



memorandum

To: Mr. Darren Parkin and Mr. Dave Derragon,
City of Laramie

From: Mr. Ryan Athey, P.G., Trihydro Corporation

cc: Mr. David Gertsch, Albany County

Date: October 25, 2017

Re: I-80 Telephone Canyon Monitoring Well Feasibility Study

Previous studies of the Casper Aquifer commissioned by the City of Laramie and Albany County have determined that a hazardous material spill on I-80 east of Laramie through Telephone Canyon would likely constitute a severe threat to water quality (CAPP 2006, CAPP 2008). In 2010, Trihydro contracted with Albany County and the City of Laramie to complete an investigation of possible emergency response and mitigation engineering recommendations, along with associated cost estimates, for addressing a hazardous material release within the Telephone Canyon section of I-80. Recommendations from that investigation included developing a monitoring plan and well system to assist in assessing potential impacts to the aquifer. In 2015, Trihydro prepared a design, locations, and cost estimate for developing the well network recommended in 2010. The purpose of this memorandum is to review the basis for the monitoring well design and locations to determine the feasibility and applicability to the City's goals for the monitoring well network.

1.0 Well Design and Location

The 2015 design plan proposed five monitoring wells in and west of Telephone Canyon, as shown on Figure 1. The basis for the well design and locations was related to the channel lining and detention pond proposed in the 2010 report. Well MW-1 was located down-gradient of the proposed channel lining to identify impacts in the area determined to be most vulnerable. This well is located within the I-80 (WYDOT) right-of-way. Wells MW-2, MW-3, and MW-4 were proposed as sentinel wells up-gradient of the Pope Springs and Soldier Springs well fields. These wells are located on private land. Well MW-5 was proposed as an up-gradient well to provide background data for the aquifer to compare with data from the down-gradient wells. This well would also be located within the WYDOT right-of-way.

Based on limited well and water-level data in the area, the wells were estimated to be completed to a depth of 300 feet with an open-hole completion. This design would allow geophysical evaluation of the well bore by the University of Wyoming (UW), if desired.

2.0 Well Network Evaluation

Based on the location of wells MW-2, MW-3, and MW-4 on private land, the City prefers not to pursue completion of these wells at this time. Trihydro reviewed Albany County plat maps to attempt to identify areas with public access such as public land (City, County, or State) or right-of-ways near the proposed



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well locations. Locations that would fulfill the goals of the project were not available. Therefore, only wells MW-1 and MW-5 are being considered for this evaluation.

The Casper Formation is comprised of five members (from bottom to top – alpha, beta, gamma, delta, and epsilon) consisting of interbedded sandstone and limestone. The most prolific water-bearing and the source water for the City’s supply wells are the epsilon and delta members. However, due to fractures in the formation, the five members are connected and considered a single aquifer. Figure 2 shows the bedrock geology in the Telephone Canyon area. The five members outcrop along the I-80 Telephone Canyon corridor with the epsilon member near the bottom (west end) and the alpha member near the top (east end).

The proposed location of MW-1 is near the contact between the Gamma and Beta members. The proposed depth of 300 feet would be completed within the Beta member. Based on water-levels in the Laramie East #1 and #2 wells, depth to water in MW-1 is estimated to be approximately 180 feet. The Laramie East #1 and #2 wells are completed to 325 and 301 feet, respectively. The casing in the Laramie East #1 well is damaged and is difficult to sample. Laramie East #2 well is located on private land that the City no longer has permission to access, therefore, MW-1 would provide a replacement for these wells.

The proposed location of MW-5 is near the contact between the Beta and Alpha members. Therefore, the well would only intercept water from the Alpha member. This well will provide useful water quality information due to the connected nature of the aquifer.

The locations of wells MW-1 and MW-5 (Figure 2) in relation to I-80 provides convenient and safe access points for well construction and sample collection. MW-1 is located where I-80 has a wide median between the eastbound and westbound lanes. This location is spacious enough for the drill rig and provides a relatively safe access point for regular sampling. MW-5 is located on a curve where the right-of-way is quite wide and provides area for drill rig and sampling access.

The well design proposed in 2015 called for open-hole completions at each well. If the City prefers to screen the wells, geophysical logging by UW could be accomplished prior to installation of the well screen. The geophysical data can be used to screen the most prolific water-bearing zones within the aquifer.

