regulations. The discharge permit is issued by the Colorado Oil and Gas Conservation Commission (COGCC). In 2021 COGCC asked for a conceptual assessment of the shallow groundwater regime and evaluation of the location of the monitoring well network near the RIBs. The assessment was completed and presented to COGCC as part Wellington Operating Company's 2021 permit renewal. As a requirement of the renewal, COGCC requested an annual update of groundwater flow direction maps associated with the monitoring well network.

ANNUAL UPDATE

To complete the annual update, we reviewed water levels recorded during routine monitoring events performed by Wellington Operating Company. The data was used to create potentiometric surface maps dating from March 2021 to April 2022 (Figures 2A – 2I). The maps depict groundwater contours which, in turn, depict flow direction. Groundwater flow direction in the area of the RIBs remains generally east- southeasterly.

GEOLOGY/HYDROGEOLOGY

The RIBs are located within the Boxelder Creek alluvial valley-fill deposit. The deposit consists of intermittent layers of unconsolidated gravels, sands, silts, and clays overlying Pierre Shale bedrock. Along County Road 70, east to west, the river valley is approximately one-mile wide. The generally flat-lying valley is evident on the topographic map (Figure 1) and is bounded by 30' to 40' high river terraces approximately corresponding to County Roads 9 and 11.

A series of groundwater monitoring wells was installed in 2006 and are associated with installation of the original treatment system and RIBS. Well locations are depicted on Figure 2A – 2I. Specific lithology in the immediate area of the RIBs is described in the log for monitoring well 050-B, attached. The log describes unconsolidated alternating layers of sand and gravel, silty sand, and clayey sand ranging to a depth of 60 feet below land surface. The material is

predominately medium to coarse grain sand and gravel with layers of silty sand and clayey sand; typical of valley-fill alluvial deposits. There are no apparent layers which significantly restrict groundwater flow.

The alluvial material described in the well log overlies Pierre Shale bedrock; encountered at a depth of 60 feet in monitoring well 050-B. This same bedrock was encountered deeper in wells 050-A (94 feet) and 050-C (85 feet). This is consistent with the generalized sections presented in other reports including: *Groundwater Resources of the Alluvial Aquifers in Northeastern Larimer County, Colorado*, US Geological Survey, Water-Resources Investigations Report 77-7.

In the area of the RIBs, Boxelder Creek is located on the extreme eastern edge of the valley floor. It has little to no impact on groundwater flow beneath the RIBs. Water levels and gauging of the creek were not considered in this assessment. Likewise, water levels in monitoring well 050-E were not included in this assessment.

As recorded during regular monitoring events, from March 2021 to April 2022, water levels in monitoring well 050-B range from approximately 47 to 50 feet below land surface. This equates to approximate elevations of 5286.5' to 5290' amsl. Specific elevations are presented in Table 1 and on Figures 2A -2I.

IRRIGATION WELLS

There are two irrigation wells owned by Seaworth Farms located approximately 1400 feet east of the RIBs. They are presented as "W-1" and "W-2" on Figure 2A-2I. According to records of the Colorado State Engineer, the wells are 91 feet and 85 feet deep with first beneficial use in 1937 and 1954. According to the owner, they irrigate 475 acres using 1 to 1.5 acre feet per acre from April through October. We do not have specific records of pumping rates or schedules.

Impact of pumping from the irrigation wells upon groundwater flow direction during monitoring events appears to be negligible.

GROUNDWATER FLOW DIRECTION

Water level data from March 2021 to April 2022 was provided by Wellington Operating Company. Using this data, groundwater table potentiometric surface maps were produced and are included herein as Figure 2A - 2I. The assessment focused on wells nearest the RIBs. Monitoring well 050-E appears to be influenced by Boxelder Creek and was not included in the evaluation of groundwater flow direction at the RIBs.

The maps show a general flow direction ranging from east-southeast to southeast. This flow direction is in regular agreement with surface topography and contour data in the other more general hydrogeological reports focused on the area.

GROUNDWATER FLOW RATE

As part of the assessment of the groundwater regime, we also estimated flow rates near the RIBs. We used published permeability coefficients for poorly sorted sandy gravel and alluvial sands and gravel (approximately $4.00E-03$ m/s) and the gradient from wells 050-A to 050-B and 050-B to 050-C (as measured in March and April 2022) to produce a range of groundwater flow velocities.

Using these parameters, the estimated time of travel from the RIBs to Well 050-B was calculated to be as little as 49.9 to 128.7 days. While greater estimated time of travel may be calculated using variable permeability coefficients and gradients, we were focused on a minimum time considering advective flow and favorable lithology. It should be noted that the values cited herein agree with empirical data recorded by Wellington Operating Company in their regular monitoring results.

This report is intended for client use in submittals to COGCC.

If you have any questions or comments relative to this report, please call (970) 231-5696.

