



**WYOMING  
GROUNDWATER, LLC**

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November 15, 2017

Mr. Darren Parkin  
Water Management Specialist  
Community Development Department  
City of Laramie  
P.O. Box C  
Laramie, WY 82073

**Re: Technical Review of *Site Specific Investigation Report: Eastridge Subdivision, Lot 16, October 27, 2017; Trihydro Corporation***

Dear Mr. Parkin:

The subject property is included in the Aquifer Protection Overlay (APO) Zone as a result of Enrolled Ordinance No. 1527 of the Laramie Municipal Code. As such, a Site Specific Investigation (SSI) is required and has been prepared by Trihydro for the proposed development. As requested by the City of Laramie, Wyoming Groundwater herein provides a technical review of the above referenced SSI report. The technical review focuses on the accuracy of report information regarding subject property geology/hydrogeology and provides professional opinions regarding consideration of a variance and appropriate measures to ensure protection of the Casper Aquifer.

### **Subject Property**

The subject property is located on the southwest corner of Beech Street and Vista Drive in the southeast quarter of the northeast quarter of Section 2, Township 15 North, Range 73 West. The 8.5-acre subject property is undeveloped with similar undeveloped land to the north across Beech Street and to the east across Vista Drive. Adjacent properties to the west and south are residential subdivisions.

The subject property is flat-lying and covered by alluvial fan deposits (i.e. loose silt, sand, and gravel). An ephemeral drainage channel occurs across Beech Street, north of the subject property.

### **Proposed Development**

As shown on the Eastridge Subdivision Lot 16 Site Plan, the proposed development is a residential subdivision comprised of 12 single-family duplex condominiums for a total of 24 units. Residential development is a permitted use in the APO Zone. The proposed development will be on City water and sewer with on-site double-lined piping. On-site runoff from paved surfaces (i.e. storm water) will drain to a concrete-lined channel that

will convey storm water to the southwest corner of the subject property where the channel will merge with an existing storm drain channel associated with the adjacent residential subdivision.

The proposed development represents the logical in-filling of similar adjacent residential development.

### **SSI Report Conclusions**

Based on data and analysis presented in the SSI report, Trihydro concludes that the proposed development poses a low risk to the Casper Aquifer for the following reasons:

- 1) Dwellings will be on City water and sewer with double-lined piping;
- 2) Dwellings near the mapped fault will not have basements;
- 3) Homeowner association by-laws will limit the types and quantities of contaminations that can be stored and used by residents;
- 4) Storm water infiltration will be “minimized” by concrete-lined drainage facilities; and
- 5) In areas where it is unfractured such as away from the fault, the thickness of the Satanka Shale at the site is sufficient to protect the Casper Aquifer from contaminant infiltration from ground surface.

Based on information presented in this review, it is Wyoming Groundwater’s opinion that Trihydro has not adequately addressed nor accurately evaluated the on-site features that enhance the Casper Aquifer’s vulnerability to contamination. The conclusion that the proposed development poses a low risk to the Casper Aquifer is not supported by geologic or hydrogeologic conditions on the subject property.

### **Variance Request**

In the SSI report, Trihydro identified an on-site fault, the Sherman Hills Fault, as a vulnerable feature. As such, proposed development is not allowed to occur within 100 feet of the fault. Per Trihydro’s recommendation, an application for a variance to exempt the development from this setback requirement was submitted to the City Planning Office on October 27, 2017. Consideration of the variance application is on-going.

As stated in Trihydro’s cover letter with the application, the variance request is based, in part, on the following site conditions and conclusions:

- The proposed development poses a low risk of contamination to the Casper Aquifer (for reasons listed in the previous section);
- There is 80 feet of Satanka Shale on the subject property which exceeds the 75 feet established for aquifer protection purposes; and
- Utility lines/excavations will not cross the Sherman Hills Fault.

This review will demonstrate that Trihydro’s conclusions regarding the thickness and adequacy of the Satanka Shale to protect the aquifer may be incorrect and should not be used as site conditions in support of a variance.

### **Technical Review of SSI Report Information**

There are four features on the subject property that are relevant to aquifer protection.

1. Sherman Hills Fault
2. On-site existing water well
3. Thickness of the Satanka Shale
4. Depth to groundwater

The technical review will focus on Trihydro’s evaluation of these features in view of existing information and alternative analysis.

