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May 17, 2018

Mr. Ryan W. Farr 18-04
Monson, Cummins & Shohet, LLC
13511 Northgate Estates Drive, Suite 250
Colorado Springs, CO 80921

Re: Janice Woodard – Preliminary Analysis for Water Rights Application, Plan for Augmentation

Dear Mr. Farr:

This letter report describes Ms. Janice Woodard's proposed plan for augmentation for the wells to serve her planned subdivision in El Paso County, Colorado. Ms. Woodard has submitted a water rights application to the Division 1 and Division 2 Water Courts for the adjudication of her Denver Basin groundwater rights and a Plan for Augmentation. She is seeking to quantify the Denver Basin groundwater underlying her property, as well as seeking approval of a plan for augmentation for the use of her not-nontributary water rights.

Project Description

Ms. Woodard owns a 13.84 acre lot in the Black Forest Subdivision located in the N ½, Section 6, T12S, R65W, 6th P.M. El Paso County, Colorado (see Figure 1). The subject property is located outside of the corporate boundaries of the City of Colorado Springs, and is outside the area served with water supply or sewerage service by Colorado Springs Utilities. The property is also located outside the boundaries of the Upper Black Squirrel Creek Designated Groundwater Basin but is located within the boundaries of the Denver Basin Aquifers. The property currently has a single home that is served by a Dawson Aquifer well (permit no. 83350-A). The current well permit allows for up to one acre-foot of pumping annually for domestic uses. This well is a

replacement well that was constructed on April 11, 1976, to a depth of 325 feet into the Dawson Aquifer (see attached permit file with well construction report).

Ms. Woodard is planning to subdivide her single Black Forest lot into two lots, with Lot 1 comprising approximately 5.03 acre lot and Lot 2 comprising approximately 8.81 acres (see attached Figure 2 - plat map). The proposed water supply for both lots will be the Dawson Aquifer. The existing Dawson well will serve Lot 2 and Lot 1 will be served by a Dawson well, to be constructed after approval of the augmentation plan. As part of the El Paso County subdivision process, Ms. Woodard is required to develop a 300 year water supply plan for the proposed subdivision. The purpose of the proposed plan for augmentation is to satisfy the State's augmentation requirements for a water supply, as well as satisfy the County's water supply plan requirement.

The Colorado Decision Support System's ("CDSS") Map Viewer was used to evaluate potential aquifer appropriation overlap issues with existing pre-213 cylinders of appropriation. If an existing pre-213 cylinder had already appropriated a portion of the water underlying Ms. Woodard's property, then the claimed appropriation amount would have to be reduced accordingly. Our evaluation determined that no pre-213 water has been appropriated in the aquifers on the subject property, therefore, no restrictions to the potential yield are necessary.

Water Demand

The proposed water demands for the Woodard subdivision include the following domestic uses: household use, large and/or small livestock animals (i.e. horses, pigs and chickens) and irrigation. The household use demand requirement is estimated to be approximately 0.26 acre-feet/yr. per lot and the irrigation demand estimate is estimated to be approximately 0.0566 acre-feet/yr. per 1,000 square feet of irrigation (up to 5,000 square feet per lot). These demand estimates are based on water demand estimates from the El Paso County Land Development Code[1]. The augmentation plan will also allow water for up to four horses on each lot. The domestic animal water demand estimate is based on water demand estimates presented in the SEO's Well Permit Guidelines[2]. The plan also allows for other animals such as small livestock like chickens and pigs (usage estimates provided in Table 1). The combined water usage from all animals residing on each lot will not exceed 0.05 acre-feet annually. Using these demand estimates, each lot will require approximately 0.59 acre-feet per year for an approximate total of 1.20 acre-feet per year for the subdivision, as summarized in Table l.

[1] El Paso County Land Development Code
[2] State of Colorado Department of Natural Resources Division of Water Resources, Guide to Colorado Well Permits Water Rights, and Water Administration, January 2008

Table 1 Proposed Annual Water Demands (Acre-Feet)

	Household Use[1] Acre-Feet	Domestic Animals/Small Livestock[2] Acre-Feet	Irrigation[3] Acre-Feet	Total Annual Volume Acre-Feet
8.81 Acre Lot	0.26	0.05	0.28	**0.59**
5.03 Acre Lot	0.26	0.05	0.28	**0.59**
Total Acre-Feet	**0.52**	**0.10**	**0.57**	**1.19**

[1]Household Use Based on El Paso County Standard HHU Estimate of 0.26 af/yr Per Household.

