April 7, 2020

IN THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REVISED REQUEST FOR APPROVAL OF ADDITIONAL USES OF PHOSPHOGYPSUM PURSUANT TO 40 C.F.R. § 61.206

Use in Road Construction projects authorized by federal, state and local Departments of Transportation or Public Works

Submitted by: **The Fertilizer Institute on Behalf of Its Members**

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This Petition and supporting risk analysis were developed by reviewing the "Applying to EPA for Approval of Other Uses of Phosphogypsum: Preparing and Submitting a Complete Petition under 40 CFR 61.206, A Workbook" (EPA PG Workbook) and prior petitions, and through a series of working meetings with EPA staff to obtain EPA input and direction on key elements of the analysis. Throughout this process, the methodologies and technical issues utilized in the technical evaluations were informed by EPA's feedback.

This Petition includes the following sections:

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DEFINITION OF KEY TERMS

The basic concepts relevant to this Petition are:

Dose: Dose measures the amount of radiation absorbed by a person. The terms radiation absorbed dose (rad) and gray (Gy) describe measurements of the absorbed dose.

1 gray (Gy) is equivalent to 100 rad; 1 rad = 0.01 Gy

Dose equivalent adjusts the absorbed dose to include the relative medical effects of gamma rays, alpha or beta particles, x-rays, or neutrons, e.g., the effects of alpha and neutron radiation are more damaging to the human body than gamma radiation.

The dose equivalent is measured in rems (roentgen equivalent man) or 1/1000th of a rem (millirem or mrem). A rem for each type of radiation is equal to the absorbed dose (in rads) times a quality factor that reflects the fact that some types of radiation cause more damage than others [see "Units of Radiation Dose," 10 CFR § 20.1004]. The scientific community is shifting to use the nomenclature developed for the international system unit, so the term sievert (Sv) is often used.

1 rem = 0.01 sievert (Sv); 1 sievert (Sv) = 100 rem; 1 millisievert (mSv) = 0.1 rem or 100 mrem.
100 rem is equivalent to 1 Sv or 0.1 rem (or 100 mrem) equals 1 mSv.

Effective Dose is the tissue (organs) weighted sum of equivalent doses summed over all specified tissues and organs where each tissue is assigned its own tissue weighting factor (written as w_T). The tissue weighting factor is intended to represent the relative contribution of that tissue or organ to the total health detriment resulting from unform irradiation of the whole body.

Government Road Project for purposes of this Petition, means a road construction or repair project that is authorized by federal, state or local governments consistent with applicable Federal Highway or state Departments of Transportation (DOT) standards and specifications, including public works departments that have adopted the state DOT standards and specifications or developed such standards in consultation with state regulatory authorities (such as the Federal Highway Administration (FHWA) regulations and guidance, State Department of Transportation (DOT), American Association of State Highway (AASHTO), American Society for Testing and Materials (ASTM)) or other generally accepted specifications for road building.

Petition Maximum average radium (226) concentration limit: The Petition requests that EPA approve use of PG containing an average radium (226) concentration up to 35 pCi/g in road construction. The 3 in 10,000 risk level (EPA's safe level) corresponds to an average radium (226) concentration of 148 pCi/g. Thus, this proposed limit is presumptively safe.

The requested limit of 35 pCi/g is consistent with the 2019 stack sampling and with prior sampling conducted by EPA. Specifically, the broad sampling data demonstrates that PG taken from the stacks is not expected to exceed that limit. As background, the risk assessment used 27 pCi/g for its baseline evaluation (this correlates to the international standard of 1Bq) and extrapolated to reach conclusions for 35 Ci/g (see Nominal radium 226 concentration definition below). An average radium (226) concentration of 35 pCi/g for PG used in road construction materials accounts for potential variability (~30 percent) observed in past testing and during implementation of road construction.

Nominal radium (226) concentration: The radium (226) concentration level utilized in the underlying Risk Assessment filed with the petition (the Petition's Risk Assessment) is a nominal radium (226) concentration of 27 pCi /g. This particular nominal concentration was chosen so that the submission contained a calculated risk using RME, which corresponds to a "nominal" concentration of radium (226). Since the relationship of radium (226) concentration in PG to risk is proportional, the risk from using PG containing any other concentration of radium (226) in road construction can be calculated from the nominal concentration.

Radioactivity is a measure of the amount of gamma rays, alpha or beta particles, x-rays, or neutrons that disintegrate from a gram of the substance being measured (in our situation, in each gram of PG). The amount of radioactivity in a gram of a substance is measured in curies (Ci) or becquerels (Bq). One curie is 3.7×10^{10}

radioactive decays per second, roughly the amount of decays that occur in 1 gram of radium per second. A Becquerel is one disintegration per second. Historically, scientists originally used units of Ci. The International System of Units (ISU) now uses Bq.

A picocurie (pCi) is one-trillionth of a curie.
1 Bq = 2.70 x 10^{-11} curies = 0.027 pCi

Many substances (often naturally occurring substances) are radioactive. Generally, the sources for this explanation include EPA, *Radiation Terms and Units*, *available at* https://www.epa.gov/radiation/radiation-terms-and-units; NRC, *available at* https://www.nrc.gov; MIT News, *Explained: rad, rem, sieverts, becquerels A guide to terminology about radiation exposure*, *available at* http://news.mit.edu/2011/explained-radioactivity-0328; National Aeronautics and Space Administration, *Radiation Math*, *available at* https://www.nasa.gov.

Radium (226) concentration level that corresponds to 3 in 10,000 risk management level that EPA has designated as safe. The risk assessment performed for the Petition demonstrates that PG containing a radium (226) concentration of 148 pCi/g presents a risk of 3 in 10,000 (EPA's safe level).

Reasonable Maximum Exposure: An estimate of a conservative exposure case, well above the average case, that is still within the range of possible exposures.

Risk: The regulatory risk assessment process converts a dose equivalent (in mrem) into an upper bound risk (or probability) of developing fatal cancers. It is based on a regulatory assumption that the dose equivalent may cause harmful effects and as the magnitude of this dose increases or decreases, the risk increases or decreases, in direct proportion, respectively, i.e., linearly (e.g., if the dose is halved, the calculated risk is halved). The risk assessment performed for this Petition concludes that an effective dose of 600 millirem corresponds to a risk of 3 in 10,000 (i.e., if all of the protective assumptions are valid, 3 in 10,000 people may develop a fatal cancer). The actual risk is likely to be lower.

I. OVERVIEW

A. INTRODUCTION

Approximately 46 million tons of phosphogypsum (PG) is produced annually in the U.S. as a byproduct of the phosphate fertilizer production process.[1] For decades, the majority of PG has been placed in large engineered gypstacks, instead of using the material in various applications.

Internationally, PG is used in road construction, concrete and building material production, agriculture, mine restoration, marine applications and for daily landfill cover. Scientific studies completed in both the U.S. and internationally support these beneficial uses of PG. The studies demonstrate use of PG in numerous applications is protective of human health and the environment and, at least as protective of human health as storage of PG in a stack.

This Petition, submitted by The Fertilizer Institute[2] (TFI), requests approval for PG use in government road construction projects. The request is submitted pursuant to the United States Environmental Protection Agency's (EPA) rule governing the distribution and use of phosphogypsum for purposes other than disposal in a stack. See 40 CFR §61.206.[3] Under this provision, a request for a proposed use with supporting information[4] must be submitted to EPA. The request is followed by EPA review and a determination allowing or rejecting the proposed use. EPA may make a determination granting the request if the proposed use is at least as protective of public health, in the short and long term, as disposal in a stack. If EPA makes a determination approving the proposed use, specific information in connection with the projects conducted must be certified and maintained for five years. For example, each time PG is removed from the stack for the approved use, the stack owner/operator must certify the identity and location of the user, the quantity of PG provided, a description of the end use, and the average radium 226 concentration.

This Petition should be approved by EPA because:

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[1] Policy Navigation Group, Economic Analysis of Phosphogypsum Reuse, 12 (December 2019) (Prepared for TFI), based on weighted average PG production per stack.

[2] TFI is the leading voice of the fertilizer industry, acting as an advocate for fair regulation and legislation, a consistent source for trusted information and data, a networking agent, and an outlet to publicize industry initiatives in safety and environmental stewardship. The fertilizer industry contributes $155 billion to the nation's economy. TFI, available at https://www.tfi.org/policy-center/economic-impact. The fertilizer producers, wholesalers and retailers, along with the businesses that serve them, support nearly half a million U.S. jobs with total annual compensation of $36 billion. *Id.*

[3] EPA, National Emission Standards for Hazardous Air Pollutants; Radionuclides, 54 Fed. Reg. 51,654 (December 15, 1989) (1989 Rule).

[4] The supporting information includes: petitioner identity, description of the proposed use, street location and mailing address of the facility where use, handling or processing of PG occurs, quantity of PG to be used, average radium (226) concentration in PG that will be used, measures to prevent PG releases to the environment, risk associated with the proposed use, including ultimate disposition, management of unused PG, requestor signature.

- The risk of radiation exposure from use of PG in road construction is low, well within EPA's 3 in 10,000 lifetime cancer risk determined to be safe and well below natural background exposure levels.

- Demand for available, cost-effective road construction materials is high. This is particularly true where other materials widely used in road construction, such as coal ash, are anticipated to become scarce and more expensive due to new regulatory contraints on production and storage.[5] Radiation from PG is similar or less than other materials currently used in road construction.

- Use of PG in road construction has environmental and societal benefits, reducing the amount of material required to be stored in stacks (and potentially eliminating existing stacks over the longer term).

- There are other economic and societal benefits (discussed in more detail in Appendix 6).

B. BACKGROUND

PG is a byproduct of the phosphate fertilizer production process. At a typical U.S. facility, approximately five tons of PG are generated per ton of phosphoric acid produced. Prior to 1989, PG was used in various applications (including, among other uses, in the construction of roads and in agriculture).

NESHAP Regulations Governing PG. Thirty years ago, EPA restricted the use of PG based on the estimated risk from exposure to naturally occurring radioactive material (NORM) in the material. These restrictions are set forth in the regulations governing the management of PG in EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart R of title 40 of the Code of Federal Regulations. Subpart R requires that, with very limited exceptions for agricultural use and indoor research, PG must be placed in engineered above ground impoundments (commonly referred to as "gypstacks").[6]

With respect to the stacking exceptions, Section 61.206(a) allows removal of PG from stacks without prior approval[7] for: (i) outdoor agricultural use of PG containing an average radium-226 concentration not exceeding 10 picocuries per gram (pCi/g) (§61.204) and (ii) indoor research and development not to exceed 7,000 pounds (§61.205).[8] These uses are self-implementing; no

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[5] Texas Department of Transportation, Technical Advisory, Fly Ash Supply Update (updated 2019), *available at* http://ftp.dot.state.tx.us/pub/txdot/mtd/ta/fly_ash_condensed.pdf. Danny L. Gray, Decrease in Fly Ash Spurring Innovation Within Construction Materials Industry, Vol. 35, Issue 6, Special Issue: Annual Outlook Issue (Jan. 2019), *available at* https://onlinelibrary.wiley.com/doi/pdf/10.1002/gas.22099.

[6] 40 CFR §§ 61.200 - 201.

[7] EPA later approved placement of PG as landfill cover in a test cell to determine if PG can be used more broadly as a landfill cover. Letter from Jeffrey R. Holmstead, Assistant Administrator of the Office of Air and Radiation, to Michael Lloyd, Jr., Research Director Chemical Processing, Re: FIPR Petition (December 22, 2004) (Holmstead FIPR Letter).

[8] 40 CFR §§ 61.204 - 61.205.

additional authorization is required. However, the stack owner and the user must comply with specific reporting and record keeping requirements.[9]

Any other uses must first be approved by the EPA Assistant Administrator for Air and Radiation. Under Section 61.206(c), the request may be approved if the proposed use is determined to be at least as protective of public health, in both the short term and the long term, as disposal of PG in a stack.

Post-NESHAP Developments. Since the NESHAP was promulgated decades ago there have been a number of developments in various realms that support broader use of PG.

- **New Scientific Information**. New data are available on the average level of radioactivity in the PG. There is also a better understanding in the scientific community concerning radiation protection and management related to PG use. Studies have been completed in the U.S. and internationally supporting expanded beneficial use of residual material from manufacture of fertilizer; these studies demonstrate protectiveness of human health and the environment.

- **Risk Assessment and Policy Updates**. Risk assessment approaches have progressed based on experience, analytical advances, and evolving policies since the 1980s.

  For example, EPA's prior assessments of the risk from use of PG in road construction (e.g., in the 1989 regulations and the EPA 1992 Background Information Document) did not evaluate the potential radiation risk from every possible road design. Rather, EPA recognized that it is not necessary to calculate every potential exposure. It is appropriate and consistent with EPA policy to examine risk by utilizing a "reasonable maximum exposure" approach (RME). According to EPA, the RME is "a conservative exposure case, (i.e., well above the average case) that is still within the range of possible exposures."[10] EPA guidance states that the assessor may derive a high-end estimate of exposure by using maximum or near maximum values for one or more sensitive exposure

[9] 40 CFR §§ 61.206 – 209. Approvals under §61.206(b) require compliance with sampling procedures (§61.207), certification requirements (§61.208), and records rquirements (§61.209(c)), unless the Assistant Administrator decides to waive or modify the record keeping requirements.

[10] EPA, Risk Assessment Guidance for Superfund: Volume III - Part A, Process for Conducting Probabilistic Risk Assessment, EPA 540-R-02-002, 7-1 (2001), *available at* https://www.epa.gov/sites/production/files/2015-09/documents/rags3adt_complete.pdf. (EPA Risk Assessment Guidance for Superfund).

See also Interstate Technology Regulatory Council (ITRC), Decision Making at Contaminated Sites, Issues and Options in Human Health Risk Assessment, 6.1.1 (2015), *available at* https://www.itrcweb.org/risk-3/Default.htm#6.%20Exposure%20Assessment.htm#6.1__Determining_Appropriate_Exposure_Factors%3FTocPath%3D6.%2520Exposure%2520Assessment%7C6.1%2520%2520Determining%2520Appropriate%2520Exposure%2520Factors%2520%7C_____0 (ITRC, Decision Making at Contaminated Sites) (citing EPA Guidance, which states that "[t]he RME . . . can be defined as 'the maximum exposure that is reasonably expected to occur within a potentially exposed population'").

factors, leaving others at their mean value.[11] Therefore, RME is not the worst-case exposure and a worst-case exposure analysis was not required by EPA.

RME provides the exposure used to calculate the maximum individual risk (MIR). As long as the risk from RME does not exceed 3 in 10,000, the exposure is "safe" (see discussion of EPA's policy on the safe risk level for PG (Section IV, below)). By definition, if the risk from a RME exposure for construction workers, truck drivers, road users, and residents is below 3 in 10,000 and, therefore, safe, all other exposures to workers, truck drivers, road users, and residents present even less risk (and in many cases, the risk is much less than 3 in 10,000).

Additionally, there has been an increased awareness of product lifecycles and sustainability. Accordingly, current EPA policies encourage use and recovery of high-volume, low-risk waste. This includes increased emphasis on understanding product lifecycles and sustainability.

- **Regulatory.** It has become apparent that the current requirement to obtain regulatory approval for each and every application of a new use is unwieldy and slows the process of implementing new uses without providing additional protection of human health (i.e., use of updated scientific and risk assessment assumptions demonstrate that road use is safe). As a result, the past interpretations impede innovation and economic efficiencies. The fact that no PG use requests have been submitted in almost 30 years (except for a landfill cover test cell) illustrates this point.

- **Commercial Economics and International Use Precedents.** The economics of gypstacks have changed. The cost to stack and manage gypstacks has increased substantially beyond original expectations. These costs adversely affect the ability of the U.S. fertilizer industry to compete internationally, where PG may be used.

  PG is used in many countries outside the U.S. in agriculture, mine restoration, building materials, marine applications, daily landfill cover, and for road construction. More than a dozen beneficial uses have been analyzed worldwide, resulting in significant, successful PG use applications in at least 21 countries.[12]

- **Public Perception.** Perceptions of gypstacks have changed. EPA's 1989 final rule did not anticipate the range of public sentiment regarding the long term presence of gypstacks. Public pressure to cease this practice is growing.

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[11] EPA, Exposure Factors Handbook 2011 Edition (Final Report), EPA/600/R-09/052F (2011), *available at* https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252 (Exposure Factors Handbook).

[12] *See* Presetnation by The Fertilizer Institute, Beneficial Use of Phosphosgypsum (Sept.6, 2018). *Also see* B. Birky, J. Hilton, & AE J. Johnston, Phosphogypsum: Sustainable Management and Use, International Fertilizer Association, Chp 5, 52-63 (2016), *available at* https://www.fertilizer.org/ItemDetail?iProductCode=10012Hardcopy&Category=ENV (IFA Sustainable PG Management Report). This section reviews international and U.S. roads constructed with PG. Other chapters address other uses.

<u>Beneficial Use of PG in Government Road Projects</u>. Based on the developments and framework described above, TFI submits this Petition seeking approval of PG for use in government road projects.[13] The scope of this request is described below.

- **<u>Description</u>.** A paved road consists of a solid surface or top layer that is typically asphalt, concrete, or some other material or mixture approved for use as pavement. The road base is a supporting layer of material approximately 0.25 m thick beneath the surface/pavement and underlying the road base is the sub-grade (as shown in Figure 1). The proposal is for approval of use of PG as road base or surface pavement.

- **<u>Design</u>.** PG may be used as road base or surface pavement when mixed with other materials such as soil, sand or aggregate or in the surface pavement. This Petition requests approval for use of up to (i) 2.5% PG in surface pavement and (ii) 50% PG in road base. This mixture is based on a design of up to equal amounts of PG and soil in roadbed.[14] Using a ratio of 50% or less PG mix in road base, approximately 4000 tons of PG per lane-mile would be used in road base and less than 100 tons per lane-mile would be used in concrete pavement (Appendix 4a: Response to EPA Comments on January 16, 2020).

  These ratios are supported by prior technical evaluations. For example, various ratios of PG to soil were studied (from 100% sand to 100% PG) and all mixes had California Bearing Ratio values higher than sand or PG separately. Studies of the road containing PG in Polk County Florida found similar results (Appendix 4a: Response to EPA Comments on January 16, 2020).

- **<u>Exposure analysis</u>.** The road design features analyzed in the Petition (Appendix 2),[15] the Metals Screening Report (Appendix 3), and Response to EPA Comments on January 16, 2020 (Appendix 4a)) were determined to represent RME for all road designs, regardless of the size of the road. That is, the radioactivity levels emitted from the road in using these design assumptions were RME assumptions and did not exceed 3 in 10,000 (Appendix 4a). Thus, assuming the RME calculation is appropriate, the radioactivity exposure risk associated with all other road designs is less than 3 in 10,000, the EPA determined acceptable risk level.

  EPA's 1992 BID risk assessment approved the use of PG for agricultural soil amendments as safe.[16] The EPA 1992 BID risk assessment assumed biennial applications of PG over 100 years on agricultural soil (with the PG containing a radium

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[13] The Petition for PG use in road construction covers only paved roads that meet the definition of "Government Road Project" included in this Petition. Unpaved roads have not been evaluated and are not within the request.

[14] This is an upper bound because industry practice recommends similar ratios or less and EPA's 1992 risk assessment used 33.3 percent PG to 66.6 percent soil (see Appendix 2).