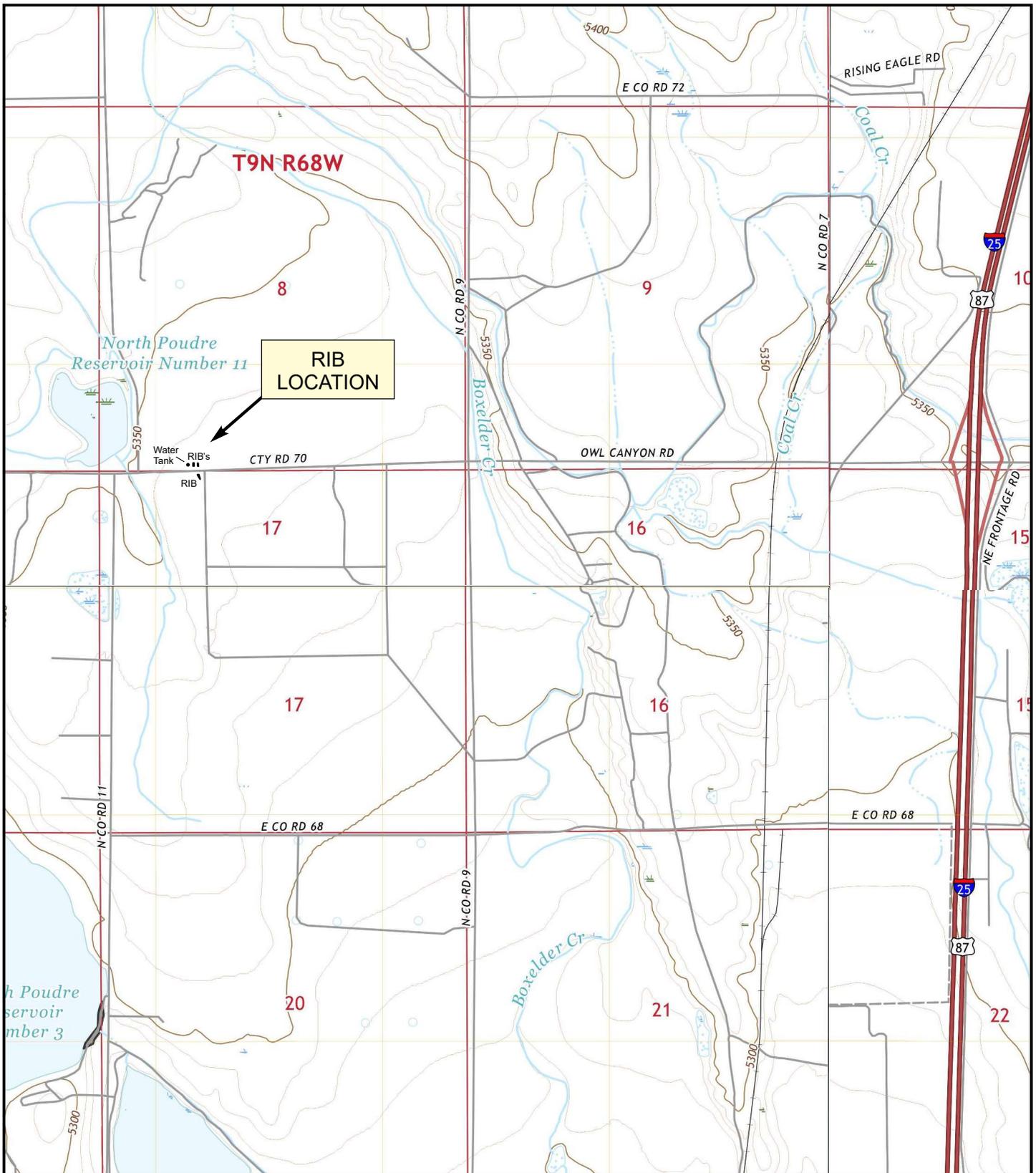
Sincerely,

STONEGATE LAND & WATER, LLC

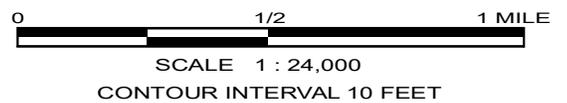
A handwritten signature in black ink, appearing to read "Paul A. Stone". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Paul A. Stone, PG
Senior Geologist

Enc



MAP SOURCE: USGS
 BUCKEYE, CO 2016, CARR, CO 2016
 COB LAKE, CO 2016, AND WELLINGTON, CO 2016



 STONEGATE Land & Water, LLC		PROPERTY LOCATION Wellington Operating Company Wellington Muddy Sandstone Unit Wellington, Colorado	FIGURE 1 SITE LOCATION



LEGEND

050-A ▲ Monitoring Well with groundwater elevation reading
5296.14'

W-1 ▲ Irrigation Well

— Groundwater Contour
5296'