[2]Domestic Animals Demand Based on State Engineer Office's Estimate on 4 Large Animals (i.e. 4 horses at 11.2 gal/day).

Small Livestock estimated at .125 gal/day for chickens and 1 gal/day for pigs. Combination of animals not to exceed 0.05 af/yr

[3]Irrigation Demand Based on El Paso County Estimate of 0.0566 af Per 1,000 sq. ft. of Irrigation. Demand Calculated for 5,000 sq. ft.

Denver Basin Water Supply

In order to evaluate the potential water supply for the planned subdivision, the State Engineer Office's ("SEO") aquifer determination tool (aka Senate Bill 5 Tool) was used to analyze the potential yield underlying the Woodard's 13.84 acre property. The SEO's determination tool estimates the potential yield by aquifer for a particular parcel using the parcel location and acreage, the specific yield of the aquifer, and the estimated net sand of each aquifer at the specified location. All values from this tool are calculated by interpolation of data used to generate the atlases that are included in the Denver Basin Rules. Table 2 summarizes the estimated aquifer depths, potential annual yield based of both the 100 and 300 year supply estimates from each aquifer. The tributary status of each aquifer is also included in Table 2, which indicates if the aquifer is not-nontributary ("NNT") or nontributary ("NT"). As displayed in Table 2, on an annual basis there is approximately 11.39 acre-feet available in the Dawson Aquifer based on the SEO's 100 year supply requirement and 3.80 acre-feet available under the County's 300 year supply requirement. The 3.80 acre-feet available from the Dawson Aquifer is more than adequate to cover the projected 1.20 acre-feet of annual usage from both wells.

Table 2 Denver Basin Groundwater Summary (based on 13.84 acres)

Aquifer	*Bottom Elevation (ft)*	*Top Elevation (ft)*	*Top of Aquifer (ft)*	*Bottom of Aquifer (ft)*	Net Sand (ft)	Specific Yield	Total Available Appropriation (Acre-Feet)	100 Year Annual Appropriation (Acre-Feet)	300 Year Annual Appropriation (Acre-Feet)	Tributary Status
Dawson	6583	7406	109	932	411.6	0.20	1139	11.39	3.80	NNT
Denver	5668	6589	926	1847	497.3	0.17	1170	11.70	3.90	NNT
Arapahoe	5115	5612	1903	2400	235.1	0.17	553	5.53	1.84	NT
Laramie-Fox Hills	4515	4846	2669	3000	187.1	0.15	388	3.88	1.29	NT
Total from all aquifers							**3251**	**32.51**	**10.84**	

The values presented in Table 2 are estimates based on best available information, and are subject to change based on a final determination that will be completed by the SEO staff. Once a

well is drilled and completed, the estimated annual appropriation amount may be revised based on actual aquifer conditions (i.e. the net sands may be adjusted).

AUG3 Model - Stream Depletion Analysis

Model Background

Stream depletions from Denver Basin aquifers were calculated using the United States Geological Survey ("USGS") MODFLOW model created by Colorado Division of Water Resources ("CDWR"). When the model was originally released in 1985, the goal of the model was to map out non-tributary groundwater areas. The current version of the model is sub-divided spatially into 18 overlapping windows for computational convenience with most aquifers having multiple windows. The streams overlying the Denver Basin are also included in the model which allows for stream depletions to be simulated in the model. The requirement for a non-tributary aquifer is that the ratio of stream depletion ("q") to well pumping rate ("Q") is less than 0.1% after 100 years of well pumping. The model utilizes a cell size of one square mile corresponding to a section of land.

The latest version of the model has been automated by the creation of an EXCEL interface and various pre-processing and post-processing programs. Collectively these programs are known as AUG3. The programs have changed over the years with the current version being released in August 2017 (this is the version used by HRS). The spreadsheet runs off of the model input parameters which consist of the well location, pumping rate, aquifer, model window, and length of pumping. The output consists of depletion curves over time and summary tables of stream depletion at 100 years and maximum depletion times. These items are all contained in an EXCEL spreadsheet file.