[15] EPA, Potential Uses of Phosphogypsum and Associated Risks, Background Information Document, 402 R92 002, 4 26 4 35 (May 1992), *available at* https://www.epa.gov/sites/production/files/2015-07/documents/0000055v.pdf (EPA 1992 BID).

[16] *Id*. at 4-26.

(226) concentration of 10 pCi/g) and no cover.[17] EPA assumed that approximately 2,700 pounds of PG per acre is "spread over a field and diluted by mixing with the soil." [18]

Unlike PG in agricultural use, PG used in road base is mixed with soil (50% PG and 50% soil), application is one-time and not repeated, and there is no cumulative concentration of radium (226).

In each case, the risk is based on the exposure assumptions utilized. The radiation dose (and, therefore the risk) is a function of the average radium (226) in the road base (or cement), not the volume of PG used in a road application.

Figure 1 provides a conceptual view; municipal roads can vary in width and structure.

- **PG Users.** This Petition requests approval to use PG in ***government*** road construction projects. Thus, the authorized users of the PG would include federal, state and local Departments of Transportation (DOT) or Public Works (PW), and their contractors. Only these governmental agencies are authorized to commission governmental roadways.

- **Project Locations.** Given transportation costs, government PG road construction projects are expected to be located in states that are in sufficient proximity to the PG stacks (i.e., Florida, Georgia, North Carolina, Idaho, Louisiana) to make PG use economically viable. Appendix 7 provides the location of the PG stacks associated with TFI member operations.

- **Project Specifications.** TFI reviewed how similar materials used in road construction are managed to determine how PG would be handled, transported, stored and used in federal, state or local government road projects. PG would not be the first byproduct to be used in road construction (see below). Nor would it be the first byproduct for which road construction specifications were developed to substitute the use of a byproduct for other road building material. Government (particularly State) DOTs have considerable experience in this regard.

While there are distinctions between PG and coal ash, the regulation of coal ash by the states is analogous because the materials are excluded from federal regulation under the RCRA Bevill amendment (42 U.S.C. § 6921(b)(3)(A), Resource Recovery and Conservation Act § 3001(b)(3)(A)). Currently, according to EPA:

> [S]tate environmental agencies are primarily responsible for regulating beneficial use [of coal ash, because the] use of coal combustion residuals is currently excluded from federal regulation under EPA's May 2000 regulatory determination that the Bevill amendment applies to such uses. [and] [t]he April 2015 final … [coal combustion] disposal rule reaffirm[ed] EPA's Bevill determination.[19]

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[17] *Id.*at 4-5 - 4-6.

[18] *Id*. at 4-5.

[19] EPA, Coal Ash Reuse, How is the Beneficial Use of Coal Ash Currently Regulated? (last updated July 15, 2019), *available at* https://www.epa.gov/coalash/coal-ash-reuse. Tecnically, the Bevill amendment applies to the type of

Analogously, the use of PG is regulated by the Clean Air Act NESHAP regulatory program based on the radioactivity in PG, but otherwise is excluded from federal regulation under the RCRA Bevill amendment.

Government road projects are constructed in accordance with overarching Federal Highway Administration (FHWA) regulations and guidance, under the direct supervision of state Department of Transportation (DOT) requirements. "Because roadway location and design decisions affect the development of adjacent areas, it is important that environmental variables be given full consideration."[20] These specifications dictate how various materials may be used, based on strength and stiffness considerations, permeability, and stability, among other factors. [21] The FHWA released guidelines for use of coal fly ash and other materials (e.g., kiln dusts) in asphalt concrete, Portland cement concrete, stabilized base, flowable fill, and embankment or fill.[22]

Specifications are designed using various materials testing methods developed by these professional organizations, such as AASHTO and ASTM. Thus, since the RME were selected based on the road construction project meeting these design criteria, the risk assessment represents RME.

<u>State Regulatory Programs</u>. In addition to EPA's NESHAP determination, use of PG in road construction will be subject to state regulation and oversight. State regulatory programs developed for managing use of industrial by-products will apply as will state specifications for road construction.

For example, the Florida Department of Transportation's Standard Specifications For Road and Bridge Construction state that roads must: (a) "[p]rovide erosion control measures where work is accomplished in conjunction with the project, to prevent erosion, pollution of water, detrimental effects to public or private property adjacent to the project right-of-way and damage to work on the project;" (b) "not drive in, operate, or place construction equipment or materials in surface waters, wetlands, groundwater, or property beyond the project limits without permitted

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waste, not just to the use. The quote describes EPA's application of the Bevill amendment in this particular use. From a broader perspective, it highlights the fact that state regulators have jurisdiction over many types of waste.

[20] Association of State Highway and Transportation Officials (AASHTO), A Policy on Geometric Design of Highways and Streets, 7th Ed., 2-95 (2018), *available at* https://store.transportation.org/item/collectiondetail/180?AspxAutoDetectCookieSupport=1 (The Green Book) (an online guidance that is over 1,000 pages). AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments and a leader in setting technical standards for design, construction of highways and bridges, materials, and many other technical areas. Consideration of impacts on the environment are explicitly required to be considered. *Id*. at 1-2.

[21] *See* Federal Highway Administration, Tech Brief, Bases and Subbases for Concrete Pavements (revised), FHWA-HIF-16-005 (August 2017), *available at* https://www.fhwa.dot.gov/pavement/concrete/pubs/hif16005.pdf.

[22] Federal Highway Administration, User Guidelines for Waste and Byproduct Materials in Pavement Construction, Coal Fly Ash, FHWA-RD-97-148, *available at* https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/97148/016.cfm.

authority for permanent or temporary impacts;" and (c) "not allow water that does not meet state water quality standards or does not meet the permitted criteria to exit the project limits."[23]

There are specifications for and policies encouraging the use of fly ash, slag, and/or other recycled material in roadways in Florida, North Carolina, Louisiana, and Idaho, among other states.[24] In Florida, industrial by-products are defined as:

> Materials that have a demonstrated recycling potential, can be feasibly recycled, and have been diverted or removed from the solid waste stream for sale, use, or reuse. The term does not include any materials that are defined as recovered materials, a mixed waste stream that is processed to removed recyclable materials; or materials the recycling or use of which is specifically addressed in [FDEP] rules, such as construction and demolition debris, ash residue, waste tires, used oil, and compost. Fla. Admin. Code 62-701.200(51).

Industrial by-products are regulated as solid waste unless otherwise exempted under Fla. Admin Code 62-701.200(51).

Florida is required to:

> Encourage recycling and resource recovery as a source of energy and materials. Fla. Stat. §403.704(6);

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[23] Florida Department of Transportation, Standard Specifications For Road and Bridge Construction, 131 (July 2020), *available at* https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/implemented/specbooks/jul2020/7-20ebook.pdf?sfvrsn=c1f3424e_4 (Florida Spec Book).

[24] See for example: Florida, Department of Transportation, State Materials Office, Frequently Asked Questions, *available at* https://www.fdot.gov/materials/administration/resources/library/issues-trends/recycling-faqs.shtm.

North Carolina Department Of Transportation Raleigh, Standard Specifications For Roads and Structures, 10-1 (slag), 1-43 (recycled) (2018), *available at* https://connect.ncdot.gov/resources/Specifications/StandSpecLibrary/2018%20Standard%20Specifications%20for%20Roads%20and%20Structures.pdf (North Carolina Spec Book).

Louisiana Department of Transportation & Development, Louisiana Standard Specifications For Roads And Bridges, 152, 200, 392, 965 (2016), *available at* http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Engineering/Standard_Specifications/Standard%20Specifications/2016%20Standard%20Specifications%20for%20Roads%20and%20Bridges%20Manual/00%20-%202016%20-%20Standard%20Specification%20(complete%20manual).pdf.

Idaho Transportation Department, 2018 Standard Specifications for Highway Construction (2018), *available at* https://apps.itd.idaho.gov/apps/manuals/SpecBook/SpecBook18.pdf.

This wide spread development by the states of specifications for the use of various recycled material is strongly encouraged by the federal government. Federal Highway Administration, Recycled Roadways, FHWA-HRT-05-003 (Jan/Feb 2005), *available at* https://www.fhwa.dot.gov/publications/publicroads/05jan/02.cfm.

Similarly, see AASHTO, Center for Environmental Excellence, The Growing Need for and Importance of Waste Minimization and Recycling, subchp. 3.12.1, (last updated 2005), *available at* https://environment.transportation.org/environmental_issues/construct_maint_prac/compendium/manual/3_12.aspx.

> Provide technical assistance to counties, municipalities, and other persons, and cooperate with appropriate federal agencies or private organizations in carrying out this Act. Fla. Stat. §403.704(2); and
>
> Assist in and encourage, as much as possible, the development within the state of industries and commercial enterprises which are based on resource recovery, recycling, and reuse of solid waste. Fla. Stat. §403.704(7).[25]

Further, the Florida DOT is required to encourage the use of products and materials with recycled content in its road construction programs and to continually update its bid procedures and specifications to encourage the use of such products and materials, *see* Fla. Stat. §336.044(4). Therefore, once EPA authorizes use of PG in road construction, the Florida DOT will have a clear path under Florida law to consider whether its existing road specifications are adequate or if any modifications are warranted.

Similarly, North Carolina has design specification guidance.[26] Notably, North Carolina includes a policy "to aid in reduction of materials that become a part of our solid waste stream."[27]

In Idaho, using fly ash as an example, materials may be used only if provided by manufacturers approved by the state's Quality Assurance Program (QAP). Manufacturers not approved under the certification program require pre-approval before use.[28] The QAP mandates sampling be conducted by accredited labs, among other requirements. Idaho has recently passed a law that requires the development of a regulatory program for PG use.[29]

Louisiana's Solid Waste Management and Resource Recovery Law directs maximum practicable use of resource recovery procedures. [30] The Louisiana Solid Waste Regulations include Section 1105: Beneficial Use of Other Solid Wastes which allows owners of waste streams to request that the waste be designated for an approved beneficial use. The application process specifies much of the same information required under the NESHAP regulation 40 CFR 61.206(b), and indicates that, at least in Louisiana, prior to any use of PG in road construction, the state may be required to make a determination similar to EPA, including approval of a handling and storage plan. [31]

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[25] Fla. Stat. § 403.704.

[26] North Carolina Spec Book, *supra* note 24.

[27] *Id*. at 1-43, Section 104-13.

[28] Idaho Transportation Department, Quality Assurance Manual, §230.02.02 (2019), *available at* https://apps.itd.idaho.gov/Apps/manuals/ManualsOnline.html.

[29] H.B. 367, 65th Leg., 2d Reg. Sess. (Idaho 2020) (signed by Gov. on Mar. 9, 2020, Sess. Law Chp. 51, eff. Jul. 1, 2020).

[30] Louisiana Solid Waste Management and Resource Recovery Law, La. Rev. Stat. § 30:2154(1).

[31] La. Admin. Code 33:VII:1:1105.

The existence of these stringent state regulatory programs coupled with the need for a specific DOT specification for PG use in roadbuilding provide additional assurances that EPA's approval of PG use in road construction will ensure responsible handling and management of PG in road construction. Therefore, once EPA authorizes use of PG in road construction, the states will be able to make informed choices as to the most appropriate and cost-effective road construction material, while still ensuring the protection of the environment.

Public Health and Environmental Evaluation. The Petition is accompanied by a Radiological Risk Assessment (Appendix 2) and a Human Health Risk Screening for Metals and Metalloids (Appendix 3). The scope and approach to these analyses were developed based on the EPA PG Workbook, prior petitions, and a series of working meetings with EPA staff that provided the benefit of EPA input and direction on key elements of the analysis.

To assist in this evaluation, TFI members measured the radioactivity level in the PG from stacks.[32] Results reflect that average radiation levels from the composite samples taken from stacks do not exceed: (a) the nominal radium (226) concentration used in the risk analysis (i.e., 27 pCi/g) and (b) more importantly, the 148 pCi/g radium (226) concentration corresponds to the 3 in 10,000 risk management level that EPA has designated as safe (see Sections II(B), III(G), V, V(D)(3,4), below).

Key points of the Radiological Risk Assessment are provided in Attachment B. In summary, this assessment demonstrates that PG can be used safely for road construction for the following reasons:

Use of Reasonable Maximum Exposures (RME) Ensures Risk is Less than 3 in 10,000

All RMEs resulting from use of PG in road construction correspond to a risk of less than the 3 in 10,000 lifetime cancer risk (the risk level that EPA has determined to be safe for alternative PG uses and well below natural background exposure (see Summary Table 1, below, and the Petition's Risk Assessment summarizing the risks from each of the five exposure scenarios calculated for this Petition)). EPA staff clarified interest in more risk distribution information on how the risk varied with the "variation of the geometry of exposure" and with different exposure time frames (Appendix 4a: Response to EPA comments on January 16, 2020). The risk distribution is similar in each scenario with the the highest risk associated with the RME exposure scenario. Most actual exposures are less than those received by the RME and hence the associated risk would also be lower (Appendix 4a: Response to the EPA Question on January 16, 2020). For example, the risk is lower for workers who are not exposed for the same duration or as directly as the RME scenarios. The analysis also shows that the risks for the residential RME scenario are much lower than for the construction worker, truck driver, and road user. In each case, most of the exposed population have a dose that is lower than the RME dose (see Appendix 4a: Response to EPA Comments on January 16, 2020).

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[32] A summary of this data was provided to EPA to support this Petition in a separate report, along with the location and address of each facility (Appendix 5).

Table 1: Dose, Risk, and Background Summary for All RME Scenarios

Receptor	CSM	Exposure Duration (years)	Exposure Dose (mrem)	Estimated Cancer Risk	Background Dose from Exposure Duration (mrem)	Exposure Dose Percentage of Background Dose (%)
Reasonable Maximum Exposure Scenarios						
Road Construction Worker	PG in Road Base	5	110	0.5 in 10,000	1550	7%
Road User (Motorist/Bicyclist)	PG in Road Base & Surface	26	28	0.1 in 10,000	8060	0.3%
Truck Driver	PG-containing material for Road Base	5	93	0.5 in 10,000	1550	6%
Nearby Resident	PG in Road Base & Surface	26	16	0.08 in 10,000	8060	0.2%
Utility Worker	PG in Road Base	1	0.8	0.004 in 10,000	310	0.3%
		EPA Cancer Risk Management Goal	600	3 in 10,000	600	

Estimated cancer risk below this goal.

- The highest risk in the Petition's Risk Assessment was for the RME construction worker scenario --- 0.5 in 10,000 and the RME worker dose is 7% of the background dose for a worker at a road construction site not using PG (see Table 1, above, summarizing the risks from all exposure scenarios).

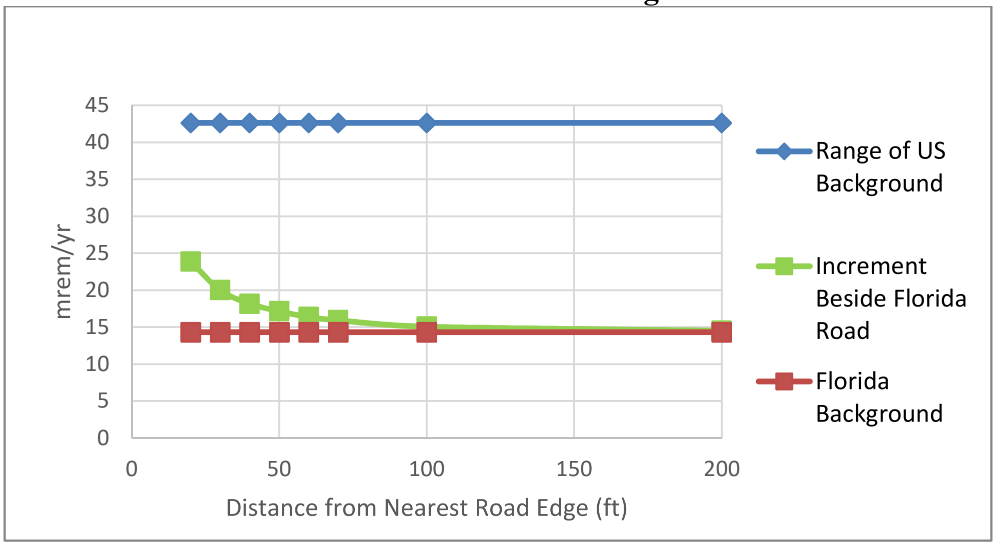
- The Response to the EPA Comments on January 16, 2020 expanded on the Risk Assessment by evaluating the uncertainty in each of these exposure scenarios and finding no significant increase even using the assumptions postulated in the EPA comments. In any case, the postulated assumptions were in excess of the RME and did not warrant a change in the risks in the Petition's Risk Assessment.

<u>Risk Distribution Issues</u>

Most of the exposed populations have a dose that is lower than the dose of the RME individual. For example, most road construction workers are exposed to a dose of less than 110 mrem, thus the risk is lower than 0.5 in 10,000 (still assuming that the radium (226) concentration is 27 pCi/g).

Residents directly adjacent to the road (the RME individual) are calculated to have a risk of 0.08 in 10,000, which is much lower than the RME construction worker. Additionally, the dose (16 mrem) is only 0.2% of the background radiation dose of the resident adjacent to a road not using PG. Thus, the incremental risk above background from a road containing PG is very low. Dose (and, therefore, risk) decreases substantially as distance from the edge of the PG road increases (see Figure 2 below). As a result, residents whose houses are not adjacent to the PG road have essentially no incremental dose and risk.

Figure 2: Incremental External Gamma Dose with Distance Compared to Terrestrial Background



(From Response to EPA Questions on January 16, 2020)

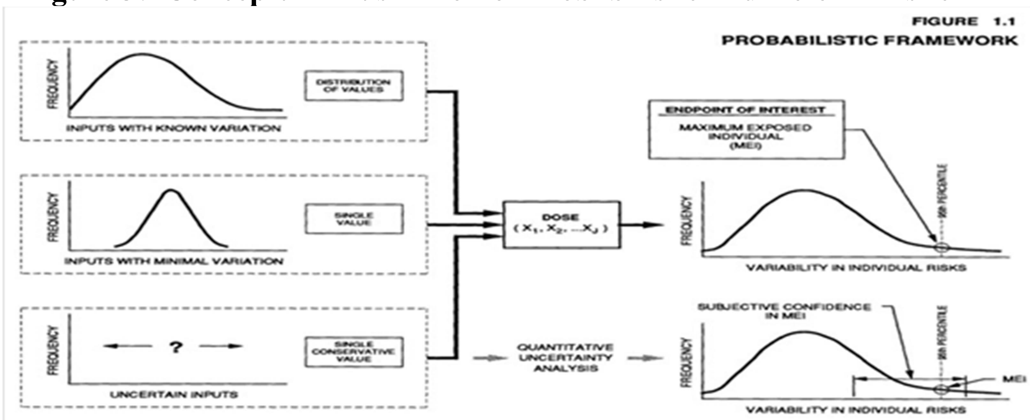
N.B.: All natural background (as used in Table 1 is higher than the Terresterial background utilized in this Figure).

<u>Uncertainties in RME Selection, Design and Average Radium (226) Concentrations</u>

The Petitioner's Risk Assessment and the Arcadis Response to EPA Comments on January 16, 2020 (Appendix 4a) compile and discuss in more detail the potential uncertainties in the risk assessment and the justification for the RMEs. For example, the design criteria used in the risk assessment were set at RME. The process of selecting the RMEs for this Petition was performed after evaluation of the road construction process and extensive pre-petition dialogue with EPA staff.