#### **Comment #1** – *Sherman Hills Fault*

Trihydro identifies that the mapped trace of the Sherman Hills Fault runs east-west along the south edge of the subject property (see Figure 1 of SSI report) and that the fault is covered by alluvium. In the course of this review, drilling logs of nearby domestic wells (Table 1) indicate that the thickness of the alluvium in the area of the subject property varies from 5 to 19 feet. Trihydro’s use of the word “inferred” regarding the location of the fault should not be construed to suggest that the fault does not exist on the subject property, but rather that there is some uncertainty regarding the fault’s precise location beneath the alluvium.

Trihydro identifies that the relative displacement on the fault is down on the south side and up on north side, but does not discuss any other aspects of the geology or hydrogeology of the fault. The Conclusions Section of the SSI report, however, provides an ambiguous fault-related statement that “In the areas where it is unfractured such as away from the fault, the thickness of the Satanka Shale at the site is sufficient to protect the Casper Aquifer from contaminant infiltration from ground surface.” What precisely does “it” refer to and at what distance “away from the fault” is “it” unfractured?

Much has been learned about the Sherman Hills Fault as a result of installing and testing three monitoring wells across the fault at Imperial Heights Park (Phase II – Laramie Monitor Well Project Report (LMWPR), City of Laramie, June 2015). Figure 1-1 from the LMWPR is attached which shows the location of the three monitoring wells, Sherman Hills Fault, and the subject property located beneath the word “Fault” on the figure. At Imperial Heights Park, the Sherman Hills Fault has the following characteristics:

- Total vertical displacement across the fault is 39 feet (up on north side, down on south side);
- Displacement does not occur across a single fault, but rather across a 250 to 300 feet wide “fault zone” consisting of multiple faults; and

- Fractures occur in the Casper Formation in the fault zone and are responsible for high permeability in the aquifer.

Although Satanka Shale is not present at these three monitoring wells (i.e. the Satanka Shale begins to overlie the Casper west of these wells), it should be recognized that the Sherman Hills Fault cuts vertically through the entire thickness of the Satanka Shale as demonstrated by the offset of the Forelle Ridge 1.2 miles to the west. This means that, along with the Casper, the Satanka Shale will be fractured along the fault.

These observations represent the best available information regarding the Sherman Hills Fault and should have been integrated into the evaluation of hydrogeologic conditions at the subject property. For example, the mapped fault trace should be viewed as the center of a fault zone that is 250 to 300 feet wide such that it is reasonable to suspect that fractured conditions (i.e. “disturbed” strata) occur in the Satanka Shale and Casper Aquifer over the southern 2/3 of the subject property. These observations, in combination with Comment #3 to follow, provide justification to modify SSI reason #5 in the SSI report conclusions sections (listed previously).

**Comment #2** – *Existing Well on the Subject Property*

Trihydro identifies an existing well (UW 208186; “KAD-1”) in the southeast corner of the subject property that was present when the property was purchased by M&W Investments in 2004 and later purchased by KAD Investments in 2007. KAD Investments proposes to use the well for landscape watering and potentially fire protection. This well is described as “the nearest well” to the subject property. The SSI report provides no information regarding well depth, completion, lithology, or depth to water. In the course of conducting this review, Wyoming Groundwater requested and received from Trihydro the following information on the well collected in 2006.

- Total Depth: 150 feet
- Depth to Water: 39 feet
- Pump Test: 20 gallons per minute with 11 feet of drawdown
- 6-inch steel casing (exposed at surface)

Apparently there is no available information regarding when KAD-1 was installed, well completion details, and the lithology encountered during drilling. Remarks in the Application for Permit to Appropriate Ground Water for KAD-1 state, “This is an existing well that is very old and was never permitted.”

An attempt is made herein to clarify what is known or could be reasonably assumed regarding this well. The fact that this well is located in undeveloped prairie, appears to be “very old”, was never permitted, and has 6-inch steel casing suggests that the well was probably a stock well completed in the early- to mid-1900s. The Hope Well (UW 160), located approximately 190 feet south of KAD-1, is a 6-inch steel well completed in 1952 for domestic and stock purposes. These old wells were completed prior to any established well construction standards. Lacking documentation of well construction, the

KAD-1 well is subject to speculation and uncertainty regarding the presence/amount of surface/annular seals, length of casing, screen, open hole, lithology penetrated, etc. A downhole camera survey and/or geophysical log may help answer some, but not all, of these unknowns.