AUG3 Model Run

Because the proposed subdivision is located within El Paso County, a 300 year water supply plan is required, therefore, the AUG3 model was setup to simulate 300 years of pumping followed by 900 years of no well pumping (the model is limited to a maximum of 1,200 years total). A pumping rate of 1.20 acre-feet was input as the annual pumping volume resulting in 360 acre-feet total pumping volume over 300 years. A post pumping period of 900 years was simulated after the initial 300 year pumping period. Table 2 shows the model inputs, as well as a summary of the streams impacted and the depletions at year 100 and the maximum depletions in the first 300 years.

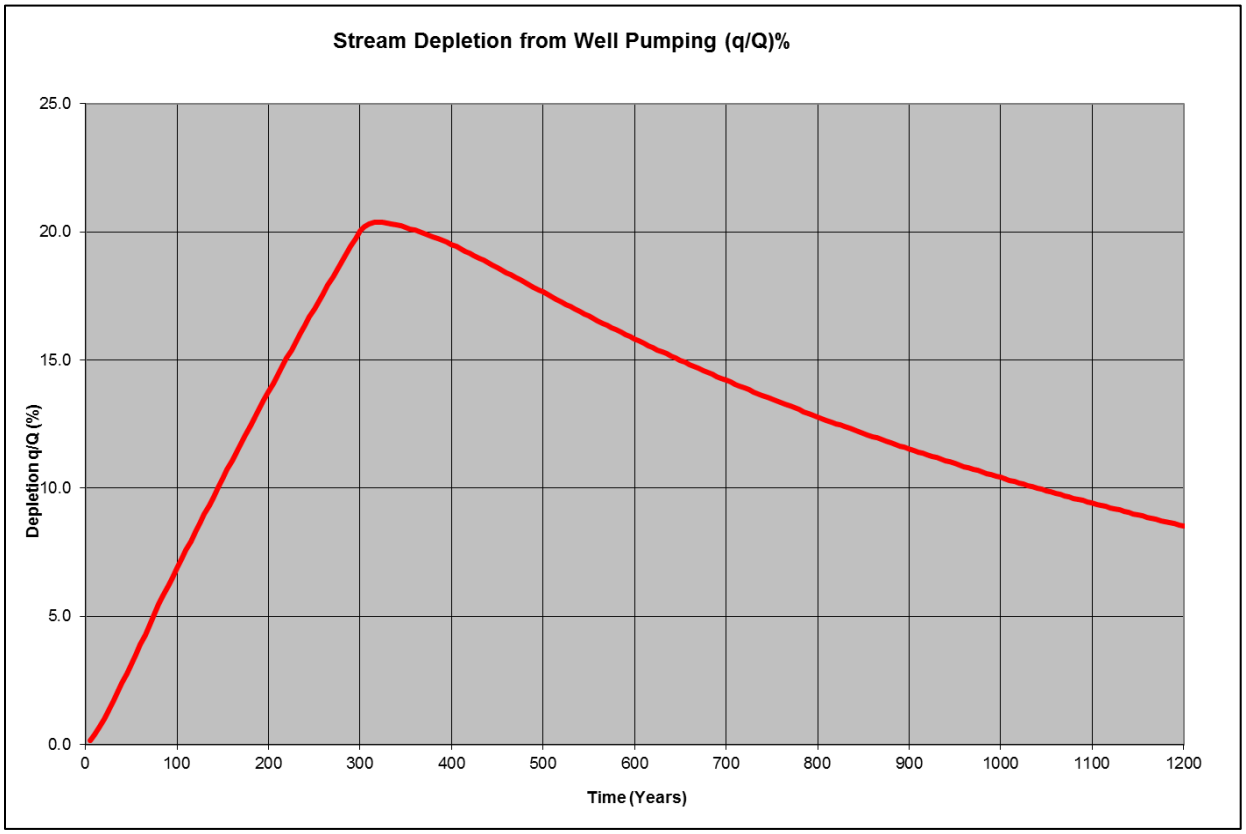
Table 3 AUG3 Input and Results Summary

Summary Table 1			Summary Table 2				
			Model Period (years)	900			
Applicant Name	Woodard		Applicant Name	Woodard			
Case No. or Receipt No.	18-04		Case No. or Receipt No.	18-04			
Number of Years of Pumping	300		Number of Years of Pumping	300			
Pumping Rate (ac-ft/yr)	1.20		Pumping Rate (ac-ft/yr)	1.20			
Total Volume (ac-ft)	360		Total Volume (ac-ft)	360			
Legal for All Sections	SEC 6 T12S R65W		Legal for All Sections	SEC 6 T12S R65W			
Model	DA02		Model	DA02			
Aquifer	DAWSON		Aquifer	DAWSON			
100th Year Stream Depletion			**Maximum Stream Depletion**				
Streams	**100th Year Depletion (ac-ft/yr)**	**q/Q (%)**	**Streams**	**Max.Depletion during model period (ac-ft/yr)**	**Year during model period**	**Max. Depletion during pumping period (ac-ft/yr)**	**Year during pumping period**
MONUMENT	0.02	1.69	MONUMENT	0.05	305	0.05	300
EAST PLUM-W BRANCH	0.00	0.00	EAST PLUM-W BRANCH	0.01	890	0.00	300
EAST PLUM-E BRANCH	0.00	0.00	EAST PLUM-E BRANCH	0.00	745	0.00	300
WEST CHERRY	0.01	0.67	WEST CHERRY	0.04	380	0.03	300
EAST CHERRY	0.02	1.66	EAST CHERRY	0.05	310	0.05	300
CHERRY	0.00	0.02	CHERRY	0.01	735	0.00	300
KIOWA	0.00	0.07	KIOWA	0.02	715	0.01	300
KETTLE	0.02	1.65	KETTLE	0.04	300	0.04	300
SAND-DIV2	0.01	1.06	SAND-DIV2	0.05	345	0.05	300
BIG SANDY	0.00	0.00	BIG SANDY	0.00	1200	0.00	300
BLACK SQUIRREL-UBSCDB	0.00	0.05	BLACK SQUIRREL-UBSCDB	0.01	430	0.01	300
Total	**0.08**	**6.87**	**Total**	**0.24**	**320**	**0.24**	**300**
South Platte (Division 1)	0.03	2.36	South Platte (Division 1)	0.11	495	0.10	300