For example, TFI's consultant intentionally chose (and EPA staff tentatively accepted) a deterministic approach. A full probabilistic approach is resource intensive, but in this situation use of a reasonable maximum exposure (RME) and an explanation of the risk distribution achieves the same goal as a probabilistic approach (see Appendix 4a: Response to EPA Comments on January 16, 2020). The RME is one point on a probabilistic distribution (see conceptual figure provided below, Figure 3, which uses 90th percentile to illustrate the concept). EPA guidance does not dictate a particular percentile as an RME, e.g., the RME for the duration of living at home is 90th percentile, but some EPA risk assessments utilize lower percentiles depending upon the facts.

Figure 3: Conceptual Illustration of Probabilistic and Deterministic Frameworks



(This conceptual figure uses a 95th percentile to illustrate a high end exposure. But as noted in EPA guidance the assessor may derive a high-end estimate of exposure by using maximum or near maximum values for one or more sensitive exposure factors, leaving others at their mean value.)[33]

The Response to EPA Comments on January 16, 2020[34] describes in more detail the substantive rationale for the RME selections and the impact of variations in design factors.

For example, the Petitioner's Risk Assessment used a distance of 50 ft between roads and homes.[35] According to the Federal Highway Administration, the "new Interstate road needs a right-of-way width of 150 to 300 feet or more; a generation ago, roadbuilders could get by with 50 or 75 feet."[36] The larger the right of way, the lower the radiation level to residents.

Also, the Petition's Risk Assessment calculated the risk based on a road bed containing 50% PG and 50% soil. A 50:50 mixture of PG and local construction materials:

> "[I]s likely to be an overestimate of the actual mix. The EPA for example in their 1992 BID used a 1:2 mix of PG:sand. This is also the ratio in the Polk and Columbia county roads constructed by FIPR with input on the design and testing of the roads from the University of Miami and the Bureau of Materials & Research, the Florida Department of Transportation. This ratio is less than the ratio of two parts PG to one part soil utilized in EPA's 1992 BID risk assessment."[37]

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[33] Exposure Factors Handbook, *supra* note 11.

[34] Appendix 2 to this Petition is the same as the Petition's Risk Assessment (Petition's Risk Assessment). Appendix 4a addresses questions EPA raised concerning the original risk assessment (Response to EPA Comments on January 16, 2020).

[35] Petition's Risk Assessment at 3-2.

[36] Federal Highway Administration, Highway History, The Size of the Job, *available at* https://www.fhwa.dot.gov/infrastructure/50size.cfm.

[37] Petition's Risk Assessment, *supra* note 34, at 2-5 n. 9 and Response to EPA Comments on January 16, 2020, *supra* note 34, see answer to EPA question 5.

Thus, EPA and other precedent accepts a 50-50 ratio as a RME. If the specific design for a particular road contains less than 50% PG then the risk is lower than the risk from RME.

Similarly, the concentration of radionuclides in concrete paving was assumed to be 2.25% PG, based on PG 15% by weight in cement and cement 15% by weight in concrete which is the same assumption utilized in the EPA 1992 BID risk assessment.[38] As a practical matter, the literature on the use of normal "gypsum" supports an upper limit of 15%.[39] If less than 15% PG is used, the average PG in the cement is less than 2.25% PG in surface pavement and the risk is lower than calculated in the Risk Assessment. Consistent with EPA policy, 50% PG for road base and 2.25% for surface pavement are appropriate RMEs. Also evaluated are the inevitable relatively slight variations in the risk potentially due to slight variations in the implementation of a 1 to 1 ratio of PG to soil in the road bed design standard (e.g., if the ratio 1.2 to 0.8 instead of 1 to 1) and the 2.25% PG in road surface design standard (e.g., if percentage of PG in the road surface is 2.7% instead of 2.25%). These variations in the input into the Risk Assessment do not significantly increase the risk. As noted above, various ratios of PG to soil were studied (from 100% sand to 100% PG) and all mixes had California Bearing Ratio values higher than sand or PG separately. See generally Appendix 4a.

As demonstrated in Appendix 4a, most of the other design features do not increase the level of radioactive emissions from the road. For example, the dose to a local resident adjacent to the road does not increase if the road has eight lanes or two lanes.

The data on the concentration of Radium-226 in the stacks (see summary above and more detailed discussions below in this Petition and in Appendix 5) are all well below the nominal concentration used in the risk assessment, therefore, the actual risk from PG use is likely to be well below the risk calculated in the Petition's Risk Assessment.

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[38] Petition's Risk Assessment, *supra* note 34, at 2-5.

[39] Since PG cannot be used in road construction in the U.S., the literature on PG is limited. However, the literature on the percentage of gypsum used in cement suggests that 15% is a reasonable number. For example, the "optimum addition of gypsum for Atbara clinker would be in the range of 3% to 5%." Amin Abdelrahman & Mohamad H. Aboud, Determination of Optimum Quantity of Raw Gypsum Addition for Atbara Cement Clinker, Khartoum University, 5, *available at* http://www.jeaconf.org/UploadedFiles/Document/82d8a051-43ad-44fa-ab1d-1ac182000608.pdf.

Similarly, the gypsum content of 5% in the composition of cement is referenced. *Available at* https://www.engr.psu.edu/ce/courses/ce584/concrete/library/construction/curing/composition%20of%20cement.htm.

Further, another article cites the use of 3% to 5% gypsum in cement. Karen L. Scrivener, Vanderley M. John, & Ellis M. Gartner, Eco-efficient cements: Potential economically viable solutions for a low-CO2 cement-based materials industry, Cement and Concrete Research. Vol. 114, 2-26 (Dec. 2018), *available at* https://www.sciencedirect.com/science/article/pii/S0008884618301480?via%3Dihub.

There is a significant reduction in the split tensile strength at 15% phosphogypsum content. Thus the optimum amount of phosphogypsum in concrete is found to be 10%. Kuriakose Reju & P.K. Shaji, Effect Of Calcined Phosphogypsum In Portland Pozzolana Cement Concrete, International Research Journal of Engineering and Technology (IRJET) Vol. 05, Issue: 04, 2008 (Apr. 2018), *available at* https://pdfs.semanticscholar.org/d7cc/03c3de65ca412971fff244b37098d479d4ab.pdf.

All of the risk values in Table 1, above, are based on the RME assumptions and the assumption that the average radium (226) concentration in this PG is 27 pCi/g. The use of a radium (226) concentration of 27 pCi/g was chosen so that the submission contained a calculated risk which corresponds to a "nominal" concentration of radium (226).[40] Since the relationship of radium (226) concentration in PG to risk is proportional, the risk from using PG containing any other concentration of radium (226) in road construction can be calculated from the nominal concentration. Thus, a concentration of radium (226) in PG of 35 pCi/g (the radium (226) concentration proposed in the Second Revised Petition as the radium (226) concentration limit on PG used in road construction) can easily be calculated to be 0.65 in 10,000 (well below the risk management level used in the PG use guidance of 3 in 10,000). Conversely, the risk of 3 in 10,000 (EPA's safe risk level) corresponds to a radium (226) concentration in the order of 148 pCi/g (see this section and Sections III(G), V, V(D)(3,4), below). The discussion of the rationale for selecting a radium (226) concentration limit of 35 pCi/g is explained below

The use of 27 pCi/g is a reasonable value for the "nominal" radium (226) concentration given historic sampling of U.S. PG stacks and the average radium (226) concentrations utilized in the 1992 EPA BID risk assessment. However, TFI members sampled nine stacks located in four states in 2019.[41] The average radium (226) concentration of all 90 samples was 18.6 pCi/g with individual samples ranging from 6.3 pCi/g to 27.9 pCi/g.[42] The average concentration of radium (226) per PG stack ranged from 7.44 to 24.7 pCi/g (which is relevant because the PG for road construction use is likely to be from an individual stack). Within each stack sampled, the ratio of the highest to lowest measured concentration ranged from 1.2 to 3.7 pCi/g. These recent data found average stack radium (226) concentrations are well below the nominal concentration of 27 pCi/g used in the Petition's Risk Assessment, the 35 pCi/g concentration limit proposed in the Petition as the limit in the PG used in road construction, and significantly below the 148 pC/g corresponding to the 3 in 10,000 safe risk level.

If the average concentration of radium (226) per PG stack measured by TFI members (i.e., 4.77 to 24.7 pCi/g) is utilized in the risk assessment, the RME construction worker's risk from the PG used in road construction work ranges from about 0.09 in 10,000 to 0.5 in 10,000. Similarly, the risk to nearby residents directly adjacent to the road (the RME individual) is approximately 0.01 in 10,000 (1.4 in one million) to 0.7 in 10,000.

Given the range of individual concentrations in the historic and recent sampling of PG stacks and the variation within the stacks between the highest and lowest radium (226) concentration, it is exceedingly unlikely that the average concentration of radium (226) in any stack would be close to 148 pC/g. Thus, variations in radium (226) will not significantly increase the risk and, in any case, the PG limit is 35 pCi/g, well below the 3 in 10,000 safe risk level. Thus, EPA could approve use of PG from stacks without any sampling.

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[40] An average of 35 pCi/g also represents the highest average level identified in prior testing by EPA. To account for some potential variability (~30 percent) that has been observed in past testing, the relief sought in this petition seeks approval to use PG containing radioactivity levels of up to an average of 35 pCi/g in road construction materials.

[41] TFI, Supplement to the October 11, 2019 TFI Phosphogypsum Reuse Petition: 2019 Radium-226 Results for U.S. Phosphogympsum Stacks,1 (December 5, 2019) (TFI 2019 Sampling). Further discussion of this new data is provided below.

[42] *Id*. at 1.

The proposal in the 2019 Petition and this Second Revised Petition proposes annual sampling to provide continuing documentation that each shipment does not contain PG with an average radium (226) concentration above 35 pCi/g. The reasons for this suggested limit are as follows. First, a radium (226) concentration of 35 pCi/g is well below the radium (226) concentration of 148 pCi/g that corresponds to the 3 in 10,000 risk level (EPA's "safe" level). Thus, a maxium average concentration of radium (226) of 35 pCi/g is "safe." Second, TFI recognizes that EPA historically has utilized this regulatory approach so the likelihood of approval of the Revised Petition will be enhanced if the approval uses a maximum radium (226) concentration. Third, the requested limit of an average radium (226) of 35 pCi/g represents the highest average level identified in prior testing by EPA. Thus, this approach will make implementation more efficient. Fourth, an average radium (226) concentration of 35 pCi/g for PG used in road construction materials will account for some potential variability (~30 percent) that has been observed in past testing and during implementation of road construction. Finally, as more data is gathered over time during the implementation of this new use, TFI reserves to right to request EPA modify its approval to include a more efficient implementation approach.

The Response to the EPA Comments on January 16, 2020 performed a series of additional evaluations of the impact from the uncertainty in each of the exposure scenarios and found no significant increase in total risk, even when using the assumptions postulated in the EPA comments. In any case, the postulated assumptions are all less conservative than the RME scenario and did not warrant a change in the risks in the Petition's Risk Assessment.

Thus, consistent with the regulations governing EPA's approval of PG uses, the use of PG in road construction is safe and at least as protective as placement of phosphogypsum in a stack.

Table 2, below provides a summary of comments on risk distributions by exposure pathway. The table explains the limited applicability of the RME scenario and the potential for lower exposures and doses to occur for a broader population (taken from the Response to EPA Comments on January 16, 2020).

TABLE 2: SUMMARY OF RISK DISTRIBUTION FROM USE OF PG IN ROAD CONSTRUCTION

Exposure Scenarios	RME (small number of people)	Potential Lower Exposures and Risk Distribution
Road Construction Worker	Risk: 0.5 in 10,000 Few if any workers would fit the RME assumption of 100% of workdays on the uncovered road base. The RME worker is exposed to less than 7% of background levels (for all members of the public).	Much less than 0.5 in 10,000 Most workers are expected to spend less than 100% of the workday on the uncovered road base. Dose and risk reduce linearly with reduced exposure time. Time on a covered road base was shown in the Risk Assessment to be a factor of 5 lower. The dose would range down to essentially zero for management and supervision who would spend very limited time on the road and out of vehicles. The number of workers in a road crew is estimated to be as small as 6 – 8 workers, which limits the risk distribution to a small group.
Road User	Risk: 0.1 in 10,000	Well below 0.1 in 10,000

TABLE 2: SUMMARY OF RISK DISTRIBUTION FROM USE OF PG IN ROAD CONSTRUCTION		
	This RME is assumed to be a heavy user of the road spending 2 hours daily on the road. This scenario is unlikely to occur until far into the future if PG roads become widely available. Until then it is unlikely a commuter would be able to spend this amount of time on a PG road. In the extreme case, the RME road user is exposed to less than 0.3% of background.	Most road users will be on the road for much less than two hours per day. Dose and risk reduce linearly with reduced exposure time. Initially when PG use in roads is newly implemented the availability of PG roads will be low reducing the opportunity to have substantive usage time. As the total amount of PG roads increase the risk distribution would increase with additional road users and cumulative usage time. The overall risk to an individual however, is not expected to exceed the RME estimates. Most road users would still have limited time on PG roads and this results in a proportionally limited dose and risk. The overall number of road users is difficult to specify as it depends on several factors including the road type and location relative to populated areas. However, the dose to road users would remain a small fraction of that from unavoidable background radiation.
Truck Driver	Risk: 0.5 in 10,000 The Truck Driver RME is limited to workers who participate in PG road construction projects. The assumptions for this scenario are set to estimate the upper end of likely dose and risk for this work. The RME Truck Driver is exposed to less than 6% of background levels.	A truck driver that has less than an RME exposure has lower risk than 0.5 in 10,000. There are a limited number of truck drivers involved in a road construction project. In addition, truck drivers will support numerous construction projects during the course of a year and many not involving use of PG. This limits the risk distribution for this exposure pathway to a relatively small number of people. In many cases, Truck Drivers will not work on PG road construction as much as assumed for the RME, resulting in a lower dose and risk.
Nearby Resident	Risk: 0.08 in 10,000 The Nearby Resident RME is based on extreme assumptions that are unlikely to apply to all residents of a PG road. The assumptions include close exposure to the road and long durations of residency throughout the exposure period. Based on these assumptions the Nearby Resident RME is exposed to 0.2% of background levels.	Most residents near a PG road would be exposed to much lower doses and risk, well below 0.08 in 10,000. Radiation levels from a PG road decrease rapidly with distance from the road and become indistinguishable from background at 50' to 100'. As a result, most residents immediately beside a PG road would be exposed to much less than the RME risk level, and residents beyond the immediately adjacent properties would experience essentially zero incremental risk. The overall risk distribution would depend on the overall length of the PG road and population density along the road but is limited to only those locations immediately beside the PG road.
Utility Worker	Risk: 0.004 in 10,000 The Utility Worker RME scenario represents an extreme case where a worker needs to disrupt the road for	Most Utility Workers would be exposed to risk much less than 0.004 in 10,000. Most utility repair requirements would involve exposure scenarios below those assumed for the RME conditions,

TABLE 2: SUMMARY OF RISK DISTRIBUTION FROM USE OF PG IN ROAD CONSTRUCTION		
	road or utility maintenance. The assumptions use worst case conditions to estimate the risks and are limited to workers in a trench in a PG road and meeting the other exposure assumptions. The RME Utility Worker is exposed to approximately 0.3% of background levels.	due to smaller trenches and exposure areas, or shorter durations. The number of individuals entering a trench in a PG road is also limited based on the uniqueness of the work and the limited space. As a result, the risk distribution for the Utility Worker is limited to a small number of individuals.
Reclaimer Extreme Scenario	Reclaimer is an extreme scenario well beyond an RME assumption and therefore, is not appropriate to determine whether the use of PG is safe. This example for ultimate disposal was selected due to the use by EPA in 1992. Risk: 0.4 in 10,000 The Reclaimer would be exposed to approximately 1% of background levels. (total exposure of 78 mrem compared to a Background of 8,060 mrem over 26 years)	The Reclaimer scenario represents an extreme situation that is unlikely to even occur as described (Appendix 4b: Responses to Second Set of USEPA Questions - Reclaimer). As a result, the risk distribution is effectively zero. More realistic situations for the ultimate disposal of the road include continued use of the road as a road, or reuse of the PG road base for a new road, if the road was to be relocated or realigned. In the extreme case where a road is abandoned and then the land is reused for other purposes, the land preparation activities will realistically result in blending and mixing of the road base to levels that are indistinguishable from background levels. Overall, the risk distribution would be effectively zero.

In summary, the risk distribution from road construction is negligible, beyond the individuals who are on or immediately beside the road, as assessed in the Risk Assessment document. Thus, consistent with the regulations governing EPA's approval of beneficial uses, the use of PG in road construction is safe and at least as protective as placement of phosphogypsum in a stack. [43]

II. PETITION REQUEST AND LEGAL REVIEW PROCESS

A. Specific Relief Sought

This Petition requests the following:

[43] EPA's "assessment of the maximum individual lifetime risk of fatal cancer from radon emissions from stacks" was "less than three in ten thousand (3 x 10-4) to the maximally exposed individual." EPA, Applying to EPA for Approval of Other Uses of Phosphogypsum: Preparing and Submitting a Complete Petition Under 40 CFR 61.206: A Workbook, 5 (2005), *available at* https://www.epa.gov/sites/production/files/2015-05/documents/wrkbk_sub-r_appl_1105.pdf (EPA PG Workbook).

Therefore, "the risk assessment must demonstrate that the proposed other use will not cause a threat to the public or environment greater than if the phosphogypsum were left in the stack. This means that the risk assessment must show that the chance of developing a fatal cancer in people who are exposed to phosphogypsum as a result of the use for which you are applying must not be more than three in ten thousand (3 x10^{-4})." *Id*. at 13.

A determination by EPA, pursuant to 40 CFR § 61.206, that PG containing up to an average of 35 pCi/g may be used in road base, paving, and various combinations of road base and paving in Government Roadway Projects that meet the commitments of this petition and are:

1. Authorized by federal, state and local Departments of Transportation (DOT) or Public Works (PW), and

2. Conducted as part of a government road project using appropriate, generally accepted road construction standards and specifications such as ASTM, FHWA, federal or state DOT standards and specifications, or standards developed or approved in consultation with the appropriate regulatory DOT or PW authorities.[44]

B. Legal Review Process

1. Components of Petition

40 CFR § 61.206(b) provides the Petition must be in writing and should address the following topics:

- The name and address of the person(s) making the request.
- A description of the proposed use, including any handling and processing that the phosphogypsum will undergo.
- The location of each facility, including suite and/or building number, street, city, county, state, and zip code, where any use, handling, or processing of the phosphogypsum will take place.
- The mailing address of each facility where any use, handling, or processing of the phosphogypsum will take place, if different from paragraph (b) (3) of this section.
- The quantity of phosphogypsum to be used by each facility.
- The average concentration of radium-226 in the phosphogypsum to be used.
- A description of any measures which will be taken to prevent the uncontrolled release of phosphogypsum into the environment.
- An estimate of the maximum individual risk, risk distribution, and incidence associated with the proposed use, including the ultimate disposition of the phosphogypsum or any product in which the phosphogypsum is incorporated.

[44] There are 50 states and each has its highway design guidance documents. Federal and state transportation departments generally cite the Green Book, *supra* note 20. Attachment B contains representative examples of road way specifications (including alternative materials that may be used in road construction from Florida, Louisiana, Idaho, and North Carolina and the Green Book).

- A description of the intended disposition of any unused phosphogypsum.

- The Petition must be "signed and dated by a corporate officer or public official in charge of the facility."