Another water quality monitoring location that should be considered is Telephone Spring, located near mile marker 321.5 (Figure 2). This spring is a perennial spring that discharges within the right-of-way of I-80. However, the discharge quickly infiltrates into the Casper Formation within approximately 3,000 feet of the spring. Therefore, samples should be collected directly at the spring. The spring was evaluated to determine if equipment such as a weir or flume could be installed to accurately measure discharge. Due to the steep sides of the drainages and the proximity to the roadway, gaining access to the



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spring area for construction may be cost prohibitive. The spring could still be sampled for water quality, but discharge measurements would not be accurate.

These three monitoring points would provide coverage throughout the Telephone Canyon corridor for water quality impacts from spills associated with I-80. The proposed locations are such that safe access for construction and sampling is accommodated.

3.0 Well Drilling and Sampling

Trihydro will provide oversight during drilling. The boreholes will be drilled using air-rotary or mud-rotary methods. As water-bearing zones are encountered, the driller will be instructed to stop drilling and circulate drilling fluid in order to clean-up the borehole for water sample collection. Trihydro will collect a sample from each major water-bearing zone encountered during drilling and send it to a qualified laboratory for analysis of the EPA Primary and Secondary Drinking Water analytes as shown on Table 1.

4.0 Estimated Costs and Schedule

Estimated well construction costs are presented in Table 2. Costs are based on installing 4-inch diameter wells. Each well will be completed with 4-inch schedule 80 polyvinyl chloride (PVC) casing and 20 feet of PVC well screen in a 10-inch diameter borehole. Well development, disinfection, and surface completion are also included in the costs. Trihydro's estimated costs for project management, drilling oversight, sampling, and reporting are presented in Table 3. We assume 10 days of drilling oversight time by Trihydro personnel. Trihydro assumes three samples will be collected from each boring during drilling and one sample from the spring for seven total samples analyzed per Table 1.

Drilling, construction, and sampling are scheduled to be completed in 2017. Borehole drilling and logging would be completed and final well construction would be completed following geophysical logging by UW. The final schedule will be negotiated following coordination with the drilling contractor and UW.

415-035-001

TABLES

TABLE 1. PROPOSED SAMPLING ANALYTES AND ANALYSES COSTS
I-80 TELEPHONE CANYON MONITORING WELLS
ALBANY COUNTY, WYOMING

Analyte	Cost per sample	Number of Samples	Total Cost
Organic Constituents	\$ 1,335	7	\$ 9,345
Acrylamide			
Alachlor			
Atrazine			
Benzene			
Benzo(a)Pyrene (PAHs)			
Carbofuran			
Carbon Tetrachloride			
Chlordane			
2,4-D			
Dalapon			
1,2-Dibromo-3-chloropropane (DBCP)			
o-Dichlorobenzene			
p-Dichlorobenzene			
1,2-Dichloroethane			
1,1-Dichloroethylene			
cis-1,2-Dichloroethylene			
trans-1,2-Dichloroethylene			
Dichloroethane			
1,2-Dichloropropane			
Di(2-ethylhexyl)adipate			
Di(2-ethylhexyl)phthalate			
Dinoseb			
Dioxin(2,3,7,8-TCDD)			
Diquat			
Endothall			
Endrin			
Epichlorohydrin			
Ethylbenzene			
Ethylene dibromide			
Glyphosate			
Heptachlor			
Heptachlor epoxide			
Hexachlorobenzene			
Hexachlorocyclopentadiene			
Lindane			
Methoxychlor			
Oxamyl(Vydate)			
Polychlorinated biphenyls (PCBs)			
Pentachlorophenol			
Picloram			
Simazine			

TABLE 1. PROPOSED SAMPLING ANALYTES AND ANALYSES COSTS
I-80 TELEPHONE CANYON MONITORING WELLS
ALBANY COUNTY, WYOMING

Styrene				
Tetrachloroethylene				
Toluene				
Toxaphene				
2,4,5-TP (Silvex)				
1,2,4-Trichlorobenzene				
1,1,1-Trichloroethane				
1,1,2-Trichloroethane				
Trichloroethylene				
Vinyl chloride				
Total Xylenes				
Disinfection Byproducts	\$	300.00	7	\$ 2,100
Bromate				
Chlorite				
Haloacetic Acids (HAA5)				
Total Trihalomethanes (TTHMs)				
Disinfectants	\$	65.00	7	\$ 455
Chloramine				
Chlorine Dioxide				
Total Residual Chlorine				
Inorganic Chemicals	\$	250.00	7	\$ 1,750
Antimony				
Arsenic				
Asbestos				
Barium				
Beryllium				
Cadmium				
Chromium				
Copper				
Cyanide				
Lead				
Mercury				
Nitrogen, Nitrate				
Nitrogen, Nitrite				
Selenium				
Thallium				
Radionuclides	\$	200.00	7	\$ 1,400
Gross Alpha				
Gross Beta				
Radium 226 and 228				
Uranium				
Microorganisms	\$	250.00	7	\$ 1,750
Cryptosporidium				