Groundwater Contours Based Upon
03/25/2021 Measurements

MAP SOURCE:
GOOGLE EARTH 7/17/19

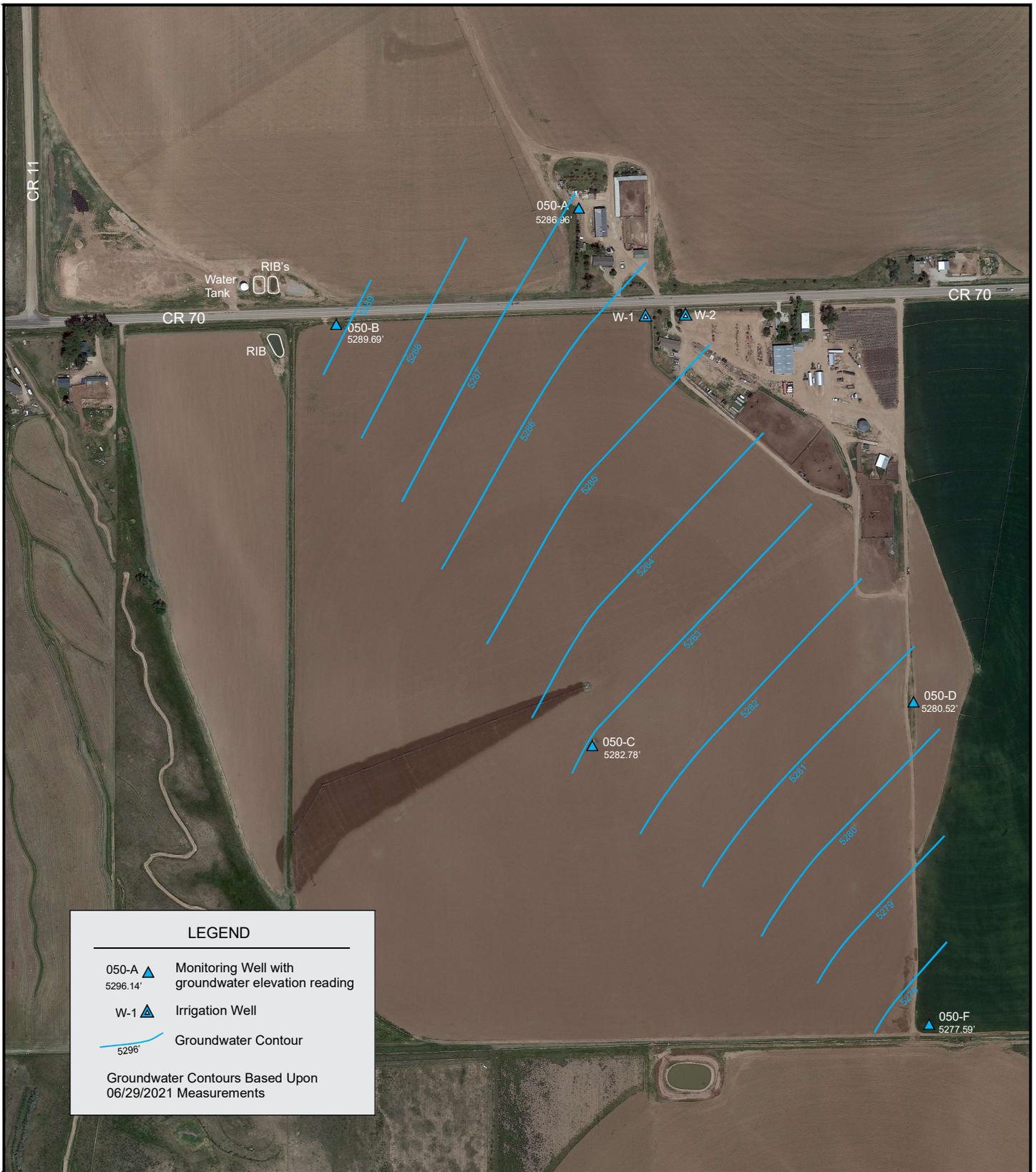



STONEGATE
Land & Water, LLC

PROJECT NUMBER 1022.003	DATE April 2022
-----------------------------------	---------------------------

PROPERTY LOCATION
**Wellington Operating Company
Wellington Muddy Sandstone Unit
Wellington, Colorado**

**FIGURE 2A
GROUNDWATER TABLE
CONTOURS 3/25/2021**



LEGEND

050-A ▲ Monitoring Well with groundwater elevation reading
5296.14'

W-1 ▲ Irrigation Well

Groundwater Contour
5296'

Groundwater Contours Based Upon
06/29/2021 Measurements

MAP SOURCE:
GOOGLE EARTH 6/11/21

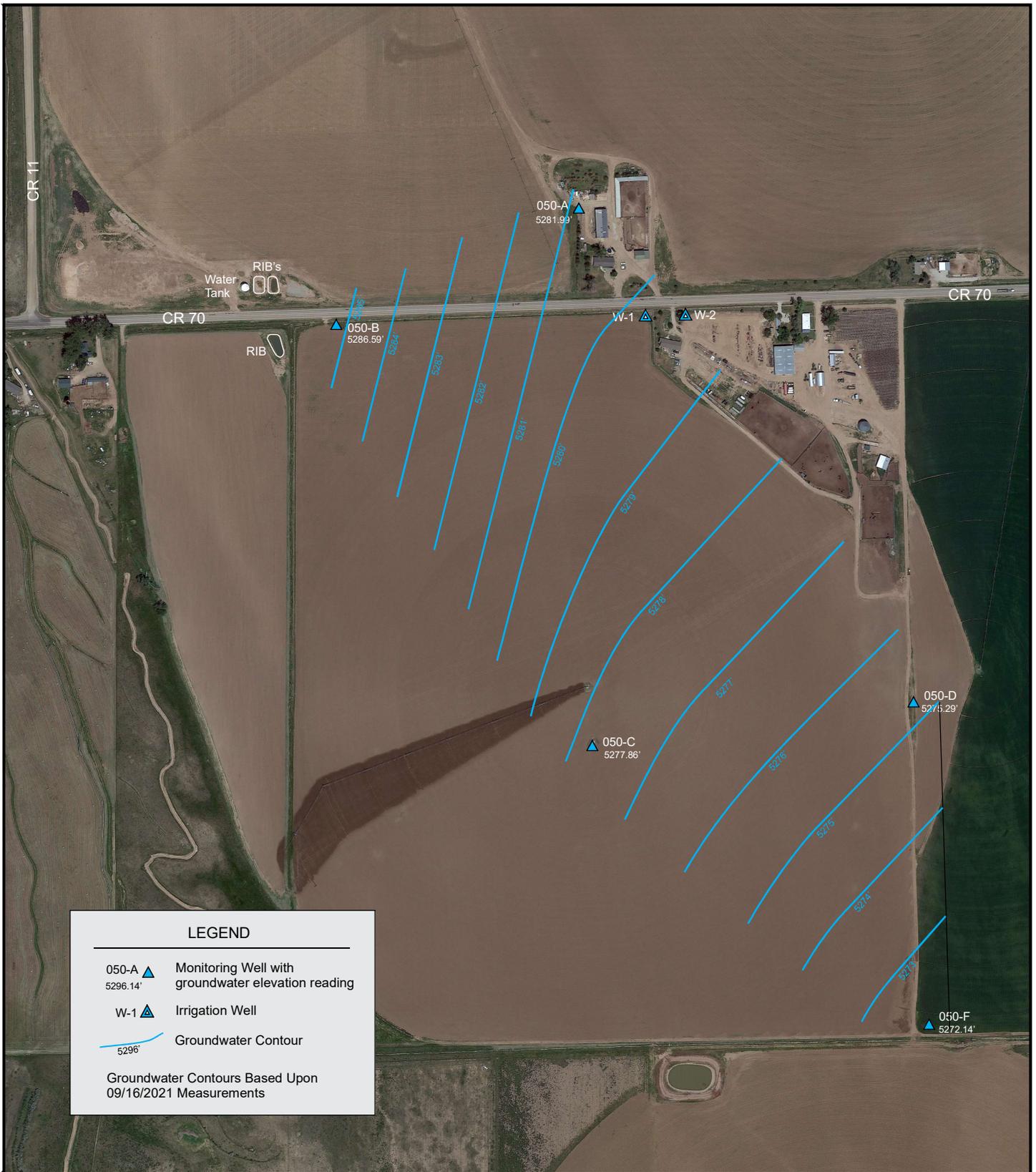


STONEGATE Land & Water, LLC	
PROJECT NUMBER	DATE
1022.003	April 2022

PROPERTY LOCATION

Wellington Operating Company
Wellington Muddy Sandstone Unit
Wellington, Colorado