2. EPA's Determination and Risk Management Decision

The decision to approve a new use for PG must be made by EPA's Assistant Administrator for the Office of Air and Radiation (OAR). As a matter of policy, the decision involves weighing results of a risk assessment, technical analyses, and other factors.[45]

Section IV summarizes the Risk Analysis and metals screening evaluation that have been completed and demonstrate the safety of PG use in road construction. Key exposure and risk calculations and application of EPA's risk management criteria are described.

Section V provides TFI's justification for approval of this Petition and explains these factors as TFI submits they should apply to EPA's risk management decision. In conclusion, the road construction scenarios were evaluated for numerous risks (e.g., a broad scope of RME radiological exposures and non-radiological constituents present in PG). The analyses clearly demonstrate that:

- Use of PG in road construction presents no greater risk than stacking of the material; and

- PG can be safely used in road construction. In scientific terms, the use presents a risk of < 3 x 10,000, the level deemed by EPA to be safe (see discussion below).

3. Information and Certifications Required to Implement EPA Determination

Once the Assistant Administrator decides to approve use of PG in road construction under 40 C.F.R. 61.206(c), each of the reporting and records requirements at §§ 61.206(d) and 61.207-209 must be met. The only limitation on these requirements is that certain record-keeping obligations at § 61.209 may be waived. These reporting requirements include reporting the annual average radium-226 concentration at the removal location, and certification documenting purchaser, quantity and use information, along with a requirement that records must be retained for five years. These requirements ensure that EPA records contain information under §61.206(b) and in any event ensure that PG use and distribution is closely managed even where it is removed from a stack for an approved use.

[45] Basic concepts and definitions to aid the reader's understanding of the Petition can be found in Key Definitions which is a preamble to this Petition.

III. REGULATORY HISTORY AND CHANGING CONDITIONS

A. Regulatory History

1. The Original 1989 NESHAP Rule

Prior to 1989, PG in the United States was used for beneficial purposes, such as constructing roadways and agricultural soil amendments. The 1989 NESHAP rule required that all PG must be placed in engineered above ground impoundments (commonly referred to as "gypstacks") or in phosphate mines where it can be used as backfill. 40 CFR § 61.202. EPA's 1989 regulatory analysis was based on an estimate of 66 stacks located in 12 states with two-thirds located in Florida, Texas, Illinois, and Louisiana.[46]

2. Post-1989 Regulatory Developments

After the issuance of the 1989 NESHAP rule, TFI petitioned for reconsideration. EPA agreed to reconsider that portion of subpart R that required that all PG be disposed in stacks or mines.[47] On June 3, 1992, EPA published a final rule approving PG use as an agricultural soil amendment and for indoor research and creating a framework for approving additional alternative uses.[48] In particular, EPA approved the use of PG as an agricultural soil amendment as long as the average concentration of radium-226 in the PG does not exceed 10 pCi/g (based on a maximum individual risk of 3 in 10,000 due to the use) and use of PG for research in amounts not to exceed 7,000 pounds. 40 CFR § 61.204-205.[49]

The amended regulations also allowed OAR to approve, on a case-by-case basis, a new use if it is as protective of public health, in both the short and long term, as disposal in a stack or a mine. 40 CFR § 61.206(a)-(c).[50] In 1992, EPA rejected the use of PG in road construction based on an analysis that assumed a roadway constructed with PG might be abandoned in the future, with a home constructed directly on top of the abandoned roadway with no site preparation (i.e., mixing). This hypothetical scenario included several extreme assumptions that resulted in unrealistic levels of exposure (i.e., it was not a RME).[51] For example, the 1992 EPA BID assumed a 70 year period for the duration of residential exposure for the hypothetical reclaimer exposure scenario even though the 1992 EPA BID used 25 years as the duration of a resident's exposure for the nearby resident. EPA's current RME for the duration of residential exposure is 26 years (a 90th percentile of exposure), precisely because "EPA has been criticized for too often

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[46] 1989 Rule, *supra* note 3.

[47] EPA; NESHAPS for Radionuclides Reconsideration; Phosphogypsum, 55 Fed. Reg. 13,480 (Apr. 10, 1990).

[48] EPA, National Emission Standards for Hazardous Air Pollutants; National Emissions Standards for Radon Emissions from Phosphogypsum Stacks, 57 Fed. Reg. 23,305 (June 3, 1992) (1992 Rule)

[49] *Id*. at 23,309, 23,311, 23,316. The volume of PG was increased by a later amendment.

[50] *Id*. at 23,319.

[51] *Id*. at 23,312.

assuming that future use will be residential" and other unrealistic assumptions.[52] Also see Appendix 4b: Responses to Second Set of USEPA Questions – Reclaimer.

3. Prior Petitions

On December 22, 2004, EPA "conditionally" approved the Petition of the Florida Institute of Phosphate Research (FIPR) to use PG as cover material in a demonstration landfill test cell project (discussions with EPA on this project were initiated in 2002 and the petition submitted December 9, 2003).[53] PG, however, was never used as cover material in a landfill test cell. As TFI understands it, by the time the petition was approved, conditions had changed and the landfill owner withdrew its request.

In 2010, Louisiana State University prepared a proposal to allow the use of PG testing to determine if PG could be used to make coastal zone protection devices.[54] TFI's understanding is that this effort proposal did not advance to the submittal of a petition.

These examples illustrate the unwieldiness of EPA's current approach to approvals for PG use. This has resulted in continued stacking, which has been subject to criticism as an unsustainable practice.

B. Factors Influencing Future Uses of PG

A number of factors influence the future uses of PG:

1. Current requirements to obtain regulatory approval prior to each individual new use slow the process of implementing beneficial, safe new uses. In many other countries, PG use is encouraged over storage and there are little or no regulatory restrictions on the use of PG up to an average radium (226) content of 27 pCi/g.[55]

2. The size, costs and complexity of gypstacks have increased (see, Appendix 6 Economic Analysis of Regulatory Costs Savings) well beyond original expectations. When the stacking solution was developed, two key factors were not fully recognized: (1) growth in the industry would result in a significant increase in the volume of PG material that would require storage capacity in stacks, and (2) the beneficial use for which PG could safely be employed. Today, active stacks are concentrated in Florida, Idaho, Louisiana, and North Carolina and contain at least 1.7 billion tons of stored PG. EPA's final rule did not anticipate the significant increase in production that would occur, creating a need for new storage capacity to handle the

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[52] EPA, EPA Land Use in the CERCLA Remedy Selection Process, OSWER Dir. No. 9355.7-04, 3 (May 25, 1995), *available at* https://www.epa.gov/sites/production/files/documents/landuse.pdf (Land Use in the CERCLA Remedy Selection Process).

[53] Holmstead FIRP Letter, *supra* note 7.

[54] Louisiana State University, Preparation of an Application for Approval to Use Stabilized Phosphogypsum as a Fill Material For Coastal Protection Devices, Final Report, Pub. No. 01-197-235 (Apr. 2010), *available at* http://fipr.state.fl.us/wp-content/uploads/2014/12/01-197-235Final.pdf.

[55] IFA Sustainable PG Management Report, *supra* note 12.

PG production rate of 46 million tons per year. As a result, EPA's 1989 final rule and its underlying analysis did not consider the full extent of present (and future) environmental impact and cost of long-term stack storage on a scale compatible with modern fertilizer production facilities.

3. Historically, EPA considered the radium-226 concentrations in individual phosphogypsum samples as ranging from 1.4 to 46 pCi/g.[56] At EPA's request, TFI members performed radiation sampling on gypstacks across the U.S. in 2019 to provide updated information (Appendix 5). Multiple stacks owned and operated by three companies were sampled (ten samples per stack were taken). The 2019 sampling found:[57]

- Radium (226) concentrations of individual PG samples ranged 6.3 to 27.9 pCi/g.

- The average radium (226) concentrations of all 90 PG samples from all stacks is 18.6 pCi/g.

- The average radium (226) concentrations per stack ranged from 7.46 pCi/g to 24.7 pCi/g. An EPA 1988 report states the mean concentrtions of radium (226) from Florida stacks ranged from 25 to 34 pCi/g.

- The average average radium (226) concentrations from PG samples taken from six Central Florida stacks is 19.6 pCi/g and for the Western US stacks is 15.8 pCi/g.

- Limited data reported in the literature on the concentrations of radium (226) in PG outside of the U.S. indicate that concentrations range from 6.7 pCi/g to 38.4 pCi/g, well below 148 pCi/g that corresponds to a risk of 3 in 10,000 (N.B.: Some data are average concentrations and others report as few as one sample).

The 2019 data demonstrate that the average radioactivity level for each stack is significantly lower than the 35 pCi/g radium (226) concentration limit requested in the Petition and less than 148 pCi/g which corresponds to EPA's safe risk level of 3 in 10,000. All of 2019 stack averages are below 27 pCi/g (the nominal concentration used in the risk assessment), thus, the risk for these stacks is below 0.5 in 10,000.[58]

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[56] EPA 1992 BID, *supra* note 15.

[57] TFI 2019 Sampling, *supra* note 41, at 1-5.

[58] The Risk Assessment found that the nominal level of radium (226) assumed for calculation purposes to be contained in PG (27 pCi/g) corresponds to a maximum risk of 0.5 in 10,000. Thus, the EPA PG risk management limit of 3 in 10,000 corresponds to a level of 148 pCi/g in PG (using the non-rounded risk for the construction worker). Therefore, PG may be safely used as road construction material.

4. The scientific community has developed an updated understanding of relative risks associated with PG.[59] This Petition has been prepared to enable EPA's regulatory decision to be based on the current, best scientific understanding of radiation protection and management related to PG use. The International Atomic Energy Agency (IAEA), an international organization which the U.S. helped establish to provide a scientific source of recommendations on radiation issues, has determined that radionuclide activity concentrations in PG material are less than 1 Bq per gram (Bq/g) (which corresponds to 27 pCi/g) "implying that it is not necessary to regulate."[60] Section IV below summarizes this updated understanding. U.S. and international research, as well as data from uses in developed nations, are now available to support various PG uses and demonstrate that PG use is at least as protective of public health as storage in stacks. More than a dozen beneficial uses have been analyzed worldwide, resulting in significant, successful PG use applications in at least 21 countries.[61]

Further, U.S. risk assessment approaches have changed based on experience and evolving environmental management policies since the 1980s, along with increased awareness of product lifecycles and sustainability. These changed conditions enable a more thorough and appropriate evaluation of PG use in road construction, and a demonstration that this use is protective of human health and the environment.

5. EPA policies encourage use and recovery of high-volume, low-risk waste. EPA's 1989[62] and 1992[63] risk management decisions concerning PG uses acknowledge, but do not provide, an effective mechanism to implement PG use decisions that are consistent with the Agency's overarching policy of supporting recycling. Since 1992, EPA has increased its emphasis on understanding product lifecycles and has adopted sustainability policies and encouraged sustainable practices.

6. The economics of gypstacks have changed. The cost to stack PG and manage gypstacks is increasing. These rising costs are a concern to U.S. phosphate fertilizer producers that must remain competitive in a global marketplace. Fertilizer companies outside the U.S. may use or sell for use their PG material safely utilizing the IAEA standards and avoid costs attendant to stacking. This puts U.S. companies at a significant economic disadvantage. The international community has actively moved in the direction of safe PG use and recycling, creating an increasing competitive

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[59] *See* International Atomic Energy Agency (IAEA), Radiation Protection and Management of NORM Residues in the Phosphate Industry, Safety Reports Series No. 78 (2013), *available at* https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1582_web.pdf (Radiation Protection and Management of NORM Residues).

[60] *Id*. at 56. This statement does not in any way preclude a risk based determination that higher levels might also be acceptable.

[61] IFA Sustainable PG Management Report, *supra* note 12.

[62] EPA, Comments and Response to Comments, NESHAP, National Emission Standards for Radon Emissions from Phosphogypsum Stacks, EPA-402-R-98-007, 3 (1998).

[63] 1992 Rule, *supra* note 48, at 23,306.

disadvantage for U.S. industry, particularly when one considers the costs associated with gypstack maintenance, closure, and long term care.

7. Perceptions of gypstacks have changed. EPA's final rule did not anticipate advese public sentiment from local stakeholders regarding the long-term presence of gypstacks, including aesthetic concerns. Some local governments and communities have expressed a preference for use of PG in a manner that encourages redevelopment of land currently utilized by and around gypstacks.[64] Such use increases economic development by generating jobs associated with the transportation and use of PG, and frees up land for other uses (Appendix 6).

8. TFI's proposal represents a significant regulatory burden reduction that will create new commercial markets, industries and jobs. This is in the context of the dramatic increase in PG use worldwide since 2008, from a baseline of close to zero to 35-40 million tons consumed worldwide by 2015.[65] To make comparable advancements, the U.S. phosphate industry, EPA approval of TFI's Petition would support the industry's sustainable development goals by expanding the list of PG beneficial uses and ameliorate substantial, avoidable regulatory burdens and costs imposed by the NESHAP Subpart R regulations.

IV. SUMMARY OF THE EVALUATIONS CONDUCTED FOR THE PETITION

A. Overview

EPA's document, titled "Applying to EPA for Approval of Other Uses of Phosphogypsum: Preparing and Submitting a Complete Petition under 40 CFR 61.206, A Workbook" (EPA PG Workbook) provides a guide for the Petition.[66] The key requirement expressed in this guidance (and the NESHAP) is that in responding to any proposed petition, EPA must decide whether the radiological risk associated with the alternative use poses no greater risk than placement in stacks.[67]

The decision concerning whether the radionuclide risk associated with PG in alternative uses is acceptable depends upon many risk analysis elements, including:

- The specific exposure scenarios that are determined to be appropriate. This Petition seeks approval of the use of PG in road construction based on a risk analysis for a series of specific exposure scenarios;

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[64] *See e.g., EPA holds meeting about Mississippi Phosphate Site*, St. Louis Post-Dispatch, Jan. 11, 2018, *available at* https://www.stltoday.com/news/world/epa-holds-meeting-about-mississippi-phosphate-site/html_0a41e1fa-96ef-54bb-a825-8fcaeb4b4463.html (comment of Pasagoula Mayor, Dane Maxwell, at an EPA public meeting regarding the Mississippi Phosphate site cleanup: "We want it clear and ready for development as soon as possible").

[65] *See* IFA Sustainable PG Management Report, *supra* note 12.

[66] EPA PG Workbook, *supra* note 43, at 13.

[67] *Id*. at 12.

- The RME exposure assumptions or parameters that are selected to estimate a high end radiation dose estimate during the alternative use of PG, i.e., an assumption likely to overestimate exposure. This Petition developed RME exposure assumptions for each exposure scenario and receptor based on high end construction design features that may affect the radiation dose and calculated a high end RME dose;

- The radiation dose to risk conversion factor used, see Attachment A;

- The cancer risk estimate based on RME exposure assumptions and the radiation dose to risk conversion factor of 5 in 10 million mrem;

- EPA's cancer risk limit for new PG uses of 3 in 10,000 during the use;

- A comparison of the estimated cancer risk to EPA's risk limit for new PG uses; and

- EPA's Risk Management Decision considering economic and other risk management factors.

EPA did not assess chemical risk from residual metals in its 1989 risk assessment or its 1992 risk assessment (which approved an agricultural use and denied approval to use PG for road construction).[68] In the 1992 EPA BID risk assessment, EPA stated that PG "contains some trace metals in concentrations which the EPA believes may pose a potential hazard to human health and the environment," particularly arsenic, lead, cadmium, chromium, fluoride, zinc, antimony, and copper.[69] The "trace metals also may be leached… and migrate to nearby surface and groundwater resources."[70] However, EPA explicitly decided in the 1992 EPA BID that these metals "will not be addressed in the risk assessment."[71] Thus, neither the 1992 EPA BID risk assessment for the approved use of PG as an agricultural amendment nor the 1992 risk assessment for use of PG in road construction (which was not approved) included a risk assessment or a screening level assessment for metals in PG.

For this Petition, however, EPA requested that TFI perform a risk screening level evaluation for the naturally-occurring radioactivity and metals. Although there is a question concerning whether EPA's NESHAP program has the legal authority to require an risk assessment of the impact of metals in PG used for road construction, TFI performed a high end exposure (i.e., RME or higher exposure) for the human health risk screening. That screening assessment concluded that the metals levels in PG are not expected to pose an unacceptable level of health risks to construction workers or cause an unacceptable impact in groundwater using PG in roadway construction. Thus, no further risk evaluation is warranted to assess risks from metals in PG used for road construction. Furthermore, proper construction practices employ BMPs such

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[68] EPA 1992 BID, *supra* note 15. 1992 Rule, *supra* note 48, at 23,305.

[69] EPA 1992 BID, *supra* note 15, at 2-8.

[70] *Id*.

[71] *Id*.

as wetting surfaces to reduce dust formation, and these measures serve to further lower exposure. Studies and the nature of the petitioned PG use in road construction material compacted or encapsulated below pavement and above the water line indicate that leaching to groundwater (or surface water) is unlikely (ie., it is not a complete exposure pathway that warrants a more detailed risk assessment of the metals). The relevant Department of Transportation has responsibility to ensure that construction, using any construction materials (including PG), is to conduct construction activities in a manner that is protective of human health and the environment.

B. Exposure Scenarios

1. Overview

PG use was considered for road construction. This led to the development of the following RME exposure scenarios evaluated in the risk assessment:

- Road Construction Worker who builds roads exclusively with PG material for five years;
- Road User who routinely commutes on the constructed roadway by vehicle, motorcycle or bicycle for 26 years (motorist/bicyclist was deemed most conservative);
- Nearby Resident who lives in a home located 50 feet or more from a PG roadway for 26 years. To illustrate the amount of exposure reduction with distance, exposure to a resident who resides 20 feet from the PG roadway for 26 years was also calculated;
- Truck Driver who delivers PG for road base material to a construction site for five years; and
- Utility Worker who excavates across a PG roadway during utility maintenance projects and is exposed in a trench for 160 hours in a year.

These exposure scenarios were selected based on a review of prior regulatory submissions as well as discussions with EPA personnel, and the best professional judgment of the scientists assisting in the preparation of the Petition.[72] This analysis includes receptors not utilized by EPA in its 1992 BID risk assessment but added at EPA's request during the working sessions to fully evaluate public health.

This Petition also includes, at EPA's request, a hypothetical scenario which assumes a home is built upon an abandoned road constructed with PG (the so called Reclaimer scenario), which results in an extreme exposure (Extreme Reclaimer), i.e., the exposure is much higher than a RME exposure scenario. The probability of this scenario is very remote and implausible in that this construction scenario would likely never occur under existing road construction practices

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[72] Arcadis (a firm specializing in design and consultancy for natural and built assets) and Exponent (an engineering and scientific consulting firm).

and contraints on future land use for public infrastructure and therefore, the assumed scenario is not reasonably likely (Appendix 4b: Responses to Second Set of USEPA Questions - Reclaimer). Although this scenario also meets the EPA risk management limit of 3 in 10,000, it is not a reasonably likely scenario and therefore should not represent a condition of approval.

The design and construction of roadways is governed by policies and constraints on future land use associated with public infrastructure. The Reclaimer scenario of building a house on top of an abandoned roadway is not consistent with typical land re-use and sustainability policies, is limited by the legal constraints on abandoning public roads, is extremely rare (research has found few, if any, examples), and ignores the economic factors favoring using existing roads even if the land is being redeveloped. Therefore it is not a reasonably anticipated land use.

Nevertheless, EPA requested this evaluation to provide historical context for the 1992 EPA BID and confirm that this scenario is not a logical concern. This is discussed in further detail in Section IV (D)(9), below.