Arkansas (Division 2)	0.05	4.40	Arkansas (Division 2)	0.14	305	0.14	300
Designated Basin	0.00	0.11	Designated Basin	0.03	650	0.02	300

The model results show depletions impacting several streams in both the South Platte River and Arkansas River basins, as well as Designated Basins within each river basin. After 1,200 years, the split between the two basins is fairly even, with 55% of the depletions occurring to the South Platte River Basin and 45% occurring to the Arkansas River Basin. The total volume of stream depletions in year 300 is 37.2 acre feet. An additional 150.66 acre-feet of stream depletions occurred over the 900 years of post-pumping for a total of 187.89 acre-feet of total stream depletions in 1,200 year period simulated in the model.

The results from the AUG3 model run are summarized in Figure 3, which shows the stream depletion as q/Q where “q” is the stream depletion rate and “Q” is the pumping rate is shown as Figure 2. The graph shows that the greatest stream depletion rate occurs shortly after 300 years, in year 310. Due to limitations of the AUG3 model, it is not possible to run the model until there are no stream depletions.

Figure 3 Stream Depletion Curve q/Q(%) 1,200 Year Model Run



Consumptive Use of Ground Water

As a result of the projected domestic well pumping, a portion of the water pumped will be lost to consumptive use processes such evaporation and evapotranspiration. Table 4 summarizes the consumptive use attributed to the proposed domestic uses. All water pumped for household use is assumed to have a consumptive use of 10% of the total pumped, with 90% returning the aquifer via the existing and proposed septic systems. All water use for domestic animal purposes is considered to be 100% consumptive with no returns to the aquifer claimed. Water pumped for irrigation use is considered to be 85% consumptive with 15% returning to the aquifer via deep percolation. These are standard engineering assumptions for domestic type uses. Based on the projected well pumping displayed in Table 1, the consumptive use is projected to be approximately 0.63 acre-feet per year. This is approximately 53% of the total annual pumping, meaning 47% will return to the stream system via return flows.