FIGURE 2B
GROUNDWATER TABLE
CONTOURS 6/29/2021



LEGEND

050-A ▲ Monitoring Well with groundwater elevation reading
5296.14'

W-1 ▲ Irrigation Well

— Groundwater Contour
5298'

Groundwater Contours Based Upon
09/16/2021 Measurements

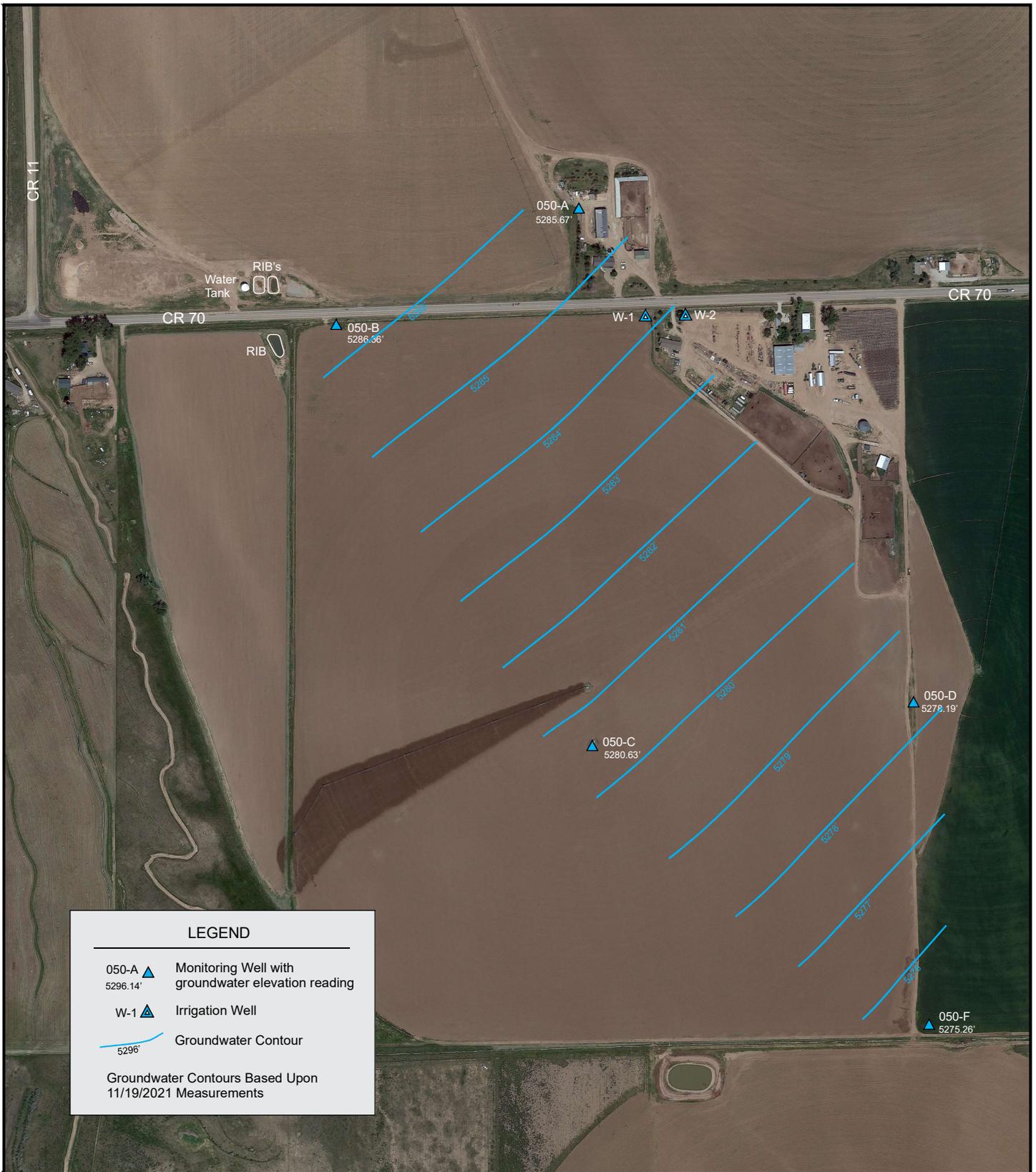
MAP SOURCE:
GOOGLE EARTH 6/11/21



 STONEGATE Land & Water, LLC	
PROJECT NUMBER 1022.003	DATE April 2022

PROPERTY LOCATION
Wellington Operating Company
Wellington Muddy Sandstone Unit
Wellington, Colorado

FIGURE 2C
GROUNDWATER TABLE
CONTOURS 9/16/2021



LEGEND

050-A ▲ Monitoring Well with groundwater elevation reading
5296.14'

W-1 ▲ Irrigation Well

— Groundwater Contour
5298'

