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March 22, 2018

Re: Comments on HB18-1215
Concerning Enhanced Protections Regarding the Disposal of Naturally Occurring Radioactive Materials
Second Regular Session Seventy-first General Assembly State of Colorado

Dear Members of the House Health, Insurance, and Environment Committee:

My name is Matt Tymchak and I am here today to provide scientific testimony regarding HB18-1215, "Concerning Enhanced Protections Regarding the Disposal of Naturally Occurring Radioactive Materials." I am a Senior Hydrologist at Gradient, an environmental and risk sciences consulting firm. I have a bachelor's and a master's degree in geology from James Madison University and the University of South Carolina, respectively. I have provided technical expertise in evaluations of a variety of industrial sites, including upstream oil and gas development, refineries, and solid waste landfills, and have dealt with a wide range of chemicals in the environment. I am currently engaged in an evaluation of waste disposal for materials containing technologically enhanced naturally occurring radioactive material (TENORM) at a facility in Kentucky.

Gradient was previously retained to work on a TENORM study for a landfill operator in Colorado (Pawnee Waste) to evaluate ranges of radioactivity in oil and gas wastes. While I was engaged in that work in the past, I'm here today on behalf of myself and Gradient to present the information from that prior work to this committee. In that study, I identified publicly available data sources that contained radionuclide sampling data from various solid wastes in the oil and gas industry. These wastes included drill cuttings, proppant, drilling mud, sludge, flowback solids, pipe and tank scale, filter cake, and other solid wastes associated with oil and gas exploration and production (E&P) activities.

I found that the data available allow for an understanding of the general ranges of radioactivity in different categories of E&P wastes and evaluated how those ranges compare to the Colorado Department of Public Health and Environment (CDPHE) administrative levels. For example, Figure 1 (attached) illustrates the range of radioactivity levels for each waste type. The data show that filter residuals, sludge, scale, and scale-impacted soil have the highest levels of radioactivity, with values typically above CDPHE administrative levels for combined radium.[1] The other waste types shown on Figure 1 (drill cuttings, mud, and proppant) have levels of radioactivity that fall both above and below CDPHE administrative levels for combined radium.

I identified radionuclide data for wastes in Colorado, New York, North Dakota, Pennsylvania, Texas, West Virginia, and the country of Poland. There were three studies with data from Colorado and nine studies with data from other states or countries. Figure 2 shows a map of the oil and gas basins in Colorado. The Denver-Julesberg basin is the only area in Colorado for which there are publicly available data on the radioactivity of E&P wastes. Most of the data I have summarized in the attached table and Figure 1 are based on information from other states. For example, there are 12 wells reported in Colorado of the 51 total reported for which radioactivity measurements from drill cuttings are available. Although

[1] CDPHE established administrative release levels for combined radium-226 and radium-228 in its "Interim Policy and Guidance Pending Rulemaking for the Control and Disposition of Technologically Enhanced Naturally Occurring Radioactive Materials in Colorado" (February 2007).

most of the drill cutting data are from other states, the drill cutting measurements from Colorado fall within the range of measurements from the other states.

I hope this summary of information is helpful in your deliberations. I would like to thank the members of the House Health, Insurance, and Environment Committee for their time today.