2. <u>Reasonable Maximum Exposure (RME)</u>

In order for there to be a risk, there must be exposure. EPA uses an RME metric to assess exposure risk. The "intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures."[73] Each exposure factor used to estimate the RME should be selected "so that the resulting estimate of exposure is consistent with the higher end of the range of plausible exposures" (citing EPA's 1991 guidance).[74]

A National Academy of Science (NAS) Committee reviewing EPA's regulation of technologically enhanced naturally occurring radioactive material (TENORM) recommended that EPA "should use exposure and dose risk assessments that are 'reasonably realistic'" in developing standards for exposure to the various types of low level naturally occurring radiation.[75] "The Committee defined 'reasonably realistic' as 'not….intended to greatly overestimate or underestimate actual effects for the exposure situation of concern,'" and EPA agreed with the Committee's recommendations.[76]

The exposure calculations in the Petition use currently accepted radiation modeling methods such as RESRAD and MicroShield. State regulators, citing to EPA guidance, note that "if high-end values are chosen for every exposure factor, then the resulting exposure estimate may no longer be consistent with the RME and may exceed the realm of possibility altogether."[77]

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[73] EPA Risk Assessment Guidance for Superfund, *supra* note 10, at 7-1. *See also* ITRC, Decision Making at Contaminated Sites, *supra* note 10.

[74] *Id*. at 6.1.1.

[75] EPA, Report to Congress, Evaluation of EPA's Guidelines for Exposures to Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM), EPA 402-R-00-01, 15 (June 2000), *available at* https://www.epa.gov/sites/production/files/2015-04/documents/402-r-00-001.pdf (describing a National Academy of Sciences report on TENORM) (EPA Report to Congress Re: TENORM).

[76] *Id*.

[77] ITRC, Decision Making at Contaminated Sites, *supra* note 10, at 6.1.1.

The use of reasonable exposure assumptions is supported by the courts, which have long held that exposure assumptions "must bear some rational relationship" to actual conditions, and disallowed unduly conservative approaches. For example, a court rejected EPA's use of an extreme assumption - that a child eats sludge applied to roadside cemeteries every day for a five year period.[78]

Scenario-specific exposure assumptions were selected for this analysis in accordance with EPA guidance and methodology (see Table 3 below). These exposure assumptions are contained in appendices and accompanied by detailed scientific support, citations to guidance, discussion of best professional judgment and prior precedent used to make the selections. A summary of key exposure assumptions is provided in Table 3 below.

Table 3: Summary of Key Exposure Assumptions

Person	Description	Years	Model	Rationale
RME Scenarios				
Road Worker	Builds roads exclusively with PG material	5	RESRAD	The worker who uses PG to build a road is closest to the PG mixtures in road base and/or paving. Used Florida Department of Transportation construction project data and EPA guidance. Other road construction workers have lower exposure and therefore less risk.
Truck Driver	Delivers PG to the construction site to be used in road base and/or paving materials	5	MicroShield	A truck driver hauls PG to the road construction site for 5 years (the truck body provides some shielding).
Nearby Resident	Resident lives in a home located 50 feet or more from a road	26	MicroShield	EPA guidance on exposure values. To illustrate the amount of exposure reduction with distance, exposure to a resident who resides 20 feet from the PG roadway for 26 years was also calculated.
Road User	Resident drives on the road in a vehicle, or on a motorcycle or bicycle (the motorist/bicyclist is evaluated as the most conservative)	26	RESRAD	EPA guidance on exposure values.
Utility Worker	Worker in trench dug across a PG roadway (e.g., utility work)	160 days	MicroShield	Best professional judgment, based, in part, on limited time trenching occurs (since, among

[78] *Leather Indus. of America v. EPA*, 40 F.3d 392, 405 (D.C. Cir. 1994).

				other reasons, it obstructs traffic).

At EPA's request, the Petitioner provided a "reclaimer scenario" (an assessment of the extreme hypothetical exposure if the road is abandoned and a house is constructed on the abandoned roadbed (see Table 4)).

Table 4: Reclaimer Scenario Exposure Assumption
(see the Petition's Risk Assessment and Appendix 4b: Responses to Second Set of USEPA Questions – Reclaimer)

Hypothetical Extreme Exposure Reclaimer Use Scenario				
Reclaimer Resident	Home constructed on an abandoned road	26	RESRAD (for gamma) Spreadsheet for radon	The abandonment of a road and construction of residential housing at the location is an extremely unlikely event included to evaluate the lifecycle and ultimate disposition of a PG road and is not a RME exposure. See discussion at Section IV(D)(9), below.

The RME is used to calculate the dose (i.e., the amount of radiation that the individual in the exposure scenario receives over a particular unit of time). In our situation, the annual and total doses depend on the length of time exposure occurs for that exposure scenario. Different exposure scenarios have different lengths of exposure. Risk is assumed to increase in direct proportion to the RME dose (i.e., if the RME dose increases by a factor of two, the risk increases by a factor of two).

The risk is then compared to the EPA risk management levels. EPA has long utilized (and courts have long upheld) the principle that a 1 in 10,000 risk level is "safe," although "[t]he upper boundary of the risk range [i.e., the 1 in 10,000 risk level] is not a discrete line." [79] As a unanimous *en banc* ruling of the Court of Appeals for the District of Columbia Circuit candidly noted, the basis for claiming harm from exposure to chemicals at extremely low environmental levels is more a function of "the rules of arithmetic rather than because of any knowledge" and there was "no particular reason to think that the actual line of the incidence of harm is represented" by the assumption selected by EPA.[80]

This acknowledgment is also apt for the risks from radionuclides. EPA's guidance for new uses of PG states unequivocally that for new PG uses to be approved, a petitioner must demonstrate that the cancer risk to those exposed to phosphogypsum as a result of proposed use "must not be

[79] EPA, Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions, OSWER DIRECTIVE 9355.0-30, 2 (Apr. 22, 1991), *available at* https://www.epa.gov/sites/production/files/2015-11/documents/baseline.pdf.

[80] *Natural Resources Defense Council, Inc. v. U.S. EPA*, 824 F.2d 1146, 1165 (D.C. Cir. 1987).

more than three in ten thousand" (i.e., 3 x10^{-4} or 3 in 10,000).[81] In the radionuclides NESHAP, EPA primarily, but not exclusively, evaluated the maximum individual risk (MIR) (which is the added chance of a cancer) and compared it to the NESHAP risk management level of 3 in 10,000.[82]

The use of the 3 in 10,000 "risk threshold is consistent with the determination of a 'safe' level first announced in the NESHAP for certain benzene source categories (54 FR 38044, September 13, 1989)."[83] As noted above, in the 1989 radionuclide rulemaking, EPA determined that six radionuclide source industries presented a cancer risk higher than 1 in 10,000 but that nonetheless was "essentially equivalent" to EPA's safe risk level "in light of the numerous uncertainties."[84] Similarly, EPA reaffirmed in 1992 that a 3 in 10,000 risk level was protective of human health and consistent with EPA's long-standing risk management goals.[85] In particular, EPA "determined" that the 3 in 10,000 risk level provided "an ample margin of safety, considering the cost, scientific uncertainty, and technological feasibility of control technologies needed to further reduce the radon emissions from [the PG] stacks."[86]

In summary, EPA explicitly has determined that the 3 in 10,000 cancer risk for radionuclides (including PG) is safe, consistent with overall EPA risk management policy. EPA has concluded that the "proposed other use will not cause a threat to the public or environment greater than if the phosphogypsum were stored in the stack," if the risk is not "more than three in ten thousand [3 in 10,000]."[87]

The relationship between exposure dose and risk is further elaborated on in Appendices 1 and 2.

C. International Commission of Radiological Protection (ICRP) Dose to Risk Relationship

The risk assessment selected in this Petition is the ICRP dose to risk conversion factor. The ICRP sets out the basis for evaluating health effects from radiological exposure along with recommendations for using specific values for regulatory purposes. While there are broad uncertainty bounds at low-dose exposures, the assumption of a linear relationship between exposure and risk is maintained regardless of the possibility of a threshold below which there is

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81 EPA PG Workbook, *supra* note 43, at 13.

82 1989 Rule, *supra* note 3, at 51,654, 51,659, 51,660. In this context, the risk distribution (i.e. the range of risks to which the population is exposed) decreases as distance to the road increases, for PG use in road construction. Relatively quickly the dose falls below the dose that corresponds to background. The exposure to the residents is below the 3 in 10,000 safe level.

83 EPA PG Workbook, *supr*a note 43, at 5.

84 1989 Rule, *supra* note 3, at 51,654, 51,664, 51,666, 51,668-69, 51,677, 51,682. Risks ranged between 1 in 10,000 and 3 in 10,000. *Id*.

85 1992 Rule, *supra* note 48, at 23,305, 23,311-12, 23,316.

86 EPA PG Workbook, *supra* note 43, at 5.

87 *Id*. at 13.

no risk. In Publication 103, ICRP provides an analysis of the exposure values considered in that analysis. On the basis of model uncertainty and epidemiological evidence, the ICRP recommends a dose-to-risk coefficient of 5% per Sievert (one Sievert is equivalent to 100 rems or 100,000 mrem, see explanation of terms in Attachment A).[88] This coefficient is the basis for current international radiation safety standards, and is considered by ICRP to be "appropriate for the purposes of radiological protection." Although it is based on cancer mortality as the endpoint, it is also approximate for all calculated detrimental effects.

For our risk analysis, we use a dose conversion expressed in terms of millirems or mrem.[89] Translating the 5% risk per Sievert recommended by the ICRP for regulatory purposes yields 5×10^{-7} risk per mrem.

The risk assessment submitted as part of this Petition estimates the annual dose for each of the exposure scenarios, summed over the associated years of exposure, to provide a total dose that is then converted to a cancer risk using a dose-to-risk conversion factor of 5×10^{-7} risk per mrem (i.e., 5/10,000,000).

Our use of 5×10^{-7} as a conversion factor is consistent with EPA risk assessment procedures.[90] The EPA's 2011 guidance provides cancer risk factors for uniform whole-body exposures of low-dose gamma radiation to the entire population, and reports an estimated 90% confidence interval for cancer mortality of 2.8% to 10% per Gy[91] (i.e., from 2.8×10^{-7} to 10×10^{-7} per mrem).[92] This range is essentially the same dose to risk conversion range derived by ICRP.

The value we use is also consistent with the perspective of the National Council on Radiation Protection and Measurements (NCRP) (the U.S. organization chartered by the U.S. Congress in 1964 to, among other things, "develop … recommendations about …protection against radiation" (i.e., NCRP uses the same dose to risk conversion factor as in the 2007 ICRP)).[93]

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[88] International Commission on Radiological Protection (ICRP), The 2007 Recommendations of the International Commission on Radiological Protection, ICRP Publication 103, 55, 87 (2007), *available at* https://www.icrp.org/publication.asp?id=ICRP%20Publication%20103 (2007 ICRP Recommendations).

[89] The mrem is a common unit of radiation dose. In this report, "dose" refers to effective dose, which simply means that when a person is exposed to a uniform radiation (e.g., external gamma radiation), all of the doses to the different organs are weighted by their radiosensitivity and added together. See Appendices 1 and 2 for more detailed discussion of the definitions and application of these factors.

[90] Similarly, the international community has widely adopted the International Atomic Energy Agency (IAEA) determination that 1 millisievert (1 mSv) per year is the acceptable level of radiation exposure (for example, the European Union [EU] regulations). *See* Radiation Protection and Management of NORM Residues, *supra* note 59, at 165. The IAEA and EU determinations are also based on the International Commission on Radiological Protection. 2007 ICRP Recommendations, *supra* note 88, at 55, 97, Table 5, 116, and Table 8.

[91] For practical purposes as to gamma radiation, 1 Gy = 1 Sv = 100 rem = 100,000 mrem.

[92] EPA, EPA Radiogenic Cancer Risk Models and Projections for the U.S. Population, EPA 402-R-11-001 (April 2011), available at https://www.epa.gov/radiation/epa-radiogenic-cancer-risk-models-and-projections-us-population (EPA Radiogenic Cancer Risk Models and Projections for the U.S. Population),

[93] National Council on Radiation Protection and Measurements, Management of Exposure to Ionizing Radiation: Radiation Protection Guidance for the United States, NCRP Report No. 180, 42 (2018), *available at* https://ncrponline.org/shop/reports/report-no-180-management-of-exposure-to-ionizing-radiation-radiation-protection-guidance-for-the-united-states-2018-2018/ (Management of Exposure to Ionizing Radiation).

The ICRP analysis was also relied upon by the European Union (EU) in selecting its general population acceptable dose level.[94] The EU appointed a group of experts to provide advice on the basic safety standards, taking into account the 2007 recommendations of the ICRP (specifically, ICRP Publication 103 since the ICRP reflected "new scientific evidence and operational experience").[95]

The most recent report of the NCRP (2018) (Report No. 180) provides a detailed discussion of the risks from exposure to ionizing radiation and states that "[*t]he value of 5 % Sv^{-1}* [i.e., 5/10,000,000 per mrem] *is a rounded value for radiation detriment used to inform all the NCRP recommendations regarding stochastic effects*,"[96] (emphasis added).

In summary, the use of the ICRP dose to risk relationship is scientifically sound and supported by many independent governmental entities, including EPA and NCRP. We elaborate further in Appendices 1 and 2. The "conservative" nature of the assumptions underlying the dose to risk relationship and associated uncertainties are discussed below.

For the reasons noted above, the risk estimates derived for PG using the ICRP dose to risk conversion factor are based on a linear relationship between dose and risk for the very low dose exposures derived for this report. Therefore, they are appropriate for use in the Petition and can be relied upon by EPA in its decision making.

D. Calculation of Risk that Corresponds to the RME

This section summarizes the RME doses calculated in the Risk Assessment and explains generally how they are derived.

1. Deriving Dose for the Period of Use

A dose is the cumulative amount of radioactivity absorbed (weighted to take into account the different medical impacts of different types of radiation). The dose is calculated using the RME associated with each scenario.

Duration is specific to the exposure scenario. For a resident, the exposure period is 26 years based on standard EPA guidance.[97] For a road construction worker, the length of exposure is

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[94] ICRP is an international expert advisory body that offers its recommendations to regulatory and advisory agencies, mainly by providing guidance on the fundamental principles on which appropriate radiological protection is based. The 2007 recommendation was produced "after eight years of discussions, involving scientists, regulators, and users all around the world." 2007 ICRP Recommendations, *supra* note 88, at 3.

[95] Official Journal of the European Union, Council Directive 2013/59/Euratom, 4 (Dec. 5, 2013), *available at* http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2014:013:FULL&from=EN. L 13/2 COUNCIL DIRECTIVE 2013/59/EURATOM (setting forth basic safety standards for protection against the dangers arising from exposure to ionizing radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom) (Council Directive 2013/59/Euratom).

[96] Management of Exposure to Ionizing Radiation, *supra* note 93.

[97] 26 year exposure duration for residence – 90th percentile recommended by EPA. EPA, Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120

five years (based on data from roadway construction projects, DOT manuals, and EPA guidance (see Petition's Risk Assessment (Appendix 2) and discussed in more detail in Appendix 4a: Response to EPA Comments on January 16, 2020, and below in this Petition, Section V). The risk assessment determined that the 3 in 10,000 risk level corresponded to a total cumulative dose of 600 mrem and this value can be used to judge the magnitudes of exposure for each scenario. Table 5 below summarizes the exposure doses calculated in the risk assessment on an annual and scenario basis.

Table 5: Total Dose Summary

Person Exposed	Annual Dose	Years	Total Use Exposure Dose (mrem)
Road Worker	22 mrem	5	110
Truck Driver	18.6 mrem	5	93
Nearby Resident	multiple exposures over 26 years	26	16
Road User	1 mrem	26	28
Utility Worker	0.8	160 hours in 1 year	0.8

2. Converting the Total Use Dose to Risk

Radiation risk for cancer is calculated as the product of the RME exposure dose for each scenario and the dose-to-risk conversion factor. The distance from the road and durations of exposure are key considerations in calculating the total dose risk. While the RME is designed to bound these, most residents would be located at greater distances from the road and/or experience shorter durations of exposure than the RME individual. Thus, actual doses for the populations would be less than those presented here.

As noted above, using a dose-to-risk conversion factor of $5x10^{-7}$ risk per mrem, 600 mrem corresponds to a 3 in 10,000 risk level. From this relationship, one can calculate the risk for a particular dose. The result of the risk calculations are summarized in Table 6 below. The results of the calculations are provided in Appendices 1 and 2 of this Petition.

Table 6: Total Use Dose and Risk Table Compared to Background

RME Exposure Scenario	Total Use Dose (mrem)	Years	Risk From the Use
Road Construction Worker	110	5	0.5 in 10,000
Truck Driver	93	5	0.5 in 10,000
Road User	28	26	0.1 in 10,000
Nearby Resident	16	26	0.08 in 10,000
Utility Worker	0.8	160 hours in 1 year	0.004 in 10,000

(Feb. 6, 2014), *available at* https://www.epa.gov/sites/production/files/2015-11/documents/oswer_directive_9200.1-120_exposurefactors_corrected2.pdf (Update of Standard Default Exposure Factors).

3. Road Construction Worker Risk

Based on the assessments provided in this Petition, the highest estimated RME exposure is for the road construction worker placing road base containing PG that contains radium -226 at 27 picocuries per gram. The exposure dose amounts to ~22 mrem/year (which results in a 110 mrem total dose for the exposure period of five years). This dose corresponds approximately to an incremental cancer risk of 0.5 in 10,000, which is over 5 times less than the PG use risk management level of 3 in 10,000.

4. Risk to the Nearby Resident

In addition to the highest risk individual (a road construction worker), the risk assessment also evaluated the exposure doses and risk to a resident who may live immediately adjacent to the road. Consideration was given to all stages of life from childhood through adult. Exposure depends on distance, with exposures dropping off quickly as distance from the road increases. Nevertheless, for people living immediately adjacent to the road, the exposures and risks are well below the risk management level of 3 in 10,000.

The exposure doses and risks were estimated without considering shielding during the period of construction; shielding was included when estimating doses following construction of the road. Shielding of residents was afforded by the road surface as well as by embankments and other structures that cover the sides of the road base.

The cumulative incremental dose associated with living in a house adjacent to a road with a PG base is 16 mrem and the associated risk is 0.08 in 10,000. These RME exposure dose and risk estimates to nearby residents are well below the EPA risk management levels.

5. RME Risk from the Other Exposure Scenarios

Doses and associated risks for all other RME exposure scenarios (the truck driver delivering the PG, the users of the road, and the utility worker in a trench near the road) are lower than those for the road construction worker (see Table 1 and 6).

6. RME Exposures/Risks, by Definition, are the Highest Exposures

All exposure scenarios have doses and risks that are less than the EPA's risk management levels. The RME risks are constructed to overestimate rather than underestimate the actual risks and this provides confidence for making decisions that are health protective.

Other workers who are more distant from the PG have lower exposures than the construction worker (and, therefore, lower risk). Similarly, most residents living near roadways are exposed to lower risk levels and most PG will contain lower radiation levels used in this calculation. Moreover, the dominant source of dose is gamma radiation which decreases with distance and hence, residents who live more than 50 feet from a road will receive a lower dose (and consequent risk) than the RME at a distance of 50 feet from the edge of the road.

A summary of the risk distribution provided in Table 2, above (which is from Appendix 4a).

In summary, the risk distribution from road construction is negligible, beyond the individuals who are on or immediately beside the road, as assessed in the Risk Assessment document.