Groundwater Contours Based Upon 11/19/2021 Measurements

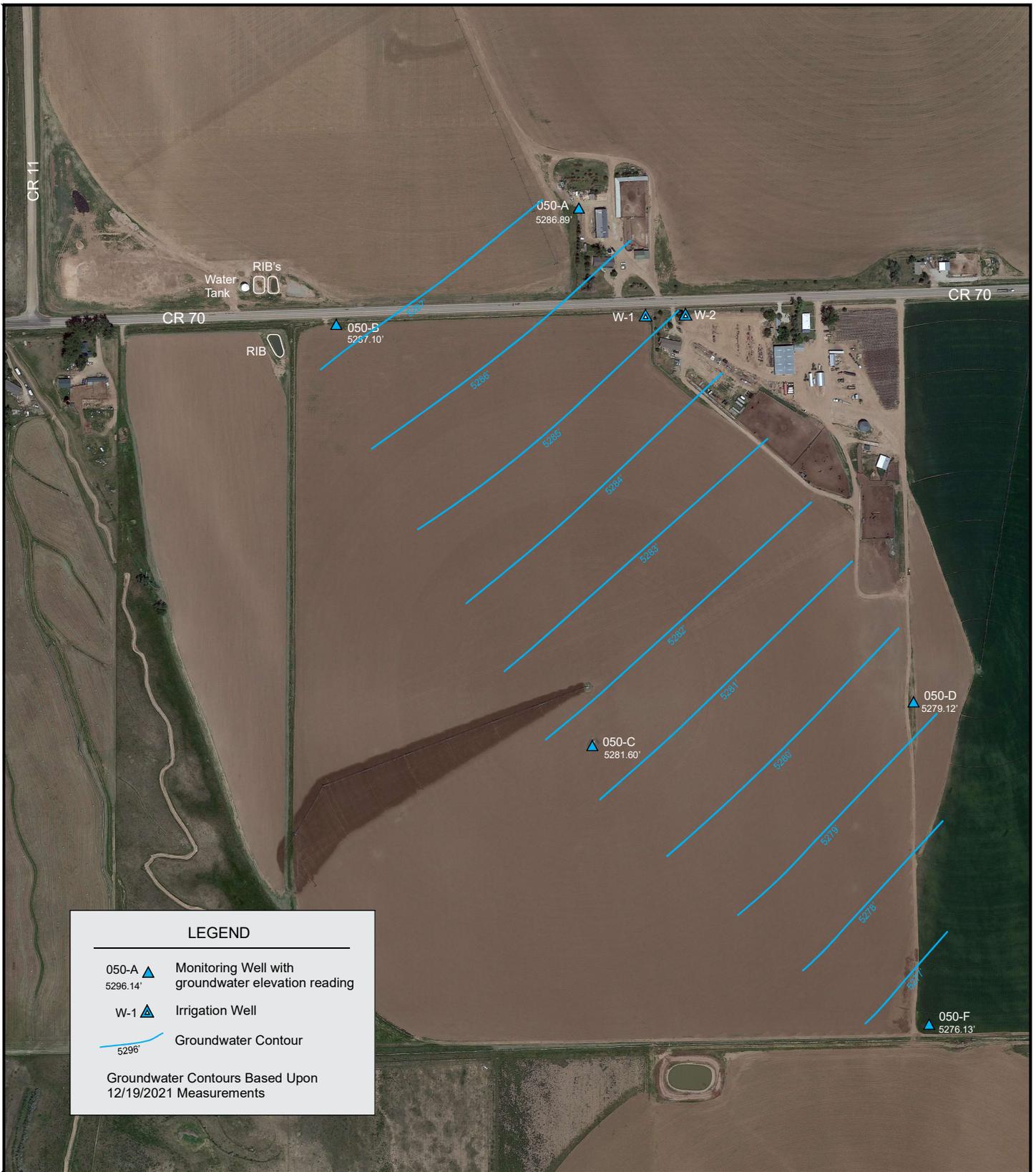
MAP SOURCE:
GOOGLE EARTH 6/11/21



 STONEGATE Land & Water, LLC	
PROJECT NUMBER 1022.003	DATE April 2022

PROPERTY LOCATION
Wellington Operating Company
Wellington Muddy Sandstone Unit
Wellington, Colorado

FIGURE 2D
GROUNDWATER TABLE
CONTOURS 11/19/2021



LEGEND

050-A ▲ Monitoring Well with groundwater elevation reading
5296.14'

W-1 ▲ Irrigation Well

— Groundwater Contour
5296'