Sincerely yours,

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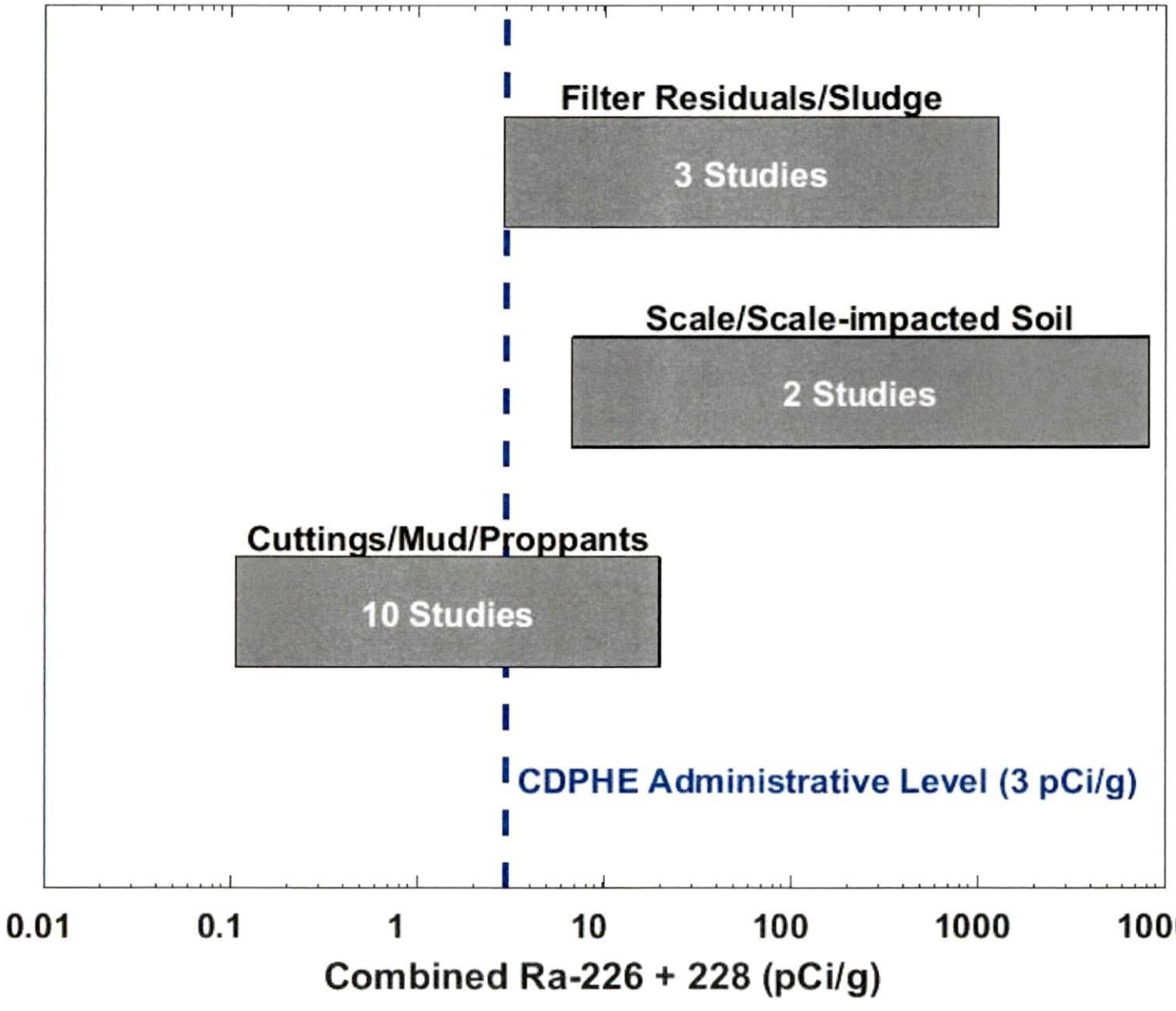
Matthew P. Tymchak, M.S.
Sr. Hydrologist

email: mtymchak@gradientcorp.com

Attachments: Figures 1 and 2
Table 1
References



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Ranges of Combined Radium (226 + 228) Activity in Categories of E&P Wastes