TABLE 1. PROPOSED SAMPLING ANALYTES AND ANALYSES COSTS
 I-80 TELEPHONE CANYON MONITORING WELLS
 ALBANY COUNTY, WYOMING

Giardia lamblia			
Heterotrophic plate count			
Legionella			
Total Coliforms			
Turbidity			
Viruses			
Secondary Analytes	150	7	\$ 1,050
Aluminum			
Chloride			
Color			
Copper			
Corrosivity			
Fluoride			
Foaming Agents			
Iron			
Manganese			
Odor			
pH			
Silver			
Sulfate			
Total Dissolved Solids			
Zinc			
Total	\$	2,550	\$ 17,850

**TABLE 2. WELL DRILLING AND CONSTRUCTION COST ESTIMATE
I-80 TELEPHONE CANYON MONITORING WELLS
ALBANY COUNTY, WYOMING**

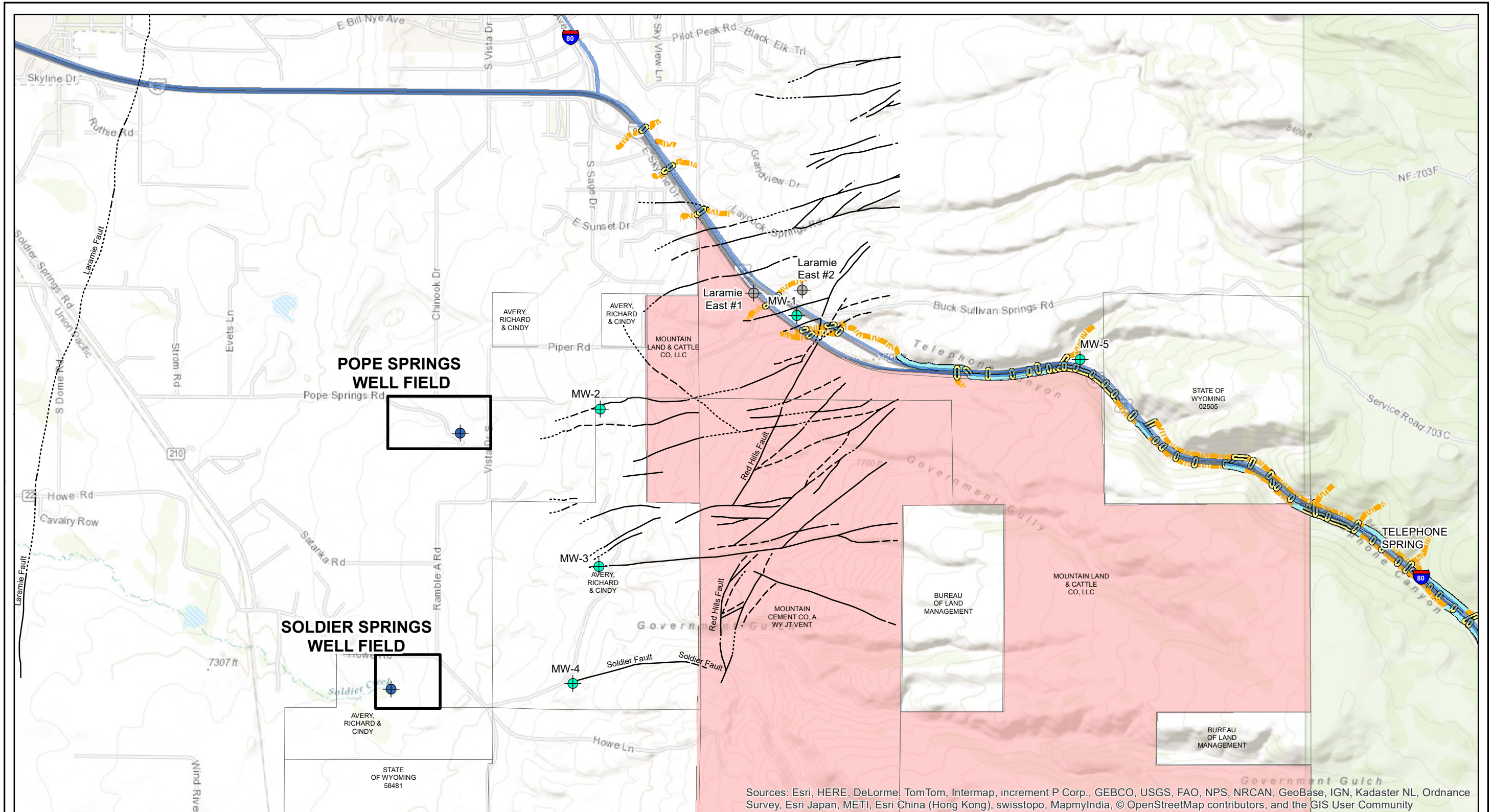
1	MOBILIZATION	LS	1	\$10,000.00	\$10,000.00
2	SURFACE CASING	LF	60	\$50.00	\$3,000.00
3	DRILL 10" N.D. BOREHOLE	LF	540	\$45.00	\$24,300.00
4	PROVIDE DEVELOPMENT EQUIPMENT	LS	1	\$2,000.00	\$2,000.00
5	WELL DEVELOPMENT	HR	20	\$250.00	\$5,000.00
7	SURFACE COMPLETIONS	EACH	2	\$250.00	\$500.00
8	WELL SITE RECLAMATION	EACH	2	\$1,000.00	\$2,000.00
SUBTOTAL					\$46,800.00
CONTINGENCY (10%)					\$4,680.00
TOTAL					\$51,480.00