Table 4 Consumptive Use (Acre-Feet)

	Estimated Consumptive Use				
	Household Use[1] Acre-Feet	Domestic Animals/Small Livestock[2] Acre-Feet	Irrigation[3] Acre-Feet	Total Annual Volume Acre-Feet	300 Year Depletion Estimate Acre-Feet
Lot 1 - 5.03 Acre Lot	0.03	0.05	0.24	**0.32**	**94.97**
Lot 2 - 8.81 Acre Lot	0.03	0.05	0.24	**0.32**	**94.97**
Total Acre-Feet	**0.05**	**0.10**	**0.48**	**0.63**	**189.93**

[1]Household Use Based on 90% Return Flow from Septic System and 10% Consumptive
[2]Domestic Animals/Small Livestock Use Assumed to 100% Consumptive
[3]Irrigation Use Assumed to 85% Consumptive

Replacement Water Supply

Per the Denver Basin Rules, full replacement of depletions is required for wells completed in the Dawson Aquifer, regardless of the distance to the nearest outcrop in connection with a stream. The proposed augmentation plan will replace stream depletions using in-house septic system return flows during the period the well is actively pumping and post pumping stream depletions will utilize a reservation of nontributary Laramie-Fox Hills ground water to cover stream depletions. Based on the AUG3 Model Run discussed above, the post-pumping stream depletion volume is 322.8 acre-feet. This post pumping stream depletion is calculated by subtracting the total 300-year stream depletion volume of 37.2 acre-feet from the total volume pumped (360 acre-feet -37.2 acre-feet = 322.8 acre-feet). As shown in Table 3, in the first 300 years of pumping, the maximum depletion is 0.24 acre-feet. During this same time period, the total annual return flows are projected to be 0.56 acre-feet (1.19 acre-feet – 0.63 acre-feet = 0.56 acre-feet) from the septic system return flows and irrigation return flows. Moreover, septic system return flows amount to 0.47 acre-feet annually (0.52 x 90% = 0.47). Therefore, the depletions can be adequately covered by the septic return flows, with no additional augmentation source required. As shown in Table 2, the NT Laramie-Fox Hills has a total of 388 acre-feet available for appropriation which sufficiently covers the post pumping depletion amount of 322.8 acre-feet.

Operation of Plan

Upon approval of the proposed plan for augmentation, the well owners will operate under the proposed plan for augmentation as follows:

- Annual pumping from both wells will not exceed 1.20 acre-feet and the pumping rates of each well will not exceed 15 gallons per minute.
- Each well under the proposed plan will have a totalizing flow meter installed, and the total pumping volume will be recorded each month. The well owners will submit accounting on a schedule and a format agreeable to the Division Engineer and any parties to the water court case.

- Well permit no. 83350-A will be repermitted pursuant to the conditions in the approved Plan for Augmentation.
- A valid well permit will be obtained from the SEO prior to constructing the Dawson well on Lot 1.
- While the wells in the plan are actively pumping, replacements of stream depletions will be accomplished using return flows from each lot's individual septic system. Post pumping depletions will be covered by the reservation of the underlying Laramie-Fox Hills nontributary water which has a total volume of approximately 388 acre-feet.
- The Dawson wells will be limited to the permitted pumping rate and annual volumetric limit, pursuant to conditions of the well permit for domestic uses.

It is our opinion that if the proposed plan for augmentation is operated according to the proposed plan of operation, there will be no injury to any water rights in the South Platte River or Arkansas River systems.

Please call us if you have any questions.

Very truly yours,

HRS WATER CONSULTANTS, INC.