7. Comparison to Background

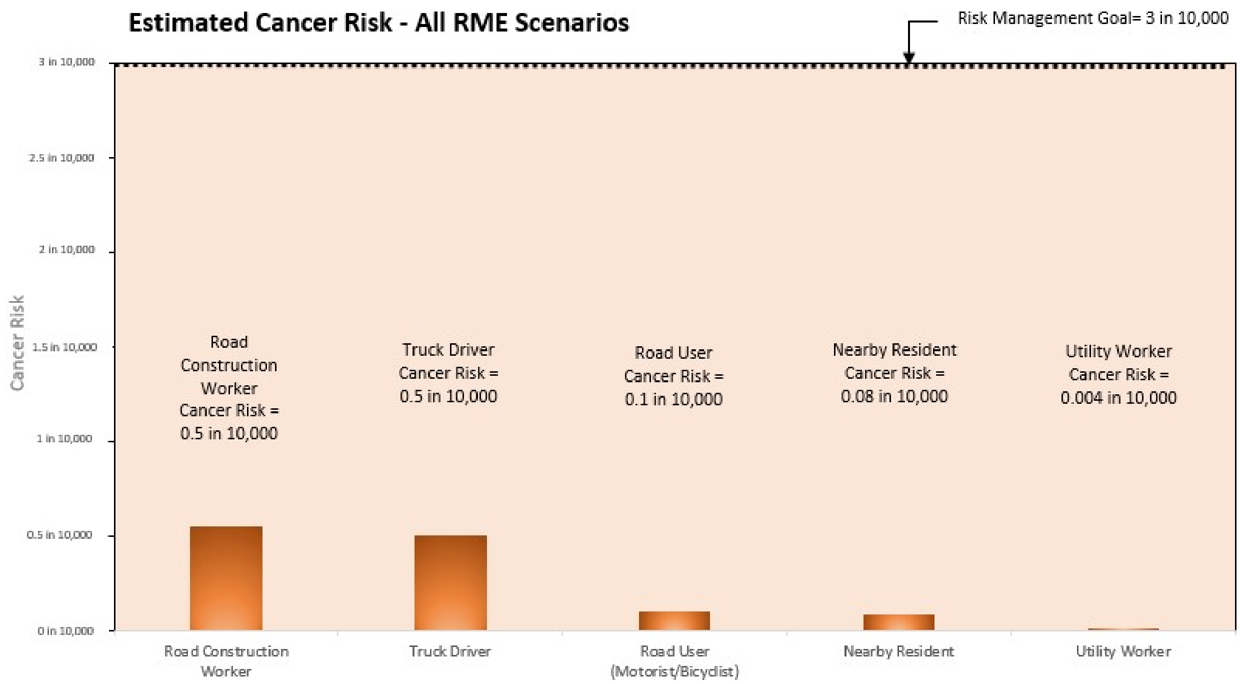
Because radiation is always present naturally, it is helpful to compare the incremental radiological exposures to background levels to provide important perspective. While natural background varies geographically (between states and even within states), a value of approximately 310 mrem a year was used for comparison because it is a widely used national background level. Background radiation varies naturally from ~100 mrem to 1,000 mrem. Thus, the ratio of total use exposure to background will vary depending upon the location of the road (see Table 1 below and provided above). Given the conservative nature of the exposure estimates, these incremental exposures would likely be within the variability of measurement for ambient radiation.

Table 1: Dose, Risk, and Background Summary for All RME Scenarios (repeated for the convenience of the reader)

Receptor	CSM	Exposure Duration (years)	Exposure Dose (mrem)	Estimated Cancer Risk	Background Dose from Exposure Duration (mrem)	Exposure Dose Percentage of Background Dose (%)
Reasonable Maximum Exposure Scenarios						
Road Construction Worker	PG in Road Base	5	110	0.5 in 10,000	1550	7%
Road User (Motorist/Bicyclist)	PG in Road Base & Surface	26	28	0.1 in 10,000	8060	0.3%
Truck Driver	PG-containing material for Road Base	5	93	0.5 in 10,000	1550	6%
Nearby Resident	PG in Road Base & Surface	26	16	0.08 in 10,000	8060	0.2%
Utility Worker	PG in Road Base	1	0.8	0.004 in 10,000	310	0.3%
	EPA Cancer Risk Management Goal		600	3 in 10,000	600	

Estimated cancer risk below this goal.

Figure 4: Estimated Cancer Risks



8. Disposition Scenario

The EPA PG use regulations require an assessment of the risk from the ultimate disposition of PG for any product in which the PG is incorporated.[98] The RME for the ultimate disposition of a new road constructed with PG is that it serves as an established part of municipal (county, state, or federal) infrastructure and as such would require periodic repair and expansion as needed. Road maintenance activities include removing the surface, grinding and reusing or disposing of the materials consistent with federal, state, and local regulations. Exposures and risks associated with maintenance of roads and reuse of construction materials are expected to be comparable to or less than those detailed in the risk assessment for road construction (Appendix 4a: Response to EPA Comments on January 16, 2020).

9. Extreme Hypothetical Reclaimer Requested By EPA (> RME)

Our evaluation is that, in light of current policies and known constraints on future land use for public infrastructure, a hypothetical reclaimer scenario does not represent a reasonably foreseeable future use for inclusion in the risk analysis for this Petition (Appendix 4b: Responses to Second Set of USEPA Questions - Reclaimer).[99]

The reclaimer scenario used in the 1992 BID Risk Assessment as a reasonable disposition scenario (without any explanation or scientific support) was the assumption that a house is built

[98] 40 C.F.R. § 61.206 (a)(8)(1).

[99] Memorandum from TFI to Lee Veal, Director, Radiation Protection Division, U.S. Environmental Protection Agency (April 24, 2019). This detailed memorandum explains the reasons that the Reclaimer Exposure Scenario is not a RME.

on the roadbed at some future time after the road is closed and the road surface has crumbled and been removed. (EPA 1992 BID, p. 4-10). This was not an RME disposition scenario then, nor is it realistic now.

First, a diligent search has not found any documentation of paved roads being abandoned and residential housing being constructed immediately on the abandoned pavement.[100]

If there are any examples, they are rare (i.e., 90th percentile or above) and beyond the RME exposure.

Second, there are many institutional and legal obstacles to abandoning roads, much less constructing homes on them. All public roadways and associated rights of way are owned and operated by the government and by law are dedicated to public use. All of these public roadways are subject to governmental jurisdiction with zoning and land use requirements that support continued roadway use. For example, to abandon a road in Florida, there must be notice of the intent to abandon the road, a public hearing, a duly adopted and entered resolution of abandonment, and notice of the abandonment resolution.[101] A road cannot be abandoned if it is a public road and is used by the public (see Florida, Idaho, Louisiana, Alabama and several other state laws). Some states, such as Alabama, have a statutory preference against abandonment. Federal highways can be decommissioned, consistent with a robust public process. In the case of the Pennsylvania Turnpike, part of it was converted to a bike path.[102] Similarly, the West Side highway in New York City was converted into an urban park, not housing. In any event, roads built with PG will be constructed and and maintained consistent with state and federal laws. Any effort to abandon and repurpose these roads, including for development, also must be consistent with federal and state statutes and local ordinances.

Similarly, some county roads are abandoned to become state roads and some state roads are abandoned to become federal roads. Transfer of a state road to the federal highway system or vice a versa is not relevant since the road remains a road.

Maintaining public roadways and associated rights of way into the future is consistent with current trends in community plans to maintain and expand roadway infrastructure and utility services (buried within right of ways) and to provide access (e.g., ingress/egress to surrounding parcels). Converting a roadway to a residential property must be done consistent with state laws and would complicate or eliminate access to surrounding parcels in addition to the redeveloped residential property[103] and is not a realistic assumption. Furthermore "[v]acating a road that

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[100] Abandonment of unpaved roads is not relevant since we are not seeking to approve of the use of PG on unpaved roads. This factor and the other factors in the text are summarized from the Petition's Risk Assessment (Appendix 2), Responses to Second Set of USEPA Questions – Reclaimer (Appendix 4b), and the legal research on the legal obstacles on abandonment of roads provided in the Revised Petition.

[101] Fla. Stat. § 336.10. *See* 23 C.F.R. § 620B.

[102] *Abandoned Stretch of Turnpike in PA*, ConstructionEquipmentGuide.com, Jan. 11, 2006, *available at* https://www.constructionequipmentguide.com/redirect/6495?story=6495.

[103] *See* James J. Fazzalaro, Local Road Abandonment and Abutting Property Owners, OLR Research Report, 2003-R-0897 (December 24, 2003), *available at* https://www.cga.ct.gov/2003/olrdata/tra/rpt/2003-R-0897.htm.

eliminates or substantially diminishes access for abutting property owners may likely amount to a taking,"[104] which is another disincentive to abandonment.

Third, economics dictates that if an abandoned road is transferred to a housing association, the land will remain as a road maintained by the housing association. More generally, since storm drains and often utility lines are placed along rights of way, the abandoned road is more likely to be used as a private road, not housing. While it is not impossible for a house to be be built on an abandoned roadway, it is certain to be extremely rare.

Fourth, the sustainability of roads and the use of road construction materials are key aspects of guidance and plans for roads under the jurisdictions of the Federal Highway Administration and state Departments of Transportation. The in-place abandonment of municipal infrastructure and allowance for construction of residences on top of these abandoned roads runs counter to sustainable infrastructure projects involving road construction. In any case, the construction activities required for road maintenance result in less exposure than during the original road construction (i.e., the construction activities on scale).

Thus, road abandonment, and the construction of a home on the abandoned road is not an RME exposure and, therefore, is not an ultimate disposition scenario. The fact that this extreme exposure scenario corresponds to a risk below the EPA risk management level confirms that the lesser exposure in the ultimate disposition scenario need not include a numerical risk assessment.

Finally, normally, the removal of unused PG during the road construction project is not an appropriate ultimate disposition because from an economic perspective, it is unreasonable to purchase more PG than will be used. Appropriate planning will ensure that all PG is mixed with soil (in a one to one ratio) and used in the road. In the rare case where there is unused PG, it can be used in another ongoing road construction project or returned to the PG source to be stored on a PG stack. Thus, a Reclaimer Exposure Scenario should not be utilized to determine whether to approve the use of PG for road construction.[105]

But, since EPA requested that the risk analysis include the extreme hypothetical reclaimer scenario, it is summarized below (see Petition's Risk Assessment and Appendix 4b: Responses

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Florida Office of the Attorney General, Counties, roads and streets, dedication, vacation, Advisory Legal Opinion – AGO 78-118 (Sep. 27, 1978), *available at* http://www.myfloridalegal.com/ago.nsf/Opinions/1F43FA7B5F1C0AF18525659300627D32. Association of County Commissions of Alabama, Acceptance, Annexation and Vacation of County Roads (May 11, 2016), *available at* https://www.alabamacounties.org/sdm_downloads/creation-acceptance-annexation-and-vacation-of-county-roads/.

[104] Thomas Ruppert, Erin Deady, Jason M. Evans, & Crystal Goodson, Legal Issues When Managing Public Roads Affected by Sea Level Rise: Florida, 5 (Spring 2019), *available at* https://www.researchgate.net/publication/332528839_Legal_Issues_When_Managing_Public_Roads_Affected_by_Sea_Level_Rise_Florida.

[105] As a practical matter, if a risk assessment uses extreme enough assumptions, the calculated risk will exceed any risk management safe level. Thus, realistic but high-end RME are used.

to Second Set of USEPA Questions – Reclaimer, which responds to the technical issues relating to the extreme Reclaimer scenario). As part of the hypothetical reclaimer scenario, the exposure assumptions still need to be RME assumptions. The duration of exposure is 26 years (because that is EPA's RME residential exposure (i.e., the 90th percentile of exposure)).[106] Normal house construction practices were utilized, such as use of non-PG fill to grade the land (which mixes the PG with non-PG soil), the use of vapor barriers and a slab beneath the house, and the like (as described in Appendix 4a: Response to EPA Comments). The annual total radiation dose is 3 mrem, which converts to 78 mrem over 26 years (the total use dose). The resident reclaimer scenario requested by EPA is an extreme exposure duration. Nonetheless, this risk (which is higher than an RME risk) corresponds to about a 0.4 in 10,000 risk, still below the PG use risk management level of 3 in 10,000.

Even this extreme hypothetical scenario does not result in exposures and risks that exceed the EPA risk management level of 3 in 10,000. It must be emphasized that the use of the reclaimer scenario does not mean it is a foreseeable ultimate disposition. In any event, the fact that this extreme exposure scenario presents a risk below 3 in 10,000 demonstrates that any conceivable RME scenario related to ultimate disposition will meet the EPA's risk management level.

E. Groundwater Pathway Screening Analysis

EPA's PG Petition guidance suggests that the Petition should address other potential pathways of exposure, such as the ground water pathway, if they are relevant.[107] The Petition used a screening analysis to address these pathways and, where appropriate, referenced EPA's prior evaluations. A conservative screening level analysis generally is used to determine at an early stage that no further analysis is warranted.

1. Radionuclides in Groundwater

EPA performed extensive modeling of the likely migration of radionuclides in a 1992 assessment of the risk from PG used in agriculture and road construction. Neither concluded that the groundwater pathway supported restrictions on the use of PG.[108] EPA's risk assessment determined in 1992 that "no radionuclides are calculated to reach the onsite well via the groundwater pathway" nor are any "radionuclide calculated to reach the off-site river or well via groundwater."[109] (see SENES 1997[110] which also examined the potential for impacts to

[106] 90th percentile exposure means that 90% of the exposed population has that level of exposure or less and only 10% of the population has higher exposure. EPA published its Superfund Land Use Directive in 1995 (Land Use in the CERCLA Remedy Selection Process, *supra* note 52) and reaffirmed the policy in 2001 (EPA, Reuse Assessments: A Tool To Implement The Superfund Land Use Directive, OSWER 9355.7 - 06P (June 4, 2001), *available at* https://nepis.epa.gov). EPA's 1995 Land Use Directive acknowledges that "EPA has been criticized for too often assuming that future use will be residential" and identifies several evaluation factors to identify reasonably anticipated future land use, such as current land use, zoning laws and maps, community master planning, population growth patterns and projections, accessibility to existing infrastructure, site location, federal/state land use designation, and others.

[107] EPA PG Workbook, *supra* note 43, at 10.

[108] EPA 1992 BID, *supra* note 15, at Chp 4. See discussion in Appendix 2.

[109] EPA 1992 BID, *supra* note 15, at 4-31, 4-34, Scenario 8, Tables 4-5, 4-18, n. C, Scenario 11, among other sources.

groundwater and surface water pathways). These studies found no realistic potential for impacts to these pathways, i.e.:

> No radionuclides are calculated to reach the on-site well via the groundwater pathway for almost 10,000 years, or the off-site river or well for more than 100,000 years because of groundwater velocities and retardation factors.[111]

The radionuclide risks were found to be negligible. The TFI consultants agree with these prior assessments and no additional evaluation was deemed necessary. No monitoring data reviewed indicates significant groundwater impact from radionuclides. The Response to EPA Comments on January 16, 2020 (Appendix 4a) provides a more detailed explanation of the extremely low risks from radionuclides in groundwater, which was the basis from the Petition's Risk Assessment not duplicating these conservative calculations.

2. Screening Evaluation of the Potential Impact of Non-Radionuclides in PG

The EPA PG Guidance states:

> [A petitioner] "must provide information on the other toxic or hazardous constituents of the waste…to assure that the proposed use does not cause non-radiological risks to human health and the environment."[112]
>
> To the extent the phosphogypsum is land applied or will remain in place following the test, the risk assessment must examine other potential pathways of exposure, in particular with respect to ground-water and surface water. Consideration of multiple pathways, particularly pathways associated with ground water, are consistent with our review of alternative uses as found in the 1992 rulemaking on phosphogypsum.[113]

Despite this, EPA did not include an assessment of the impact of metals in its review of alternative uses of PG in 1989 or 1992 (see Appendix 3).

However, EPA requested that TFI perform screening analyses of the potential impact of direct contact with PG by road construction workers, and evaluate potential metals leaching on ground and surface water quality. Thus, these assessments were performed and appear in Appendix 3.

These analyses confirm that PG is "safe" for worker handling with respect to non-radionucldes as well. Road construction workers were assumed to come into direct contact with PG (incidental ingestion, inhalation, and dermal contact). The PG concentrations were then compared to health-based screening levels. The chemicals in PG were found to be either a low risk or present at background levels.

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[110] SENES Consultants Limited, Application for Exemption – For Use of PG in the Construction of Thornhill Road, Polk County Florida (Draft), Prepared for the Florida Institute of Phosphate Research (1997).

[111] EPA 1992 BID, *supra* note 15, at Chp 4, Note C, Table 4.15.

[112] EPA PG Workbook, *supra* note 43, at 9.

[113] *Id*. at 12.

Appendix 3 contains an assessment of the potential for metals to leach from a roadbed using PG. The design of new roads affects the potential for exposures by creating a degree of isolation of the base layer from the environment. The PG in the proposed alternative use is placed above the water table and underneath the road's paved surface. Additionally, the roads are sloped to drain precipitation.[114] This further limits water contact with the PG isolated within the base layer. Thus, for purposes of the Petition, leaching of PG to groundwater or surface water is likely not a complete exposure pathway of concern for roadbed use and therefore no more detailed risk assessment is needed based on the typical screening level approach.

The metals concentration in the road base (and, therefore, the amount that is leached) is only 50% of the concentration of metals in PG because the PG is mixed with soil, sand, or aggregate (see Appendix 3).

The literature shows limited leaching directly from PG. For example, a 2011 University of Florida study by Mostary (2011) took twelve samples and performed comprehensive leachability testing for PG sampled from one stack in Florida (see Appendix 3). In this study, there were no exceedances of EPA's primary drinking water standards in synthetic precipitation leaching procedure (SPLP) testing and no exceedances of Resource Conservation and Recovery Act (RCRA) toxicity characteristic leaching procedure (TCLP) limits (see Appendix 3). The TCLP and the SPLP tests extracted relatively similar metal concentrations (except calcium).

Another apt risk comparison for the metals in PG are the federal and Florida land application limits for biosolids[115] (see Appendix 3). EPA limits were based on a risk assessment for 14 exposure pathways, including groundwater (Table 6 in U.S. EPA 1995 for a guide on the Part 503 Rule.).[116] For metals in biosolids, EPA found that leaching into groundwater or runoff into surface waters were not limiting pathways (see Appendix 3).

For the purposes of an EPA NESHAP review, it is important to understand and consider the fact that groundwater protection is primarily governed by state law and is considered under federal and state highway guidance. For example, the Florida Department of Transportation's Standard Specifications For Road And Bridge Construction states roads must: (a) "[p]rovide erosion control measures where work is accomplished in conjunction with the project, to prevent erosion, pollution of water, detrimental effects to public or private property adjacent to the project right-of-way and damage to work on the project;" (b) "[d]o not drive in, operate, or place construction equipment or materials in surface waters, wetlands, groundwater, or property beyond the project limits without permitted authority for permanent or temporary impacts; and (c) [d]o not allow water that does not meet state water quality standards or does not meet the permitted criteria to exit the project limits.[117] That is, metals impact on groundwater will and should be determined at the local level.

[114] Appendix 3.

[115] 40 C.F.R. Part 503. Fla. Admin. Code 62-640.

[116] EPA, A Guide to the Biosolids Risk Assessments for the EPA Part 503 Rule, EPA/832-B-93-005 (1995), *available at* https://www.epa.gov/sites/production/files/2018-11/documents/guide-biosolids-risk-assessments-part503.pdf.