Groundwater Contours Based Upon 12/19/2021 Measurements

MAP SOURCE:
GOOGLE EARTH 6/11/21

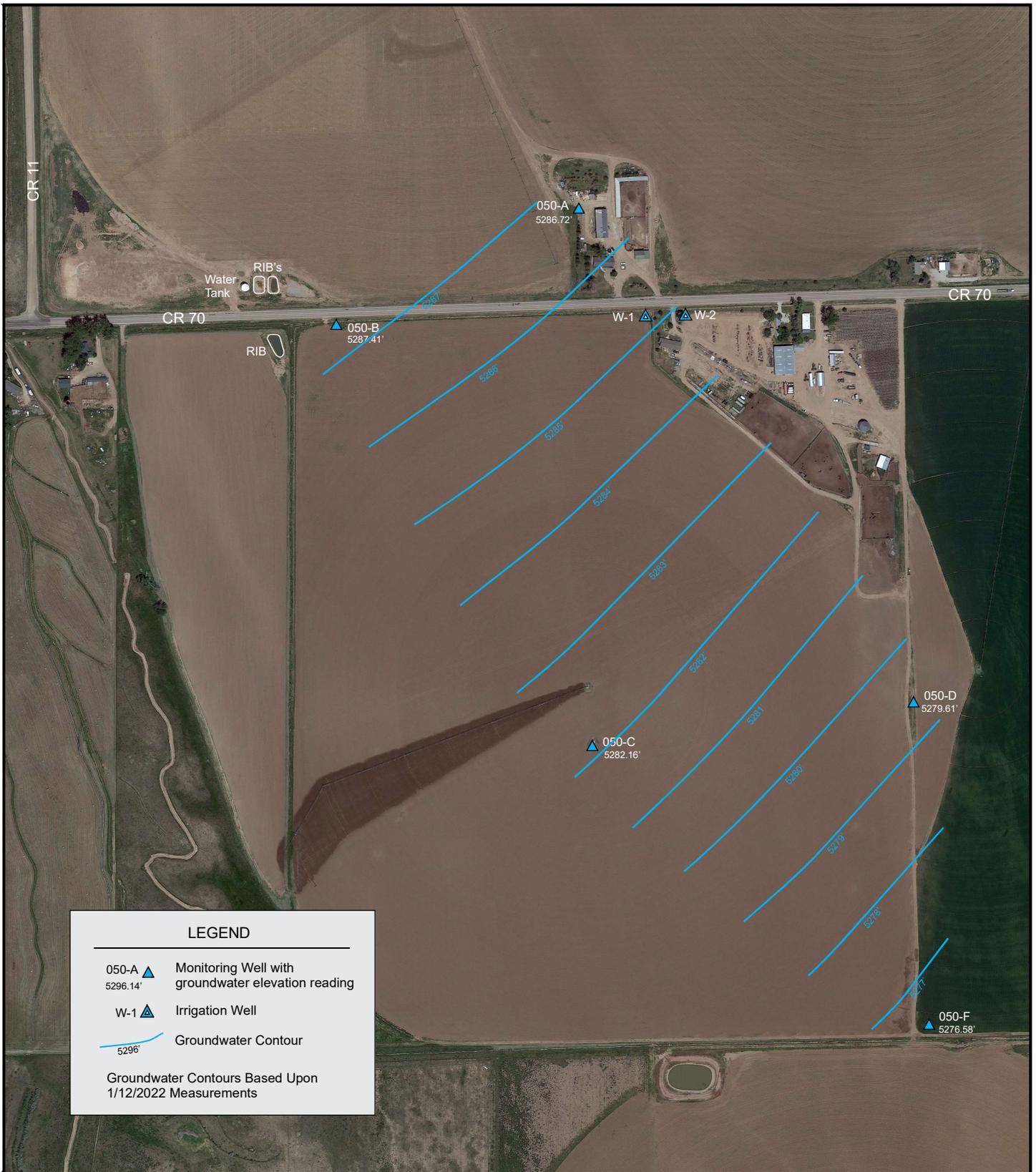



STONEGATE
Land & Water, LLC

PROJECT NUMBER 1022.003	DATE April 2022
----------------------------	--------------------

PROPERTY LOCATION
Wellington Operating Company
Wellington Muddy Sandstone Unit
Wellington, Colorado

FIGURE 2E
GROUNDWATER TABLE
CONTOURS 12/19/2021



LEGEND

050-A ▲ Monitoring Well with groundwater elevation reading
5296.14'

W-1 ▲ Irrigation Well

— Groundwater Contour
5296'

Groundwater Contours Based Upon
1/12/2022 Measurements

MAP SOURCE:
GOOGLE EARTH 6/11/21



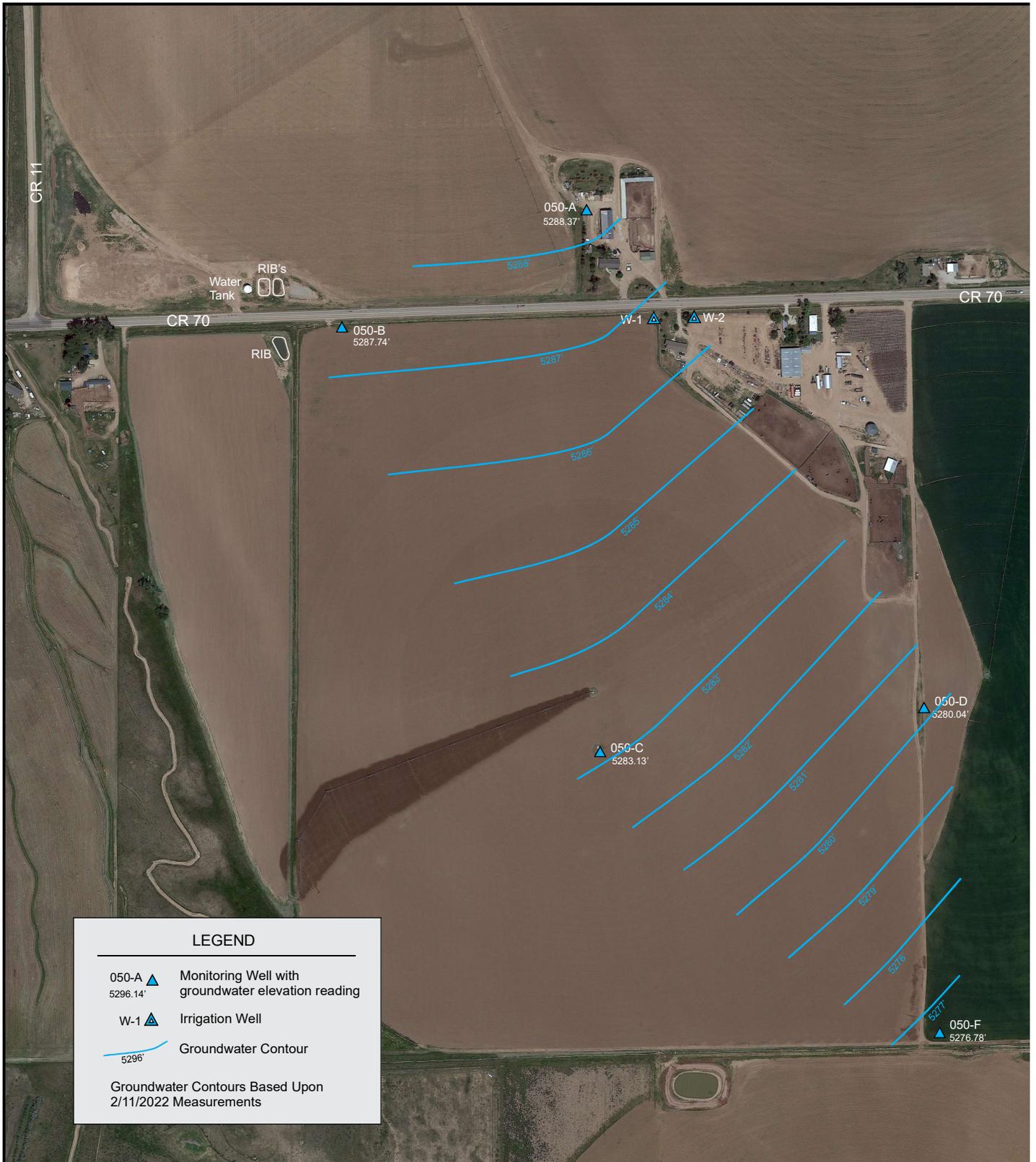
STONEGATE
Land & Water, LLC

PROJECT NUMBER	DATE
1022.003	April 2022

PROPERTY LOCATION

Wellington Operating Company
Wellington Muddy Sandstone Unit
Wellington, Colorado