Per the estimated 80-foot thickness of the Satanka Shale presented in the SSI report or the alternative thickness provided in this review (see Comment #3), the well's total depth of 150 feet indicates that KAD-1 is completed in the Casper Formation.

Although KAD-1 is located on the geologic map (i.e. see Figure 1 in the SSI report), the well is not located on the proposed site plan. Using measurements (i.e. paced steps) obtained by Wyoming Groundwater during a site inspection on November 3, 2017, the KAD-1 well may be located on or very near a driveway of a proposed duplex. Clearly, the preliminary site plan did not take into account the existence of this well.

Due to KAD-1's age, unknown construction, poor location relative to proposed structures, and completion in the Casper Aquifer, this existing well represents a potential conduit for the introduction of surface or near-subsurface fluids into the aquifer. Given the time and expense that may be expended to better define well construction/completion, it may be prudent to properly plug and abandon the well and to install a new well that complies with current well construction standards and that is installed at a location that 1) optimizes the proposed use for lawn watering, 2) prevents unauthorized entry, and 3) minimizes exposure to surface water infiltration and activities involving hazardous materials.

### **Comment #3** – *Thickness of Satanka Shale*

Trihydro estimates that the thickness of the Satanka Shale on the subject property is approximately 80 feet. This value was calculated using a stratigraphic dip of 3 degrees across a distance of 2,900 feet eastward from the subject property to the Casper outcrop. The distance of 2,900 feet used Trihydro's calculation is incorrect for two reasons: First, the distance used should reflect the Satanka-Casper contact, rather than the first surface exposure of the Casper. The 2,900 feet reflects the contact where alluvium overlies the lower part of the epsilon member of the Casper. Second, in this area, Ver Ploeg's (2009) map showing Satanka Shale and Casper epsilon member exposures is incorrect. The Laramie Monitor Well Project Report (Hinckley and Moody, 2015) rectified map inaccuracies by redefining the Satanka-Casper contact as controlled by well data and surface exposures (see attached Figure 1-1).

Using the epsilon member-Satanka shale contact shown on Figure 1-1, the distance from the center of the subject property to the contact is 2,180 feet. Using a stratigraphic dip of 3 degrees minus a ground elevation difference of 50 feet between the contact and the subject property, a calculated thickness of the Satanka Shale on the north side of the fault in the center of the subject property is approximately 64 feet. Assuming an average value of 9 feet for the thickness of the alluvium in the area of the Sherman Hills Fault (Table 1), the approximate thickness of the Satanka Shale in the center of the subject property

may actually be 55 feet (i.e. slightly thicker at the west edge and slightly thinner at the east edge of the subject property).

Based on this analysis and recalculation, the thickness of the Satanka Shale at the subject property is probably less than Trihydro's calculated 80 feet and less than the 75 feet of "undisturbed" Satanka Shale used in the Casper Aquifer Protection Plan (CAPP) to indicate adequate physical protection of the underlying Casper Aquifer. This discussion of the thickness of the Satanka Shale, and whether or not the thickness equals or exceeds 75 feet, is rendered somewhat irrelevant because it is reasonable to suspect that the Satanka Shale is "disturbed" by deformation and fractures within the Sherman Hills Fault Zone which occupies the southern 2/3 of the subject property. On both counts – thickness value and likelihood of being disturbed – it is reasonable to conclude that the Satanka Shale will not, per CAPP criteria, provide adequate physical protection to the underlying Casper Aquifer at the subject property.

Trihydro's statement in the SSI report (pg 2-4) that "The thickness of the Satanka Shale should be sufficient to protect the aquifer from surface contamination at the site" is not correct and related statements in the variance application regarding the thickness and adequacy of the Satanka Shale to protect the aquifer should not be used as site conditions in support of a variance.