FIGURE 1

Date: 3/21/2018

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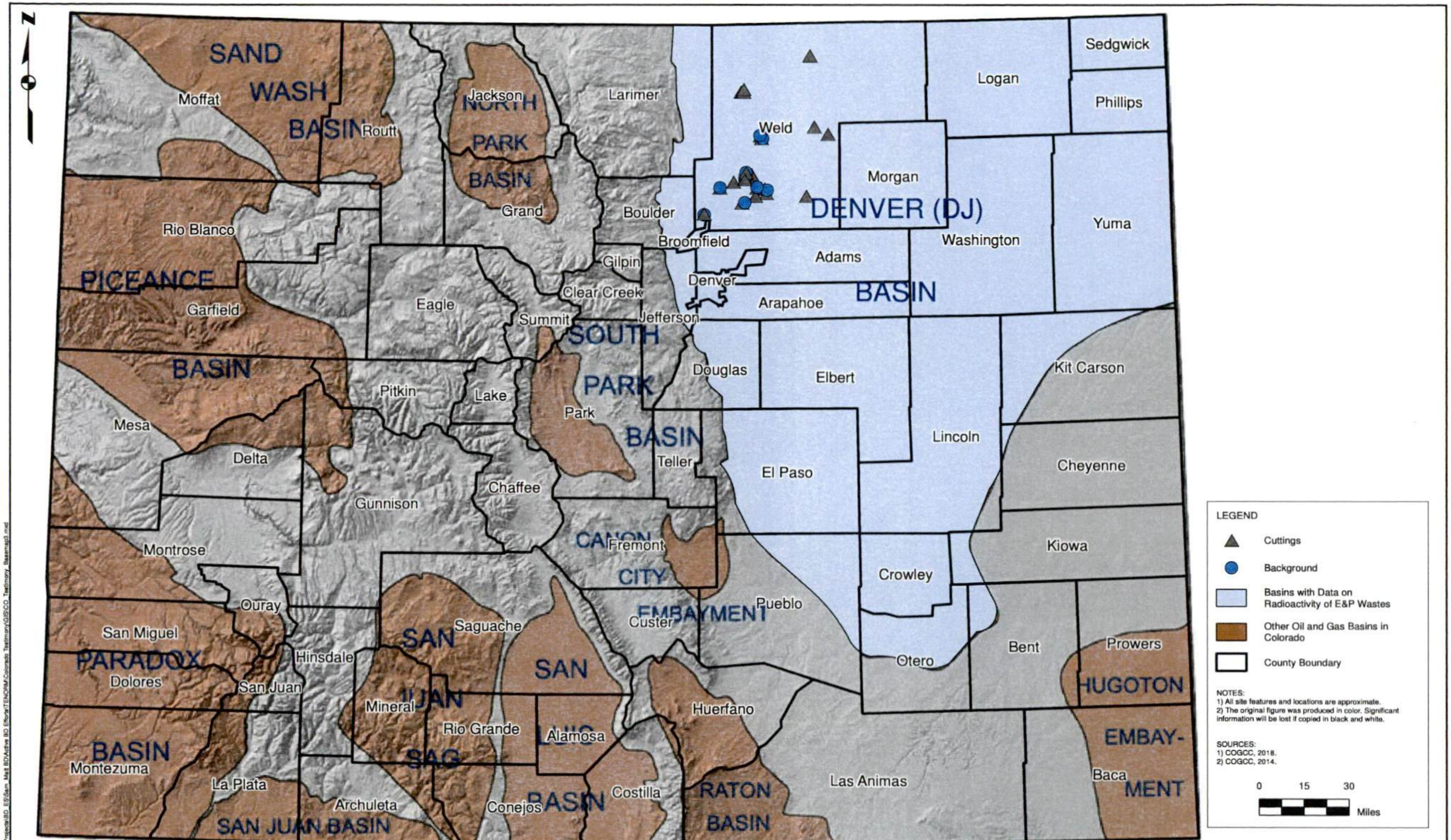

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Oil and Gas Basins in Colorado With NORM Locations

Colorado

FIGURE 2

Date: 3/22/2018

Table 1 Summary of Radioactivity in Background Soil and Wastes from Oil- and Gas-shale Exploration and Production