FIGURE 2F
GROUNDWATER TABLE
CONTOURS 1/12/2022



LEGEND

050-A ▲ Monitoring Well with groundwater elevation reading
5296.14'

W-1 ▲ Irrigation Well

5296' Groundwater Contour

Groundwater Contours Based Upon 2/11/2022 Measurements

MAP SOURCE:
GOOGLE EARTH 6/11/21



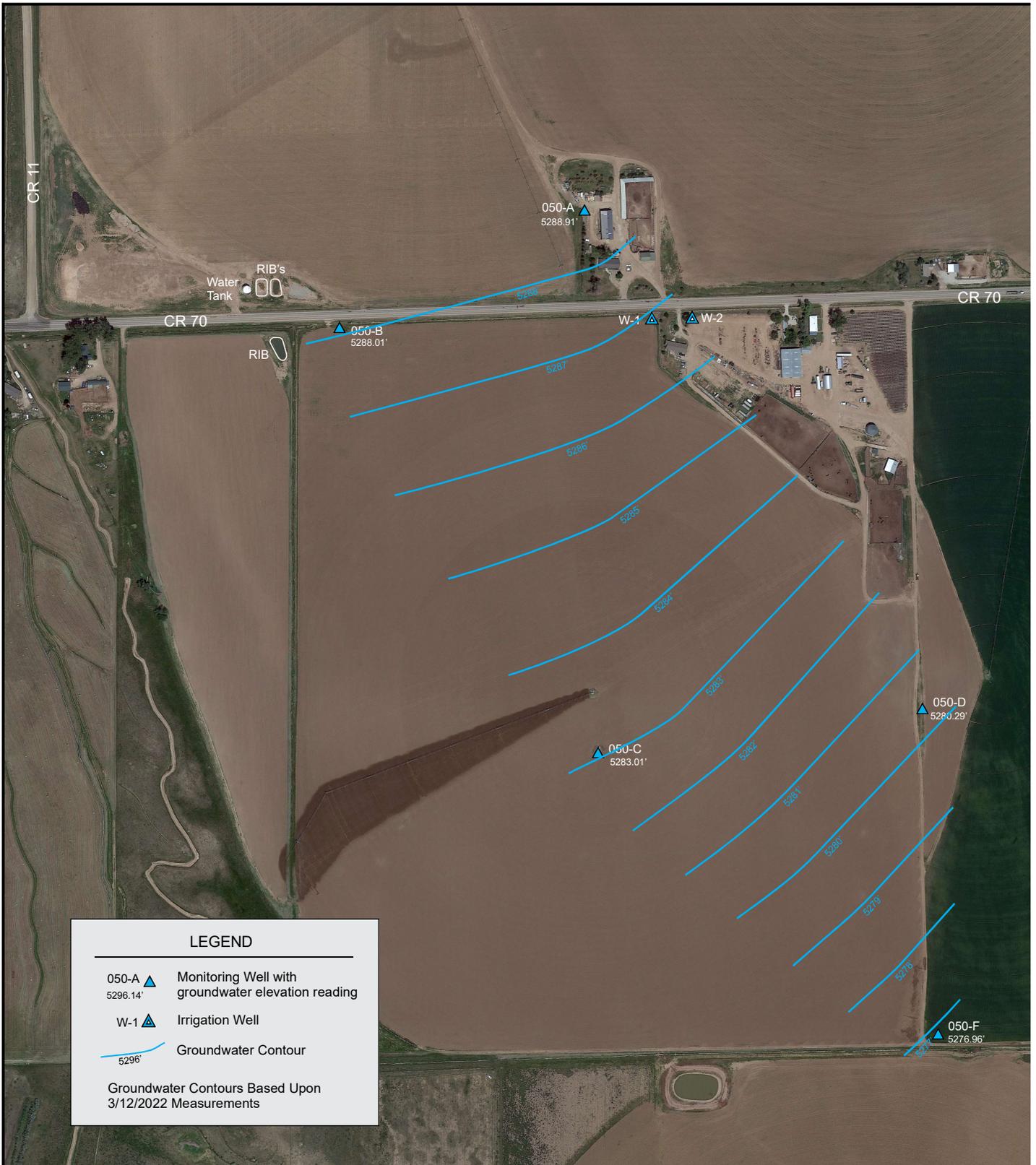

STONEGATE
Land & Water, LLC

PROJECT NUMBER 1022.003	DATE April 2022
-----------------------------------	---------------------------

PROPERTY LOCATION

**Wellington Operating Company
Wellington Muddy Sandstone Unit
Wellington, Colorado**

**FIGURE 2G
GROUNDWATER TABLE
CONTOURS 2/11/2022**



LEGEND

050-A ▲ Monitoring Well with groundwater elevation reading
5296.14'

W-1 ▲ Irrigation Well

— Groundwater Contour
5298'

Groundwater Contours Based Upon
3/12/2022 Measurements

MAP SOURCE:
GOOGLE EARTH 6/11/21




STONEGATE
Land & Water, LLC

<small>PROJECT NUMBER</small> 1022.003	<small>DATE</small> April 2022
---	-----------------------------------

PROPERTY LOCATION

Wellington Operating Company
Wellington Muddy Sandstone Unit
Wellington, Colorado

FIGURE 2H
GROUNDWATER TABLE
CONTOURS 3/12/2022



LEGEND

050-A ▲ Monitoring Well with groundwater elevation reading
5296.14'

W-1 ▲ Irrigation Well

— Groundwater Contour
5296'

Groundwater Contours Based Upon
4/24/2022 Measurements

MAP SOURCE:
GOOGLE EARTH 6/11/21



STONEGATE
Land & Water, LLC

PROJECT NUMBER 1022.003	DATE April 2022
----------------------------	--------------------

PROPERTY LOCATION
Wellington Operating Company
Wellington Muddy Sandstone Unit
Wellington, Colorado