Steven K. Barrett
Principal, Water Resources Specialist

cc: Janice Woodard
File

References

Aquifer Determination Tool, Colorado Decision Support Systems, April 2018, http://cdss.state.co.us/onlineTools/Pages/AquiferDeterminationTools.aspx

AUG3Spreadsheet Model, Colorado Division of Water Resources, August 2017 Version

El Paso County Land Development Code, Chapter 7 Rules Governing Divisions of Land, January 6, 2015

State of Colorado Department of Natural Resources Division of Water Resources, Guide to Colorado Well Permits Water Rights, and Water Administration, January 2008

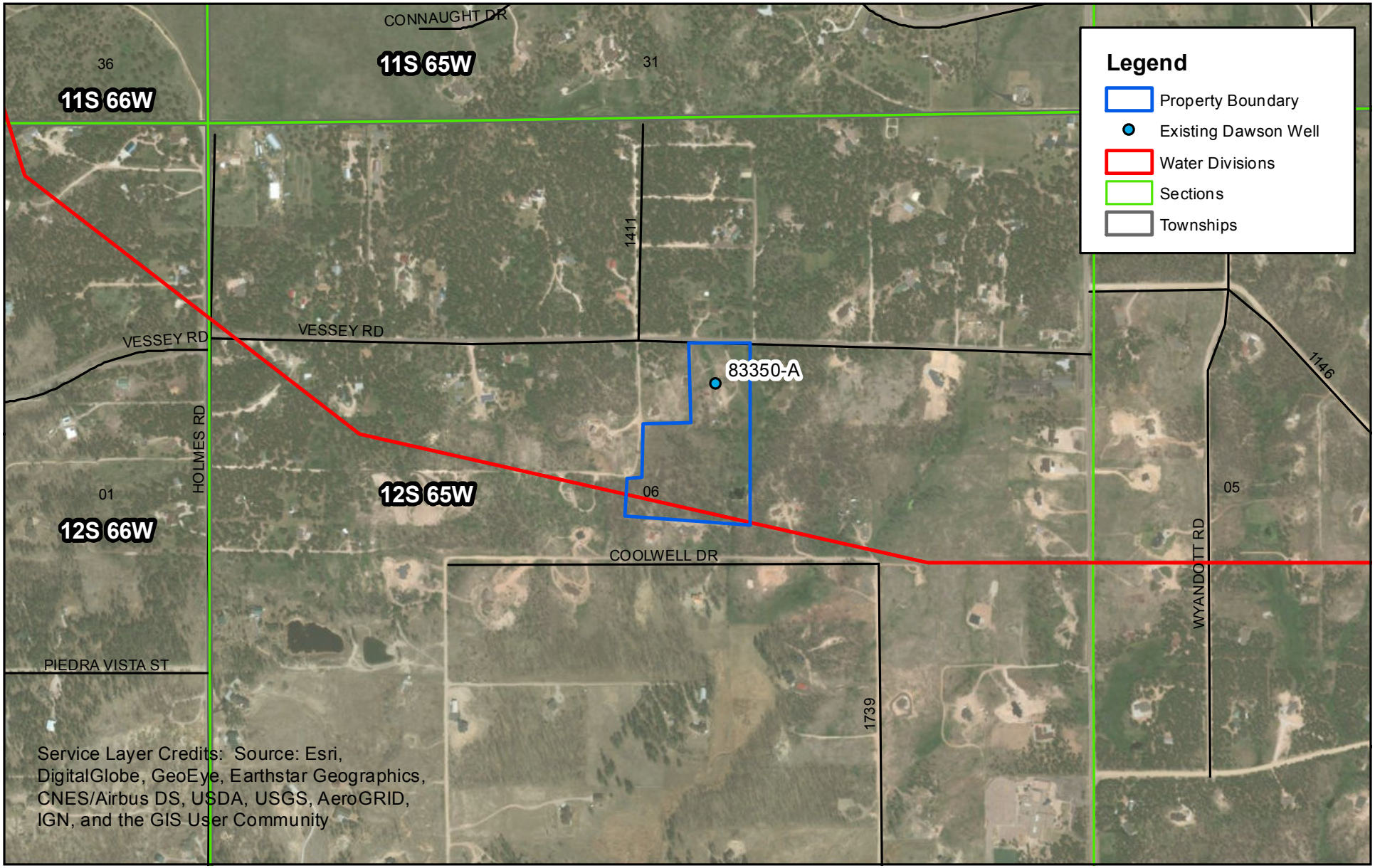


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Figure 1 - General Location Map

Client: Janice Woodard
Job Number: 18-04
Prepared By: SKB
Date: May 2018
Projection: UTM13N
File Name: Woodard_Figure1

1 inch = 833.33 feet

0 625 1,250 Feet

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