**TABLE 3. PROJECT COST ESTIMATE
I-80 TELEPHONE CANYON MONITORING WELLS
ALBANY COUNTY, WYOMING**

		Trihydro Corporation						
		Project Principal	Professional Level 10	Professional Level 5	Professional Level 2	Technical Level 3	Administrative 2	Labor Subtotal
TASK	DESCRIPTION	\$180	\$160	\$102	\$67	\$66	\$55	
Task 1	Project Management and Administration	4		16	8		8	\$3,328
Task 2	Drilling oversight		4	40	60			\$8,740
Task 3	Sampling			10	10			\$1,690
Task 4	Reporting	2	4	20	32	12	4	\$6,196
	Phase I Subtotal (hours)	6	8	86	110	12	12	234
	Phase I Subtotal (\$)	\$1,080	\$1,280	\$8,772	\$7,370	\$792	\$660	\$19,954
	Total (hours)	6	8	86	110	12	12	234
	Total (\$)	\$1,080	\$1,280	\$8,772	\$7,370	\$792	\$660	\$19,954

Expenses						Task Total
Direct Reimbursables					Expenses Subtotal	
	Subcontracts (Labor, Equipment and Services)	Consumable Field Supplies	Rental Equipment (Project Specific)	Company Vehicles (Daily)		
	Cost + 10%	Cost + 10%	Cost + 10%	\$86.00		
				/day		
					\$0	\$3,328
	\$56,628	\$100	\$500	10	\$58,088	\$66,828
	\$19,635	\$100	\$250	1	\$20,071	\$21,761
					\$0	\$6,196
Cost	\$76,263	\$200	\$750	\$946	\$78,159	--
Subtotal	\$83,889	\$220	\$825	\$946	\$85,880	\$105,834
Cost	\$76,263	\$200	\$750	\$946	\$78,159	--
Total	\$83,889	\$220	\$825	\$946	\$85,880	\$105,834

FIGURES



Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

EXPLANATION








-  WATER SUPPLY WELL
-  MONITORING WELL
-  RUNOFF, DRAINAGE PATH
-  OPEN CHANNEL
-  STORM DRAIN, CULVERT
-  FAULT (DASHED WHERE INFERRED)
-  MOUNTAIN CEMENT PERMIT AREA