FIGURE 2 I
GROUNDWATER TABLE
CONTOURS 4/24/2022

Table

TABLE 1
Wellington Operating Company
Groundwater Elevation Data

Monitoring Wells ID	050-A		050-B		050-C		050-D		050-E		050-F	
TOC Elevation (ft amsl)	5335.4226		5336.6102		5322.6319		5319.1419		5311.7207		5316.6081	
Date of Measurement	Static Water Level (from toc)	Static Water Level (amsl)	Static Water Level (from toc)	Static Water Level (amsl)	Static Water Level (from toc)	Static Water Level (amsl)	Static Water Level (from toc)	Static Water Level (amsl)	Static Water Level (from toc)	Static Water Level (amsl)	Static Water Level (from toc)	Static Water Level (amsl)
3/25/2021	47.58	5287.84	50.05	5286.56	40.26	5282.37	39.29	5279.85	13.78	5297.94	39.90	5276.70
6/29/2021	48.46	5286.96	46.92	5289.69	39.85	5282.78	38.62	5280.52	13.68	5298.04	39.02	5277.59
9/16/2021	53.43	5281.99	50.02	5286.59	44.77	5277.86	43.85	5275.29	14.56	5297.16	44.47	5272.14
11/19/2021	49.75	5285.67	50.25	5286.36	42.00	5280.63	40.95	5278.19	15.00	5296.72	41.35	5275.26
12/19/2021	48.53	5286.89	49.51	5287.10	41.03	5281.60	40.02	5279.12	15.16	5296.56	40.48	5276.13
1/12/2022	48.70	5286.72	49.20	5287.41	40.47	5282.16	39.53	5279.61	15.32	5296.40	40.03	5276.58
2/11/2022	47.05	5288.37	48.87	5287.74	39.50	5283.13	39.10	5280.04	15.38	5296.34	39.83	5276.78
3/12/2022	46.51	5288.91	48.60	5288.01	39.62	5283.01	38.85	5280.29	15.40	5296.32	39.65	5276.96
4/24/2022	46.85	5288.57	48.75	5287.86	39.82	5282.81	39.02	5280.12	15.68	5296.04	39.80	5276.81

Well Log

SOIL BORING LOG

BORING NUMBER
050-B

PROJECT NUMBER 3470-001 (15)	SOIL LOGGED BY Paul Stone	SCREEN TYPE AND SLOT SIZE PVC 0.010"	HOLLOW STEM AUGER INSIDE DIAMETER 4.25"
CLIENT Wellington Water Works	DATE STARTED 01/19/06	SAND SIZE 10/20	BOREHOLE DIAMETER 8 inches
DRILLING COMPANY Spectrum Exploration, Inc.	DATE COMPLETED 01/19/06	RISER TYPE AND SIZE PVC 2-inch	SAMPLING METHOD Cuttings
DRILLING RIG TYPE CME 75	TOTAL DRILLED DEPTH ~ 60.5 ft. bgs	INITIAL GROUNDWATER DEPTH 53.5 ft. bgs	GROUND ELEVATION (top of casing) ~ 5331 ft amsl
DRILLER(S) Todd and Terry	CONVERTED TO MONITORING WELL (Y/N) Yes	RELATIVE LOCATION OF BORING See Sketch Below	

DEPTH (FT)	SAMPLES LAB ANALYZED	RECOVERY (INCHES)	HEADSPACE PID TESTING (PPM)				WELL GRAPHIC	SOIL GRAPHIC LOG
			VALUE	0	10	100		
0								
5								
10								
15								
20								
25								
30								
35								
40								
45								
50								
55								
60								

GEOLOGIC DESCRIPTION

Top Soil, tilled earth Depths referenced to surface grade

Red-Brown Sand and Gravel, coarse sand and gravel to 1.5", poorly sorted, dry

Red-Brown Sand and Gravel, coarse sand and gravel to 1.5", poorly sorted, dry
auger chatters on gravel

Red-Brown Sand and Gravel, coarse sand and pea gravel, poorly sorted, dry

Same as above
Fining downward

Red-Brown silty SAND, minor gravel,
loose, very slightly moist

Red-Brown clayey SAND, minor gravel,
slightly moist

Same as above, small signs of water
at 35' - possible water?

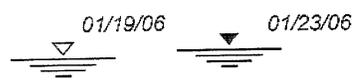
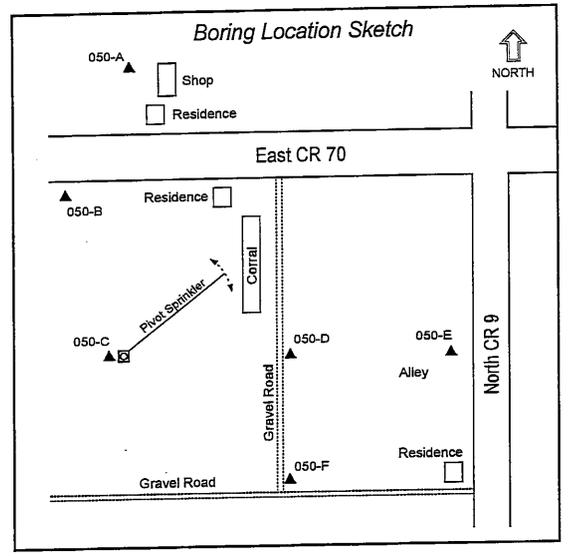
Red-Brown Sand and Gravel, moist

Same as above, moist

Red-Brown Sand and Gravel, moist

Red-Brown Sand and Gravel?, no return of cuttings

Same as above, soft drilling, wet
Same as above, tag top of bedrock at 60'
T.D. at 60.5' -gray weathered sandy SHALE, Pierre Shale



PROJECT Wellington Water Works	COUNTY Larimer	BORING NUMBER 050-B
ADDRESS 3218 East CR 70	CITY/STATE Wellington, Colorado	PAGE OF 1 1