[117] Florida Spec Book, *supra* note 23, at 131.

The fact that materials utilized to construct roads can impact the environment has been reported by the NAS,[118] states,[119] and other federal agencies,[120] and applies to all road construction material, not just PG. States provide comprehensive guidance on roadway design.[121] Thus, regardless of the source of the road construction material, the federal, state, and local road building agencies will assess the environmental and physical characterization to determine whether there is an impact from utilizing material A versus material B and decisions on how to mitigate any impacts is within the discretion of these agencies.

Lastly, the footprint of a road on the landscape is very small compared to agricultural lands upon which biosolids and amendments with many higher allowable metal concentrations than those in PG are permitted for continuous use (see EPA 1992 BID). The smaller footprint and lower likelihood of leaching from a constructed road compared to an agricultural field indicates that the influence on groundwater from PG in the road is likely to be comparatively very small. The amount of PG in road base is expected to be negligible in comparison and thus can be used safely in road construction given the lower metals content in PG and the smaller footprint and confinement of the base layer above the water table.

In summary, the presence of other substances that are not radionuclides in PG is unlikely to present an unacceptable worker exposure or adversely impact groundwater or surface water quality. The leaching pathway is likely not a complete pathway of concern for the PG use in road construction proposed in this Petition.

F. <u>Risks From Other Pathways</u>

The Response to EPA Comments on January 16, 2020 (Appendix 4a) contains an explanation of the low risks from other pathways (air, ingestion of food from a garden, etc.) and the rationale for not duplicating the risk assessment on these pathways from the 1992 BID risk assessment.

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[118] The National Academies of Science, Assessing and Managing the Ecological Impacts of Paved Roads (2005), *available at* https://www.nap.edu/catalog/11535/assessing-and-managing-the-ecological-impacts-of-paved-roads.

[119] Idaho Transportation Department, Impacts of Using Salt and Salt Brine for Roadway Deicing, RP 231 (2014), *available at* https://www.ctcandassociates.com/work-samples/saltimpacts.pdf.

[120] USDA, Reclaimed Materials and Their Application in Road Construction: A Condensed Guide for Road Managers (December 2013), *available at* https://www.fs.fed.us/t-d/pubs/pdfpubs/pdf12771807/pdf12771807dpi72.pdf.

European countries compile information on mitigation environmental impacts. Roadex Network, Environmental Issues on Low Volume Roads, *available at* https://www.roadex.org/e-learning/lessons/environmental-considerations-for-low-volume-roads/preface-environmental/.

[121] Florida Department of Transportation, Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways (Draft), Chapter 4 (2018), *available at* https://www.fdot.gov/roadway/floridagreenbook/fgb.shtm (Commonly known as the Florida Greenbook).

G. Comparison of TFI Risk Assessment and Screening Evaluation with EPA's 1992 EPA Background Information Document (BID) Risk Assessment

Appendix 2 performed a very "high level" and preliminary overview of the main differences that we could readily identify between the dose and risk results provided in EPA's 1992 BID and those previously discussed in this report. The following is a list of comparisons:

- A 1:1 dilution of PG with soils (higher PG to soil than EPA's 1:2 PG to soil in 1992. Appendix 2, 1992 BID page 4-9).
- A road thickness of 0.25 m (the same as in 1992).
- The current risk assessment considers the same receptors as EPA did in 1992 as well as two additional receptors suggested by the EPA, namely, the truck driver transporting PG to the construction site and a utility worker who works some time in a trench cutting across a road constructed with PG.
- For the road construction worker, the EPA considered workers standing on the road base and unshielded, as was also assumed for the current risk assessment.
- The current risk assessment assumes a worker moves around over the road surface and is exposed at the average of the gamma fields at the center and edge of the road. While not fully clear, the EPA in 1992 may have assumed a worker was always in the center of the road which would largely account for the difference between gamma doses estimated in 1992 and now.
- The road user is assumed in both cases to drive on a road with a PG base and a cover (in 1992 asphalt or cement) and in the present analysis, for purpose of illustration, concrete road surface was assumed. Only annual dose and risk are available from the 1992 risk assessment. The 1992 EPA risk assessment used a 0.6 shielding for the road user, but rather than determine the degree to which vehicles have changed in the amount of metal in the under carriage of cars, the current risk assessment takes no credit for shielding provided by the vehicle that would provide some level of shielding which is a conservative assumption and could reasonably be considered.
- The dose to the nearby resident is dominated by exposure to gamma radiation which decreases rapidly with increasing distance from the edge of the road. The 1992 risk assessment assumed the nearest resident would be at 100 meters (approximately 328 ft) from the edge of the road. The current assessment considers the RME exposure scenario to be a resident whose home is located a distance of 50 feet from the edge of the road (an urban resident whose home is at 20 feet from the edge of the road is also calculated to illustrated the change in exposure levels with distance).
- The 1992 BID mentions the presence of metals, but did not consider any substances other than radionculides in the 1992 risk assessment. The current Petition includes a metals screening evaluation to justify the fact that a quantitative risk assessment is not warranted.

- The EPA BID risk assessments considered a reclaimer scenario with exposures from gamma radiation and radon, in which the surface is removed and a house is directly built upon PG, and a resident lives in the house for 70 years (see Petition's Risk Assessment and Appendix 4b for a full review of the so called reclaimer scenario).

    - At EPA's request, this Risk Assessment calculated this reclaimer scenario, even though such a scenario is an extreme hypothetical case that is not a RME exposure. Both the 1992 and present calculation assume the surface is removed, but the current assessment takes into account the necessary construction site preparation and grading, which reduces the thickness and to a lesser degree, the concentration of residual road base construction activity that would be necessary to construct a house.

    - The 1992 BID does not indicate how the risk from radon was calculated (dose from radon was not reported in the 1992 BID).

    - The 1992 BID assumed 70-years residency and the current assessment uses EPA's current RME for duration living in a residence of 26-year residency (the upper 90th percentile) (see more in depth discussion in Sections I(B), III(A)(2), and IV (D)(9), above). Even the 1992 BID risk assessment used 26 years as the duration a person might reside in the house. Thus, the 70-year residency for the reclaimer scenario in the 1992 BID appears to be inconsistent with the residency lengths used by EPA in other parts of the 1992 as well as current EPA guidance.

    - The current assessment also assumes a 6 ml poly layer which is standard as a vapor barrier in current home construction.

    - Both the 1992 BID Risk Assessment (at Table 4) and the Petition's Risk Assessment calculated the risk based on an assumed concentration of radium (226) (26 pCi versus 27 pCi/g).[122]

These comparisons demonstrate the upper bound nature of the risk assessment. Actual doses and risks are likely to be lower.

V. RISK MANAGEMENT DECISION

TFI has provided information required by EPA[123] necessary for completing the agency's evauation and determination that use of PG in road construction may be deemed at least as protective of human health as disposal on a stack. Risk management factors favor approving the use of PG for road construction. The petition and supporting risk analysis demonstrates that this use can be advanced safely. Justifications for this determination include:

The Risk Management limit of 3 in 10,000 is consistent with other NESHAP risk limits.

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[122] The 1992 BID Risk Assessment include in the table the risk from a range of radium (226) concentrations.

[123] Information requirements at 40 C.F.R. §§ 61.206(b) (1), (2), (6), (7), (8), and (9) for EPA approval based on a risk assessment determination and conditioned upon receipt of information requirement (3), (4), (5), and (10).

- The highest Reasonably Maximum Exposure (RME) for the use of PG in road construction, 0.5 in 10,000 (0.5 in 10,000 is 5 in 100,000), is well below the NESHAP radionuclide risk management limit of 3 in 10,000.

- For ease of calculation, this Risk Assessment used a nominal average radioactivity level in PG of 27 pCi/g. By "nominal average" we mean this is the average radioactivity level we used in our initial calculation. This number is reasonable and is similar to numbers EPA previously used.

- Once the risk from the initial calculation is determined, EPA can then estimate the risk from higher and lower radioactivity levels. For example, if the average radioactivity level for a stack is (13.5 pCi/g, then the risk is one half of that calculated for 27 pCi/g).

- At EPA's request, TFI members recently sampled PG from multiple gypstacks (Appendix 5). This report confirms that the existing data supports the use of the PG stacks in the U.S for use in road construction. In summary, the average radioactivity level for each stack was significantly lower than 27 pCi/g.

- Furthermore, the risk assessment performed for this Petition demonstrates that 27 pCi/g corresponds to a cancer risk of 0.5 in 10,000 for the highest RME use of PG in road construction (i.e., the road construction worker), therefore the risk from these stacks is less than 0.5 in 10,000. Based on the risk assessment performed for this Petition, EPA's PG risk management safe risk level of 3 in 10,000 corresponds to a radium (226) concentration in the PG of 148 pCi/g (see Sections I(B) and III(B)(3) and Appendix 2). Thus, PG materials in TFI's member's stacks may be safely used as road construction material. It is extremely unlikely if not impossible for random variation in the PG radioactivity levels to exceed an average 148 pCi/g, the radioactivity level that corresponds to a 3 in 10,000 risk management level. EPA performed extensive modeling of the likely migration of radionuclides from PG used in road construction in a 1992 assessment discussed below. The EPA concluded that the radionuclide doses from the groundwater pathways are all negligible. EPA's assessment demonstrates that the radionuclide risks were found to be zero.

- Screening evaluation of the potential impact of metals in PG shows that PG can be used safely by workers in road construction. Paving limits direct contact by the community and also limits water contact with PG isolated in the base layer.

- Care has been taken in the assessment process to manage scientific uncertainties by choosing values and approaches that are likely to overestimate rather than underestimate risks. These result in an RME value, which serves as a reasonable upper bound on the risk distribution and is a readily accepted approach for representing maximum exposures (see Appendix 2). It also provides insight into risks to the population. RMEs overestimate risks for highest exposure situations such that actual risks would be lower.

- For perspective on exposure magnitudes, radiation levels from the use of PG are compared to naturally occurring background. Each exposure scenario has incremental radiological dose that are well below naturally occurring background levels. Exposures to the public using the road or living immediately adjacent to the road are likely to be indistinguishable from the natural variability in background.

- There are naturally occurring background radiation and metals in other non-PG construction material including coal ash, fly ash, bottom ash, and other common construction materials. These materials have been deemed safe to use in road construction and other applications. Similarly, this Petition demonstrates the same is true for PG. The use of PG for road construction is consistent with EPA policy on recycling of wastes and waste residuals.The use of PG for roadway construction provides a net economic benefit.

- Approval of the use of PG for road construction is consistent with the Administration's regulatory reform policies.

A. Overview

The regulatory decision to approve a new use for PG is a risk management decision that is assigned to the Assistant Administrator for Air and Radiation. Risk management decisions involve weighing the results of a risk assessment with "the results of other technical analyses and nonscientific factors, to reach a decision about the need for and extent of risk reduction to be sought in particular circumstances and of the means for achieving and maintaining that reduction."[124]

This Petition and its Appendices provide the facts and science required to approve this Petition. This subsection applies these facts and the science to EPA's risk management factors and explains TFI's position that approval is appropriate.

B. The Risk Management Level of 3 in 10,000 is Consistent with Other NESHAP Goals

The EPA Office of Air and Radiation policy is to make a case-by-case decision concerning the acceptability of the risk from exposure to radionuclides.[125] However, the PG risk management limit of 3 in 10,000 is consistent with other typical EPA risk management decisions.

C. The Highest RME Risk Scenario for the Use of PG in Road Construction is Below the NESHAP Radionuclide Risk Management Goal of 3 in 10,000

This Petition demonstrates that the risks of using PG material in constructing roads satisfy the risk management goal for approved alternative uses of PG. In fact, the risk of PG in road construction is well below the risk management goal of 3 in 10,000.

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[124] Institute of Medicine, Environmental Decisions in the Face of Uncertainty, Box 2-1 (2013), *available at* https://www.ncbi.nlm.nih.gov/books/NBK200844/box/box_2_1/?report=objectonly (Uncertainty in Environmental Decisionmaking).

[125] 1989 Rule, *supra* note 3, at 51,564.

The risks from all exposure scenarios were calculated, but the highest RME risk is calculated for the road construction worker who is involved with paving the road with PG that is mixed with soil (i.e., a cancer risk of 0.5 in 10,000, lower than the PG alternative use risk management goal of 3 in 10,000). EPA has long concluded that 3 in 10,000 is the equivalent of the risk from the existing PG stacks, so this alternative does not present a meaningful difference in the risk from the existing stacks. The focus is on the road construction worker since the risks from all other exposure scenarios fall below 110 mrem during road construction use and are of lower risk, although the road worker's risk falls within EPA exposure limits as well.

The vast majority of road construction workers have much lower risks than those calculated in this Petition. Highway construction workers not directly working on the road are located further from the PG and the associated risks are lower.

The risk calculation for the highest RME for a worker placing road base assumes that the PG emits 27 pCi/g exposure for five years. Based on the preliminary data on radiation levels from PG stacks, the average level of radioactivity from the PG material in each sampled stack is less than the nominal 27 pCi/g used in the risk assessment, thus, the risk from these sampled stacks is even further below the EPA risk management safe limit of 3 in 10,000 risk level. The calculated risk is scalable, i.e., if the radioactivity level in a stack is 13.5 pCi/g, the risk is one half of the risk calculated for the nominal radioactivity level of 27 pCi/g (i.e., the 13.5 pCi/g stack corresponds to a 0.28 in 10,000 risk level, significantly lower than the EPA PG risk limit of 3 in 10,000). On average, the RME exposure and the dose to risk conversion for road construction workers using PG are likely to overestimate risk.

Similarly, the highest RME to a resident living near a road (the resident lives in a home located 50 feet or more from a road for 26 years) assuming the PG contains 27 pCi/g is approximately a 0.08 in 10,000 cancer risk, again, well below the PG use risk management goal of 3 in 10,000. Most residents living near roadways are located further than 50 feet from the edge of the road, and the RME exposure and dose to risk conversion are likely to overestimate risk.

The reclaimer scenario is not a RME since it is such a rare potential event, and should not be used in the risk management decision. Nonetheless, the risk assessment report calculated a risk using RME-type exposure input below the PG use risk management goal of 3 in 10,000.

D. Science Policy Assumptions and Uncertainties are Taken into Account in the Final Risk Management Decision

1. Overview

Each of the factors EPA considers in its risk management decision has sensitivities, variabilities, and uncertainties. EPA specifically considered uncertainties and other nonrisk factors in its 1989 and 1992 decisions on acceptable alternative uses of PG.[126]

A recent NAS report recommended incorporating an uncertainty analysis, which was broadly defined to include sensitivities, variability, and various other uncertainties, into EPA

[126] EPA PG Workbook *supra* note 43, at 5.

decisions.[127] This NAS report recommends that an "uncertainty analysis" be "designed on a case-by-case basis."[128] EPA considered uncertainties in previous risk calculations and decisions concerning alternative uses of PG.[129] However, combining RME with the inherent uncertainties in the dose to risk conversion factors can yield risks that are overly conservative compared to actual risks.

Science policy influences both the exposure calculation and the cancer potency and noncancer risk factors that convert the exposure to risk. The EPA decision makers and the public need to understand how policy influences the risk calculation. Put simply, regulatory risk is not the same as actual harm. Unduly conservative risk calculations do not serve the public, since they divert limited resources to issues that present less risk. Science policy based on accumulations of conservative assumptions, including extra layers based on uncertainties, can distort risk estimates and undermine the value and credibility of risk management decisions.

2. Measurement Variation and Uncertainty

Each calculated risk depends upon how sensitive the calculation is to changes in the measurements and input values used in any risk assessment. Risk is assumed to be linearly proportional to dose and the length of exposure. For example, if the concentration of radionuclide in PG increases by 10%, the dose (and, therefore, the risk) increases by 10%. Similarly, if the length of exposure increases by 20%, the total dose increases by 20%. See Section IV, above for a discussion of the variation.

3. Variation by Location

Some of the inputs to risk assessments naturally vary. For example, the average radioactivity level in PG stacks depends upon the source of the phosphate ore and other site specific factors. This risk assessment assumed average radioactivity levels of 27 pCi/g. However, the average level of radioactivity in PG stacks in the TFI 2019 sampling varied from 6.3 to 27.9 pCi/g and data from 1988 had average stack concentration of 34 pCi/g (see Sections I(B), III(B)(3), and Appendix 5). Even levels of 148 pCi/g are safe.[130] Again, dose is directly proportional to the radioactivity level.

4. Variation Due To Design Facts

The Risk Assessment was developed to examine a conceptual road design, to provide an estimate of the upper end RME risks associated with PG use in roads. This approach is appropriate because it is impractical to perform a risk assessment that uses different values for every conceivable road design. Neither the 1989 nor the 1992 BID risk assessment considered every conceivable road design.

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[127] Uncertainty in Environmental Decisionmaking, *supra* note 124, at 5.

[128] *Id*.

[129] EPA PG Workbook, *supra* note 43, at 5.

[130] Based on the risk assessment, PG with radiation levels a couple of times greater than 27 pCi/g may still be utilized for road construction. In fact, an average radiation level of 148 pCi/g corresponds to EPA's risk management goal of 3 in 10,000.

The following factors utilized to minimize the impact of any uncertainties are discussed in the Response to EPA Comments on January 16, 2020 (Appendix 4a).

- The 2019 radiological testing demonstrates that no individual radium (226) concentration the exceeds 35 pCi/g radium (226) concentration requested as a concentration limit and the measured stack averages are well below the 3 in 10,000 safe risk level (i.e., a radium (226) concentration of 148 pCi/g).

- The EPA 1992 BID assumed a 1:2 dilution of PG with soils for a road base concentration of 10 pCi/g. The Petition's Risk Assessment utilized less dilution (1:1 PG:soil).

- The EPA 1992 BID assumed the road base was 0.25 m thick and 30 feet (9.15m) wide and that the road base is covered with a 0.12 m (5 in) thickness of asphalt. The Petition's Risk Assessment utilized a road thickness of 0.25 m (the same as in the EPA 1992 BID).

- The EPA 1992 BID assumed PG in a concrete road incorporates 15% PG by weight and 0.12 m thick (5 in) and 24 feet wide (7.32 m). The Petition's Risk Assessment reviewed road base design criteria and concluded 15% was a high-end criterion.

- The EPA 1992 BID used exposure to the critical population group member (nearby resident 100 m (i.e., 328 ft) from the edge of the road). The Petition's Risk Assessment calculated the radiation levels at 50 feet from the edge of the road.

- The current risk assessment assumes a worker moves around over the road surface and is exposed at the average of the gamma fields at the center and edge of the road, which is more reasonable than assuming a worker never moves for 5 years. The stationary worker is not realistic or reasonable, therefore it is not an RME.

- The 1992 EPA risk assessment used a 0.6 shielding for the road user, but rather than determine the degree to which vehicles have changed the amount of metal in the under carriage of cars, the current risk assessment takes no credit for shielding provided by the vehicle which would provide some level of shielding which is a conservative assumption and could reasonably be considered.

- The current risk assessment considered two receptors beyond those considered in the 1992 BID (truck driver and utility worker).

5. <u>The Influence of Exposure Policies</u>

It is well settled that exposure is not sufficient to support regulation unless there is a significant risk.[131] Because empirical data are often not available, a 2013 National Academies of Science

[131] "When the administrative record reveals only scant or minimal risk of material health impairment, responsible administration calls for avoidance of extravagant, comprehensive regulation. Perfect safety is a chimera; regulation must not strangle human activity in the search for the impossible. *Indus. Union Dep't. v. API*, 448 U.S. 607, 642 (1980). *See Natural Resources Defense Council v. EPA*, 824 F.2d at 1164-65.