Shale Formation or Basin	State or Country	Material Sampled	Activity (pCi/g)						Data Source
			Combined Ra-226+228		Thorium (Natural)		Uranium (Natural)		
			Min.	Max.	Min.	Max.	Min.	Max.	
Colorado Department of Public Health and Environment Administrative Levels			**3**		**3**		**30**		**CDPHE (2017)**
Denver-Julesburg	**CO**	**Background Soil Samples**	**1.38**	**4.2**	**2.42**	**5.93**	**0.82**	**2.80**	**COGCC (2014)**
Denver-Julesburg	CO	Drill Cuttings and Drill Cuttings Mixed with Soil	1.36	4.15	2.61	5.06	0.906	4.15	COGCC (2014)
Denver-Julesburg	CO	Drill Cuttings (Vertical/Horizontal Transition)	4.47						ALS Environmental (2017)
Marcellus[a,b]	NY	Drill Cuttings	0.872	1.84	0.567	1.02	0.079	0.185	NYSDEC (2015)
Marcellus[a,c]	PA	Drill Cuttings	0.84	6.30	1.27	8.05	2.22	15.57	Eitrheim *et al.* (2016)
Lublin Trough	Poland	Drill Cuttings	3.27	4.41	0.95	1.16	1.89	2.68	Jodlowski *et al.* (2017)
Baltic Basin[d,e]	Poland	Drill Cuttings	1.38	3.30	0.51	1.27	0.95	2.35	Jodlowski *et al.* (2017)
Marcellus	PA	Vertical Drill Cuttings	0.805	20.0	0.110	2.74	0.18	2.14	Perma-Fix Environmental Services, Inc. (2016)
Marcellus	WV	Vertical Drill Cuttings	3.40	4.11					Marshall University (2015)
Marcellus	WV	Vertical Drill Cuttings	3.0	3.3					Carr (2017)
Denver-Julesburg	CO	Horizontal Drill Cuttings	7.42						ALS Environmental (2017)
Marcellus	PA	Horizontal Drill Cuttings	0.107	13.6	0.016	1.14	0.272	5.75	Perma-Fix Environmental Services, Inc. (2016)
Marcellus	WV	Horizontal Drill Cuttings	5.67	8.98					Marshall University (2015)
Marcellus[a]	PA	Horizontal Drills Cuttings	0.6	4.3	0.5	1.2			NYSDEC (2015)
Marcellus	WV	Horizontal Drills Cuttings	4.7	10.8					Carr (2017)
Not Specified	ND	Proppant	4.86	20.3	8.1	10.2			Argonne National Laboratory (2014)
Marcellus	PA	Proppant Sand	0.196	0.396	0.007	0.115	0.012	0.332	Perma-Fix Environmental Services, Inc. (2016)
Lublin Trough	Poland	Proppant, Waste	0.62	12.49	0.14	6.62	0.38	5.03	Jodlowski *et al.* (2017)
Baltic Basin	Poland	Proppant, Waste	20.3	25.16	11.3	13.92	9.84	10.62	Jodlowski *et al.* (2017)
Marcellus	PA	Flowback Solids, Sand	0.957	8.35	0.191	0.609	0.397	1.03	Perma-Fix Environmental Services, Inc. (2016)
Lublin Trough	Poland	Solid Waste	1.03	1.89	0.43	0.65	0.95	1.03	Jodlowski *et al.* (2017)
Baltic Basin	Poland	Solid Waste	0.86	1.62	0.35	0.70	0.95	1.24	Jodlowski *et al.* (2017)
Marcellus	PA	Drilling Solids, Mud	0.857	4.05	0.120	0.435	0.215	1.75	Perma-Fix Environmental Services, Inc. (2016)
Barnett Shale	TX	Reserve Pit (Drilling Fluid) Sludge	ND	3.11	0.64	0.72	ND		Rich and Crosby (2013)
Not Specified	ND	Scale	16.9	8,290	6.5	460			Argonne National Laboratory (2014)
Not Specified[a]	N/A	Soil from Pipe Scale Cleaning Field	6.75	1,681					Wilson and Scott (1992)
Denver-Julesburg	CO	Sump Pump Grit and Filter Cake	2.91	32.6	0.045	3.98	0.426	2.92	Tetra Tech, Inc. (2016)
Not Specified	ND	Sludge (from tanks, flare pit, treatment)	3	1,293	2.1	97.5			Argonne National Laboratory (2014)
Not Specified	ND	Filter Sock	3.51	504	6.5	18.9			Argonne National Laboratory (2014)
Denver-Julesburg	CO	Filter Cake (Oil Recycling Operations)	12.42		2.12		2.08		Pace Analytical Services, Inc. (2014)
Denver-Julesburg	CO	Filter Cake (Water)	15.05		0.778		1.45		Pace Analytical Services, Inc. (2014)
Denver-Julesburg	CO	Filter Press Solids (Oil Recycling Operation)	32.56		2.93		2.15		Pace Analytical Services, Inc. (2015)
Denver-Julesburg	CO	Sump Pit Solids (Oil Recycling Operation)	2.91		3.98		1.58		Pace Analytical Services, Inc. (2015)

Notes:

COGCC = Colorado Oil & Gas Conservation Commission; N/A = Not Available; ND = Not Detected; Ra = Radium; Th = Thorium; U = Uranium.

(a) Only Ra-226 was reported.

(b) Only U-235 was reported.

(c) Only Th-230 was reported.

(d) Only Th-228 was reported.

(e) Only U-238 was reported.

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