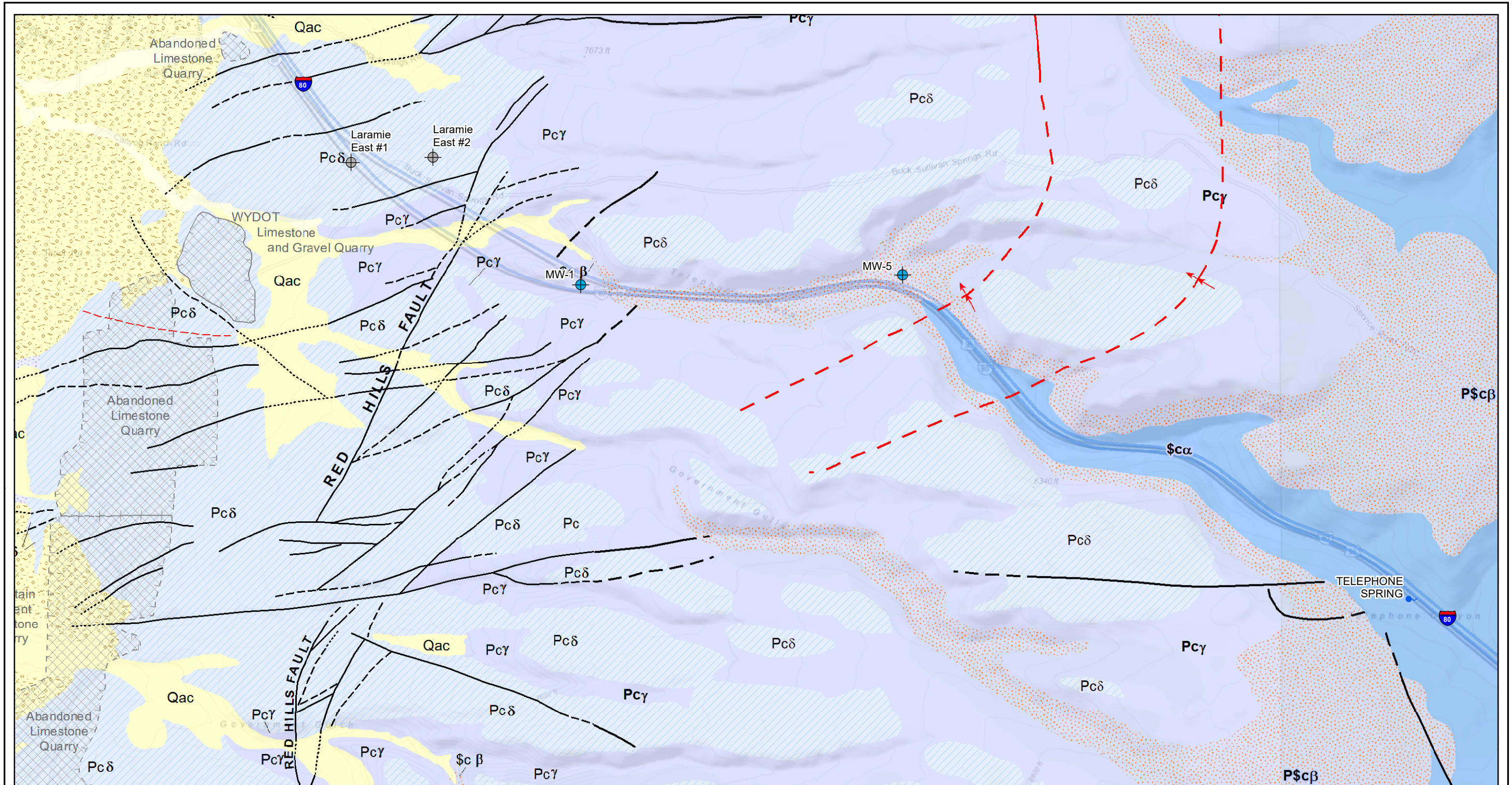


FIGURE 1

PROPOSED MONITORING WELL LOCATIONS - 2015

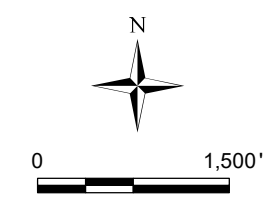
**I-80 TELEPHONE CANYON
CASPER AQUIFER PROTECTION DESIGN
LARAMIE, WYOMING**

Drawn By: PH Checked By: RA Scale: 1" = 2500' Date: 11/5/14 File: Laramie_I80_PondDesignFig1.mxd



Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

EXPLANATION	
	EXISTING WELL
	PROPOSED MONITORING WELL
	TELEPHONE SPRING
	FAULT (DASHED WHERE INFERRED)
	MONOCLINE
	ALLUVIAL DEPOSITS (HOLOCENE)
	MIXED ALLUVIUM AND COLLUVIUM (HOLOCENE/PLEISTOCENE)
	ALLUVIAL FAN DEPOSITS (HOLOCENE/PLEISTOCENE)
	CASPER EPSILON MEMBER (PERMIAN)
	CASPER DELTA MEMBER (PERMIAN)
	CASPER GAMMA MEMBER (PERMIAN)
	CASPER BETA MEMBER (PERMIAN AND PENNSYLVANIAN)
	ALPHA MEMBER (PENNSYLVANIAN)



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FIGURE 2

PROPOSED MONITORING WELL LOCATIONS - 2017

**I-80 TELEPHONE CANYON
CASPER AQUIFER PROTECTION DESIGN
LARAMIE, WYOMING**