#### **Comment #4** – *Depth to Water*

Trihydro uses water level data from a City monitor well, SHMWE, located approximately 1,100 feet due west of the subject property (not 550 feet southwest as reported in the SSI report) to estimate an on-site depth to water of 25 feet. It is odd that water level data from a far-away well was used when a water level in a well on the subject property (depth to water was 39 feet in 2006) could be measured directly to provide an accurate and representative on-site depth to water.

#### **Summary Opinions**

The conclusion that the proposed development poses a low risk to the Casper Aquifer is not supported by geologic or hydrogeologic conditions on the subject property. The subject property is situated on a vulnerable feature (Sherman Hills Fault Zone) with an estimated thickness of the Satanka Shale that, in Wyoming Groundwater's opinion, is likely to be less than 75 feet, and that fractured conditions (i.e. disturbed) in the Satanka Shale and Casper Aquifer are likely to exist over most of the subject property. A "very old" on-site well provides a potential vertical conduit for subsurface contamination.

Consideration of a variance (i.e. waive the 100-foot development setback from a vulnerable feature - the fault) will require engineering controls to reduce the potential to contaminate the aquifer. The double-lined pipes for sewer lines, proper drainage structures, and homeowner covenants regarding hazardous materials, as mentioned in the SSI report, are good first-steps toward aquifer protection on the subject property. Additional engineered facilities may be appropriate upon further review.

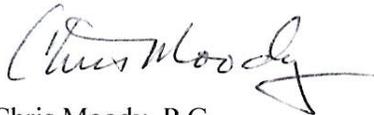
Most importantly, construction details for the existing on-site well should be defined and evaluated for adequacy or, better yet, the well should be properly plugged and abandoned. If required or pursued, the plugging of the existing well should focus on a method designed to establish an annular seal between the casing and the drilled hole. Perhaps, rather than trying to rehabilitate the existing well for the proposed uses and to design the site plan and dwellings around the well, a practical and cost-effective approach may be to install a new well that is properly designed, documented, and located to better serve proposed uses and aquifer protection.

As part of the variance, if granted, the City should consider obtaining permission (i.e. memorandum of understanding) to collect water samples from the well (old or new well) to establish baseline (i.e. pre-development) water quality and to monitor any changes in water quality through time.

Trihydro should be allowed the opportunity to respond to this review by providing alternative interpretations of subject property geology/hydrogeology and to modify the SSI report and application for variance as appropriate.

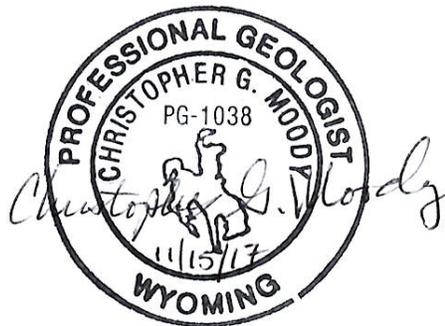
Wyoming Groundwater's expertise is in hydrogeology and not engineering-based topics such as surface drainage, flood control, and development design. If you have any questions or comments, please feel free to contact me by phone or email.

Sincerely,



Chris Moody, P.G.  
Wyoming Groundwater, LLC

Attachments (2)