(NAS) report noted that EPA's risk assessment policies and practices rely heavily on default options or generic approaches. [132] These approaches can introduce high levels of uncertainty into risk assessments.

As noted above, the "intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures."[133] A NAS Committee reviewing EPA's regulation of technologically enhanced naturally occurring radioactive material (TENORM) recommended that EPA "should use exposure and dose risk assessments that are 'reasonably realistic'" in developing standards for exposure to the various types of low level naturally occurring radiation.[134] The Committee defined "reasonably realistic" as "not….intended to greatly overestimate or underestimate actual effects for the exposure situation of concern" and EPA agreed with the Committee's recommendations.[135] Thus, by definition, RME exposures should be intentionally set at levels that are at the high end, but not an extreme worst case.

The use of defaults has been criticized by independent commentators for: (a) "lack of an adequate scientific basis;" (b) the fact that default "can mask the uncertainty;" (c) observations that defaults can be "overly conservative;" (d) the fact that cumulative impact of uncertainties is not well defined; and (e) concerns "whether there is any basis for believing that the upper-bound estimate for one substance has the same relation to the 'true' risk as it does for another substance."[136]

The Response to EPA Comments on January 16, 2020 (Appendix 4a) summarizes and expands on the discussion of the reasons that the RMEs are supportable and consistent with EPA policies and the recommendations of learned advisory bodies.

6. <u>Risk Factor Policies and Uncertainties</u>

EPA has long utilized (and courts have long upheld) the principle that a 1 in 10,000 risk level is "safe." As a unanimous *en banc* ruling of the Court of Appeals for the District of Columbia Circuit candidly noted, the basis for claiming harm from exposure to chemicals at extremely low environmental levels is more a function of "the rules of arithmetic rather than because of any knowledge" and there was "no particular reason to think that the actual line of the incidence of

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[132] *See* Uncertainty in Environmental Decisions, *supra* note 124, at 58. *See also* National Research Council, Science and Judgment in Risk Assessment, 65 (1994), *available at* http://www.nap.edu/openbook.php?record_id=2125&page=65. *See also* General Accounting Office, Use of Precautionary Assumptions in Health Risk Assessments and Benefits Estimates, GAO-01-55, 7 (October 2000), *available at* https://www.gao.gov/products/GAO-01-55.

[133] EPA Risk Assessment Guidance for Superfund*, supra* note 10, at 7-1.

[134] EPA Report to Congress Re: TENORM, *supra* note 75, at 15.

[135] *Id*. citing the NAS Report at p. 245. "If high-end values are chosen for every exposure factor, then the resulting exposure estimate may no longer be consistent with the RME and may exceed the realm of possibility altogether." ITRC, Decision Making at Contaminated Sites, *supra* note 10, at 6.1.1.

[136] Uncertainty in Environmental Decisions, *supra* note 124, at 58. The RME and other factors utilized in the risk assessment are documented in the literature (*see* RESRAD documentation, EPA guidance or as justified in the various Appendices to this Petition).

harm is represented" by the assumption selected by EPA.[137] This acknowledgment is also apt for the risks from radionuclides.

The 2013 NAS noted that:

> EPA originally selected the linear, no-threshold default as a "conservative" or "health-protective" policy choice because it assumes that there is no dose below which risks are not increased. It is likely to generate the highest, or upper-bound, risk estimate consistent with the data; the actual risk almost certainly will not exceed the upper bound and will likely fall below it.[138]

Use of the International Commission on Radiological Protection (ICRP) value (proposed by the international institution whose purpose is to provide such advice) is supported by several factors:

First, ICRP is an expert advisory body that offers its recommendations to regulatory and advisory agencies, mainly by providing guidance on the fundamental principles on which appropriate radiological protection is based. The 2007 recommendation was produced "after eight years of discussions, involving scientists, regulators, and users all around the world."[139]

Second, the Petition's use of the ICRP dose to risk conversion factor is consistent with EPA's radiation risk assessment factors and procedures. For example, the EPA 2011 radiation guidance[140] provides cancer risk factors for uniform whole-body exposures of low-dose gamma radiation to the entire population, essentially the same dose to risk conversion range derived by the ICRP.

Similarly, as noted above, the organization chartered by the U.S. Congress in 1964 to, among other things, "develop … recommendations about …protection against radiation" (i.e., the United States National Council on Radiation Protection and Measurements (NCRP)) uses the same dose to risk conversion factor as the 2007 ICRP.[141]

Third, the international scientific and regulatory communities have widely adopted the ICRP recommendations.[142]

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[137] *Natural Resources Defense Council v. EPA*, 824 F.2d at 1165.

[138] Uncertainty in Environmental Decisions, *supra* note 124, at 58.

[139] 2007 ICRP Recommendations, *supra* note 88, at 3.

[140] EPA Radiogenic Cancer Risk Models and Projections for the U.S. Population, *supra* note 92.

[141] Management of Exposure to Ionizing Radiation, *supra* note 93, at 42.

[142] *See* Radiation Protection and Management of NORM Residues, *supra* note 59, at 165. The IAEA was founded to "establish or adopt … standards of safety for protection of health and minimization of danger to life and property" and while "[r]egulating safety is a national responsibility . . . many States have decided to adopt the IAEA's standards for use in their national regulations" (including Sweden, Denmark, the Netherlands, the UK, Japan, Canada, Belgium, Japan, and the EU). IAEA, Governmental, Legal and Regulatory Framework for Safety, 7 (2016), *available at* https://www.iaea.org/publications/10883/governmental-legal-and-regulatory-framework-for-safety.

Fourth, the International Atomic Energy Agency (IAEA) (an organization in which the U.S. is a member and helped establish) and the European Union (as well as each of its member countries) utilized a 1 millisievert (1 mSv) per year acceptable level of radiation exposure, which has been widely adopted by the international community, such as the IAEA and EU regulations. This corresponds to a 26-year total dose of 26 mSv (i.e., 2,600 mrem).

The ICRP approach is more stringent than the large, and growing, body of scientific literature that radiation risks have a threshold. Also, in 2015, a U.S. Nuclear Regulatory Commission (NRC) Advisory Committee acknowledged that:

> There is a large, and growing, body of scientific literature as well as mechanistic considerations which suggest that 1) the LNT model may overstate the carcinogenic risk of radiation at diagnostic medical, occupational, and environmental doses and 2) such low doses may, in fact, exert a hormetic (i.e., a beneficial or protective) effect.[143]

The United Nations Scientific Committee on the Effects of Atomic Radiation notes that below doses of 100 to 200 mGy (roughly equivalent to 10,000 to 20,000 mrem), "[e]pidemiological studies alone are unlikely to be able to identify significant elevations in risk."[144]

Because, as a matter of policy, neither EPA nor the Nuclear Regulatory Commission has changed its "no threshold" default assumptions, this Petition does not seek to go beyond the widely accepted ICRP value. In reality, the actual risk may be lower.

E. <u>Comparison of Radioactivity Levels from Use of PG and Naturally Occurring Background</u>

Each exposure scenario we assessed results in a radiation dose well below the annual natural background level (see Table 1, above). The annual background level of naturally occurring radiation is 310 mrem.[145] For a 26 year period, the cumulative dose is 8,060 (310 mrem times 26), thus the total dose for a nearby resident (16 mrem) given this PG use is 0.2% of the cumulative natural background dose levels ((16 divided by 8,060) (See Section I(B) and Tables 4 and 5, above)). For the RME construction worker scenario (a risk of 0.5 in 10,000), the RME worker dose is 7% of the background dose for a worker at a road construction site not using PG. (see Tables 4 and 5, above summarizing the risks from all exposure scenarios). As a result, there

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See Council Directive 2013/59/Euratom, *supra* note 95.

See UNSCEAR, Report of the United Nations Scientific Committee on the Effects of Atomic Radiation, 8 and n. 17 (2010), *available at* https://www.unscear.org/docs/reports/2010/UNSCEAR_2010_Report_M.pdf (UNSCEAR Report).

143 Nuclear Regulatory Commission, Advisory Committee on the Medical Uses of Isotopes (ACMUI), Report on the Hormesis/Linear No-Threshold Petitions, 1 (October 14, 2015), *available at* https://www.nrc.gov/docs/ML1528/ML15287A494.pdf.

144 UNSCEAR Report, *supra* note 142, at 8.

145 Appendix 2.

will be no meaningful incremental increase above the background exposure dose for any of the exposure scenarios, but particularly for the nearby resident and road user.

Background levels of radiation are often considered in governmental decisions. For example, EPA's PG Workbook compares the risk from use of PG to background levels of radiation.[146] When the calculated risk for receptors in a risk assessment is lower than background, it is a relevant factor in the risk management decision.

F. EPA Policy Supports Recycling of Wastes and Waste Residuals

EPA's 1989[147] and 1992[148] risk management decisions concerning alternative uses of PG took into account the Agency's overarching policy of supporting recycling. Since 1992, EPA has increased its emphasis on adopting sustainability policies.

EPA has prioritized policies to encourage recycling of a wide variety of byproducts and other materials.[149] Similarly, the U.S. Department of Agriculture also has issued guidance on using various reclaimed materials in road construction.[150] The recycling of PG decreases raw material costs for companies and government entities that use the PG material. It also decreases greenfield impacts, increases beneficial land use, and reduces long-term maintenance costs. Reuse of PG avoids potential environmental concerns with long-term storage of PG. As EPA notes in the context of coal ash use:

> Beneficial use is the recycling or use of coal ash in lieu of disposal. For example, coal ash is an important ingredient in the manufacture of concrete and wallboard, and EPA supports the responsible use of coal ash in this manner. This final rule supports the responsible recycling of coal ash by distinguishing beneficial use from disposal.[151]

EPA recently concluded that:

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[146] EPA PG Workbook, *supra* note 43, at 13 ("To put this number in perspective and to illustrate how little additional risk is permitted, the risk in the United States of developing a fatal cancer (from all causes) is about one in four").

[147] 1989 Rule, *supra* note 3.

[148] 1992 Rule, *supra* note 48, at 23,306.

[149] "Sustainable Materials Management (SMM) refers to the use and reuse of materials in the most productive and sustainable way across their entire life cycle. On a broader scale, SMM looks at social, environmental and economic factors to get a more holistic view of the entire system. The benefits of maximizing this connection include conserving resources, reducing waste, slowing climate change, and minimizing the environmental impacts of the materials we use." EPA, Advancing Sustainable Materials Management: 2016 Recycling Economic Information (REI) Report, EPA 530-R-17-002, 2 (2016), *available at* https://www.epa.gov/sites/production/files/2017-05/documents/final_2016_rei_report.pdf.

[150] Reclaimed Materials and Their Applications in Road Construction, *supra* note 120.

[151] EPA, Frequent Questions about Beneficial Use of Coal Combustion residuals (CCR) (last updated March 26, 2019), *available at* https://www.epa.gov/coalash/frequent-questions-about-beneficial-use-coal-ash.

> [E]nvironmental releases of COPCs from CCR fly ash concrete and FGD gypsum wallboard during use by the consumer are comparable to or lower than those from analogous non-CCR products, or are at or below relevant regulatory and health-based benchmarks for human and ecological receptors. Thus, EPA supports the continued beneficial use of coal fly ash in concrete and FGD gypsum in wallboard. Furthermore, the Agency believes that these beneficial uses provide significant environmental and economic benefits, and opportunities to advance Sustainable Materials Management (SMM).[152]

The use of CCR for beneficial use in road construction is analogous to and supports the Office of Air and Radiation's approval of the use of PG in road construction. More generally, approval of the use of PG in road construction is consistent with EPA's policy of encouraging recycling.

G. Naturally Occurring Background Radioactivity and Metals are Present Widely in the Environment, Including Existing Road Construction Materials

Many consumer products contain radioactive components (smoke detectors, clocks and watches, older camera lenses, older gas lantern mantles, older televisions and computer monitors, sun lamps and tanning salons, ceramic materials such as tiles and pottery, glassware, and some EXIT signs, among other products).[153] Most consumer products contain metals. Similarly, "[r]adioactive materials (including uranium, thorium, and radium) exist naturally in soil and rock."[154] Essentially all air contains radon and many types of soil and natural rock emit radiation.[155] In addition, virtually all road construction materials contain radioactivity and metals.

Coal ash, fly ash, bottom ash, natural gypsum, and other common construction materials[156] contain radioactive material (see Table below).[157]

A 2014 evaluation of coal ash beneficial uses concluded that:

> All of the existing evaluations identified concluded that radiation exposures from fly ash concrete are not a major source of concern. Several of these existing evaluations compared fly ash concrete to analogous products and found that the potential exposures

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[152] EPA, Coal Combustion Residual Beneficial Use Evaluation: Fly Ash Concrete and FGD Gypsum Wallboard, 5-25 (Feb. 2014), *available at* https://www.epa.gov/sites/production/files/2014-12/documents/ccr_bu_eval.pdf (Coal Combustion Residual Beneficial Use Evaluation).

[153] EPA, What kinds of consumer products contain radioactive materials (last updated on September 19, 2019), *available at* https://www.epa.gov/radiation/what-kinds-consumer-products-contain-radioactive-materials.

[154] U.S. Nuclear Regulatory Agency, Natural Background Sources (last updated October 2, 2017), *available at* https://www.nrc.gov/about-nrc/radiation/around-us/sources/nat-bg-sources.html#terr.

[155] *Id*.

[156] See Attachment B: Road construction specification examples.

[157] EPA Report to Congress Re: TENORM, *supra* note 75, at Appendix A.

> do not represent an appreciable addition to the background radiation that the general public is subjected to on an annual basis. Naturally occurring radionuclides are present throughout the environment in food, air, water, soil, consumer products, and even the human body. All natural resources used in building construction (e.g., cement blocks, bricks, granite, soil, rocks) contain some trace level of naturally occurring radionuclides. For example, the USGS concluded that "the radioactivity of typical fly ash is not significantly different from that of more conventional concrete additives or other building materials such as granite and red brick." The NCRP concluded that exposures from living in concrete buildings containing fly ash are "similar to calculations made for individuals living in a brick and masonry home. Consequently, it is assumed that the use of [coal ash] in building materials has not substantially increased the average dose to an individual in the population residing in a building constructed with brick or masonry materials."[158]

The United Kingdom Health Protection Agency "concluded that exposures to '…members of the public from the use of [fly ash] in building materials is negligible.'"[159]

Thus, the appropriate risk management consideration is not whether PG has a low level of radioactivity or metals, but whether the risk is below the EPA PG risk management goal of 3 in 10,000.

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[158] Coal Combustion Residual Beneficial Use Evaluation, *supra* note 152, at 1-7.

[159] *Id*.

Table 6 (copied (without footnotes) from "Appendix A – Table 1, TENORM Materials and References.")

As a comparison to background levels, radium 226 concentrations in soils of the U.S. are shown at the top of the table.

TENORM Material	Range of Radioactivity Concentrations, Radium 226		
	Low	Average	High
Soils of the United States [1]	0.2	1.1	4.2
Uranium Mining Overburden [2]	3	3.0	low hundreds
Uranium In-Situ Leach Evaporation Pond Solids [3]	300	–	3,000
Phosphate Ore (Florida) [4] Phosphogypsum [5] Phosphate Fertilizer [6]	7	17.3-39.5 11.7-24.5 5.7	6.2-53.5 36.7 21
Coal Ash[7]-Bottom Ash Fly Ash	1.6 2	3.5-4.6 5.8	7.7 9.7
Petroleum (oil and gas) Produced Water [8] Pipe/Tank Scale [9]	0.1 pCi/1 <0.25 pCi/g	– <200 pCi/g	9000 pCi/1 >100,000 pCi/g
Water Treatment Sludge [10] Treatment Plant Filters [11]	1.3 pCi/1 –	11 pCi/1 40,000 pCi/g	11,686 pCi/l –
Rare Earths [12] Monazite Xenotime Bastnasite	5.7	–	3,244
Titanium Ores [13] Rutile Ilmenite Wastes	3.9 – – –	8.0 19.7 5.7 12	24.5 – – –
Zircon [14] Wastes	– 87	68 –	– 1300
Aluminum [15] (Bauxite) Ores Product Wastes	4.4 – –	– 0.23 3.9-5.6	7.4 – –
Copper Wastes [16]	0.7	12	82.6
Geothermal Energy Waste Scales [17]	10	132	254

H. Use of PG For Roadway Construction Provides a Net Economic Benefit and is Consistent with the Administration's Regulatory Reform Policies

A detailed report explaining the various economic benefits to be expected from approval of PG use in road construction accompanies this Petition. The report concludes that use of PG in road construction is expected to produce cost savings ranging from $37 million to $160 million during the period 2020-2042.[160]

The approval would impose no new substantive regulatory requirements and is consistent with Presidential Executive Orders that encourage: (a) reducing unnecessarily burdensome and costly regulation;[161] (b) maximizing the use of goods, products and materials produced in the U.S.;[162] and (c) encouraging innovative strategies and trade policies.[163]

I. Other Benefits to Eliminating PG Stacks

Construction and maintenance of PG stacks are large engineering projects. There are environmental and actuarial risks presented by any such construction project. The approval of PG for use in road construction will reduce future potential risk by limiting the size of existing and potentially eliminating the need for new PG stacks.

J. Final Agency Action

EPA's determination that use of PG in road construction is deemed approved, consistent with certain criteria that must be met prior to use, constitutes final agency action under the Clean Air Act, 42 U.S.C. 7607 (b)(1), and the Administrative Procedures Act, 5 U.S.C. Section 704.

Under established legal precedents, an agency approval conditioned on specified requirements "mark[s] the consummation of the agency's decision-making process" and determines the "rights and obligations" of relevant parties, with "direct and appreciable legal consequences."[164] The approval process outlined above satisfies these legal prerequisites.

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[160] Interestingly, the lost opportunity costs from not using fly in road construction has been estimated at $4.5 billion. Transportation Development Foundation, The Economic Impacts of Prohibiting Coal Fly Ash Use in Transportation Infrastructure Construction, 5 (Sept. 2011), *available at* https://www.artba.org/wp-content/uploads/2017/06/study2011flyash.pdf. EPA should consider this lost opportunity cost in its risk management decision.

[161] Presidential Executive Order on Reducing Regulation and Controlling Regulatory Costs, Executive Order 13771 (Jan. 31, 2017).

[162] Presidential Executive Order on Buy American and Hire American, Executive Order 13788 (April 18, 2017).

[163] Presidential Executive Order on Establishment of Office of Trade and Manufacturing Policy, Executive Order 13797 (April 29, 2017).

[164] *Bennett v. Spear*, 520 U.S. 154, 178 (1997). *Whitman v Am. Trucking, Ass'n*, 531 U.S. 457, 478 (2001).

SIGNATURE PAGE

I, Andrew (Andy) T. O'Hare, CAE, am Vice President of Public Policy for The Fertilizer Institute[165] (the national trade association for fertilizer companies, including the companies that own and/or operate phosphogypsum stacks). I coordinated the preparation of this Petition and am signing on behalf of all of the TFI members who own or operate PG stacks.

Andrew (Andy) T. O'Hare

Vice President of Public Policy

The Fertilizer Institute

[165] Since multiple companies that own and operate PG stacks are making this request, this Petition was prepared and submitted to EPA by TFI on behalf of its members. A representative of TFI is included on the signature page.