References Cited

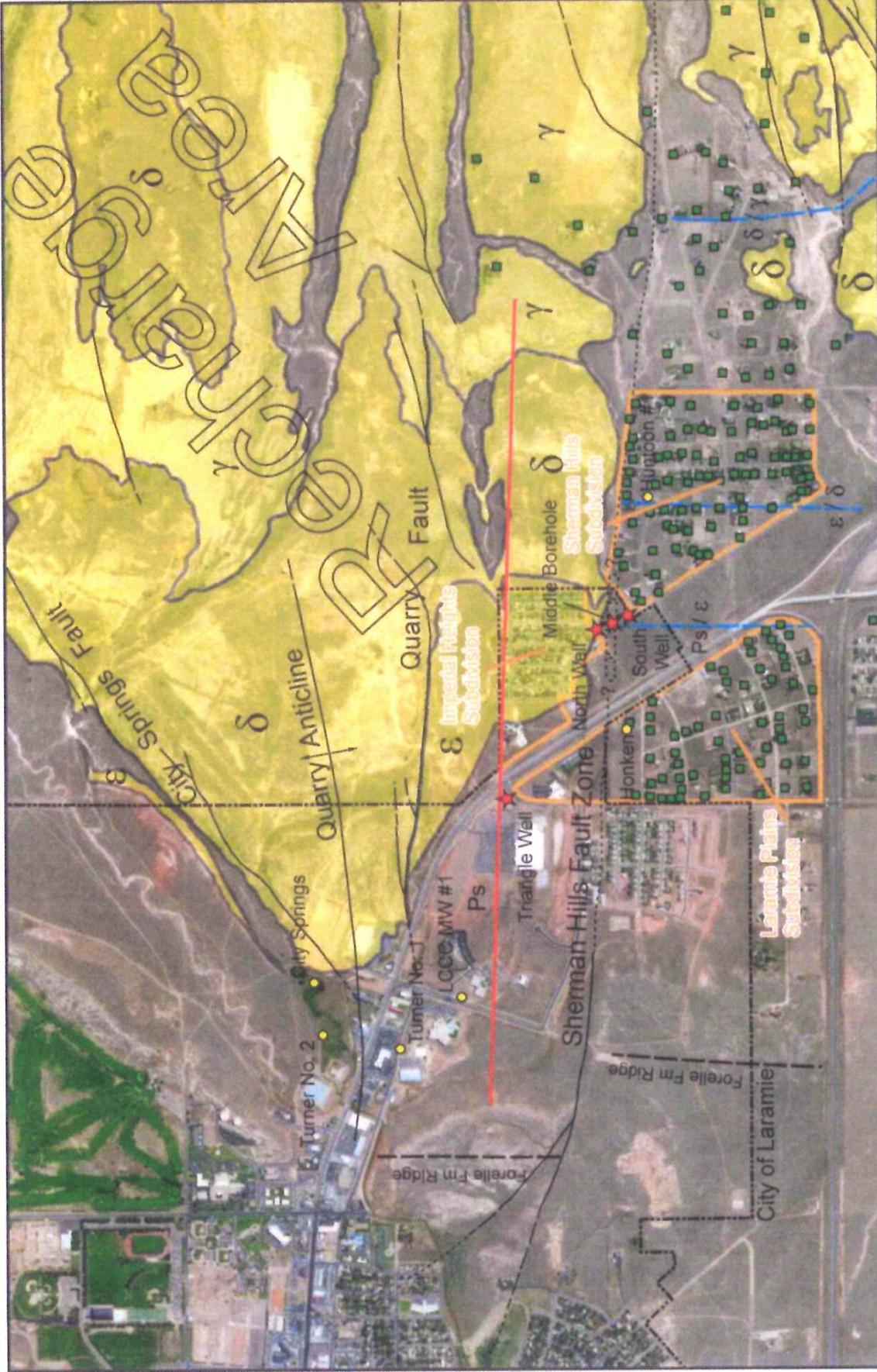
Ver Ploeg, A.J., 2009, Revised Geologic Map of the Laramie Quadrangle, Albany County, Wyoming, Wyoming State Geological Survey

Hinckley, B., and C. Moody, June 18, 2015, Phase II – Laramie Monitor Well Project Report, Consultant report submitted to the City of Laramie

**Table 1 - Thickness of the Alluvium at Water Wells Near Subject Property**

Data Source: Permit Data from State Engineer's Office e-Permit database

Well Name	Permit #	Thickness of Alluvium, ft.
Hope Well	UW 160	10
Stahl #1	UW 35807	19
Jim #1	UW 93491	6
Animal Center No. 1	UW 99001	5
Triangle Well	UW 203337	6
Average Thickness, ft.		9



■ Septic Systems (2008 CAPP)  
 - Buried Contact (Inferred Location)  
 - Line of Section Figure 1-2  
 ■ Casper Formation Outcrop (with exposed contacts)  
 - Fault or Fold (dashed where buried)  
 - Fault Zone  
 - Exposed Contact

Ps - Satanka Shale  
 Casper Formation Members:  
 ε - Epsilon  
 δ - Delta  
 γ - Gamma

(Geology modified after VerPloeg, 2009)

0 1,000 2,000 Feet

North

**Figure 1-1 - Location Map**  
**Laramie Monitor Well Project**

Source: Phase II - Laramie Monitor Well Project Report, June 18, 2015