DECLARATION OF JAMES DeWOLF

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I, James DeWolfe, declare:

1. I am employed by Arcadis U.S., Inc. ("Arcadis"), as a Principal Environmental Engineer. My resume is attached to this Declaration as Exhibit A. Pacific Gas and Electric Company ("PG&E") has engaged Arcadis to assist with issues surrounding the chromium plume in Hinkley, California. I have been working on chromium treatment-related issues for PG&E since October 2009. I was asked to lead a team tasked with analyzing the feasibility of Draft Cleanup and Abatement Order No. R6V-2011-0005A1 (the "Draft CAO") insofar as it requires whole-house water replacement to residents and businesses whose well water supplies have potentially been impacted by the Hinkley chromium plume. The team consisted of Arcadis' Dennis Reid, Scott Seyfried, Katie Porter, Nicole Blute, Edward Means, Sunil Kommineni, Jenifer Beatty and me. The opinions I express in this Declaration are a result of our collective analysis.

2. My opinion is that:

(a) The Draft CAO's replacement water requirements are not feasible because there is no known technology or combination of technologies that can reliably achieve hexavalent chromium levels of 0.02 ppb or less; and

(b) Even if the appropriate technologies were available, the deadlines set forth in the Draft CAO cannot be met.

3. For purposes of our analysis, we made the following assumptions:

(a) Because the declared background Cr6 concentrations in the Hinkley area average 1.2 ppb and have a declared maximum value of 3.1 ppb, we assumed all wells in the "affected area," as defined in the Draft CAO, will have Cr6 levels above the Public Health Goal

("PHG") of 0.02 ppb (*i.e.*, two orders-of-magnitude below the declared average and declared maximum background Cr6 levels). The deadlines contained in the Draft CAO would not provide sufficient time for testing and analysis to determine the exact number of "impacted wells," as defined in the Draft CAO. Based on this assumption and a review of the number of homes within the "affected area," we predict that the Draft CAO, if adopted, would require that interim replacement water be provided to between 250 and 300 homes.

(b) Cr6 concentrations in the Hinkley area wells are known to fluctuate over time in a nearly random pattern. Due to the natural variability in Cr6 detection at any given well, we assumed that at any given point in time one-third of the wells in the "affected area" will have decreasing Cr6 concentrations, one-third will have stable concentrations and one-third will have increasing concentrations. Consequently, we estimate that 100 homes (one third of all wells in the "affected area") will require permanent replacement water.

(c) According to the Draft CAO, the interim replacement water supply must, "at a minimum," provide enough water for "drinking, cooking, and swamp cooler needs." Assuming an average of three occupants per household, we estimate that the average household will consume (via ingestion) 33 gallons per day ("gpd") for drinking and cooking based on the estimates for daily per capita faucet use found in the 1999 study *Residential End Uses of Water* by the American Water Works Association. Swamp coolers can add 40 gpd per household per day during warm months. In that regard, see http://www.consumerenergycenter.org/home/heating_cooling/evaporative.html.) These values do not include water used for other purposes, such as washing, showering, and irrigation – water use in these categories can vary widely. Thus, in order to comply with the interim replacement water requirements of the Draft CAO, PG&E would need to provide 73 gpd to the average household during the warm months. In light of our estimate that between 250 and 300 locations would qualify, each month during the warm seasons PG&E would need to provide between 547,500 and 657,000 gallons of interim replacement water with Cr6 levels at or below 0.02 ppb.

(d) In light of our estimate that 100 locations would qualify for permanent replacement water, based on *Residential End Uses of Water* estimate of approximately 60 gpd per capita of indoor water use and the above described estimates for swamp cooler use, during each month of the warm seasons, PG&E would need to provide 660,000 gallons of permanent replacement water with Cr6 levels at or below 0.02 ppb.

4. Most chromium treatment studies that have focused on hexavalent chromium treatment have had target effluent concentrations of 1 to 5 ppb. Those studies include Brandhuber, *et al.*, *Low-Level Hexavalent Chromium Treatment Options: Bench-Scale Evaluation*, Project 2814, Water Research Foundation, Denver, Colorado, 2005; and McGuire, *et al.*, *Hexavalent Chromium Removal Using Anion Exchange and Reduction with Coagulation and Filtration*, Project 3167, Water Research Foundation, Denver, Colorado, 2007. Those targets are the manifestation of a scientific consensus that trying to achieve hexavalent chromium concentrations below 1 ppb is unrealistic at this time.

5. Outside of the laboratory, experiments with treatment technologies target much higher hexavalent chromium concentrations than what would be called for by the Draft CAO. For example, at West County Road 112 in Midland, Texas, the Texas Commission on Environmental Quality has installed whole-house, ion exchange treatment systems in forty-five homes. But those systems are targeting total chromium concentrations of 100 ppb. The Midland, Texas project is described at http://www.tceq.texas.gov/remediation/sites/cr112.html.

6. My team analyzed the available technologies and mechanisms for achieving the results that would be required by the Draft CAO. My conclusions are set forth in the following paragraphs. My overall conclusion is that reliably providing replacement water meeting the PHG of 0.02 ppb hexavalent chromium on the timeline set forth in the Draft CAO is technically infeasible.

7. Currently, there is no drinking water standard specific to hexavalent chromium in bottled water. Total chromium, which includes hexavalent chromium, in bottled water is regulated by the 100 ppb EPA standard for total chromium.

8. We considered the possibility of using bottled water to satisfy the requirements of the Draft CAO. Providing between 547,500 and 657,000 gallons of bottled water each month to between 250 and 300 locations throughout Hinkley poses logistical obstacles that could not be overcome in two weeks. In my opinion, the distribution of bottled water is the best alternative available, but would not satisfy the Draft CAO's requirements for the following reasons:

(a) The treated bottled water concentrations for hexavalent chromium are typically significantly greater than 0.02 ppb. In that regard, see Krachler, M. and Shotyk, W. (2008), *Trace and Ultratrace Metals in Bottled Waters: Survey of Sources Worldwide and Comparison With Refillable Metal Bottles,*" Science of the Total Environment, 407:1089-1096 (132 brands surveyed with Cr6 concentrations ranging from 0.06 to 172 ppb and a median of 8.2 ppb).

(b) PG&E could not monitor at the source the extent to which bottled water distributed to the Hinkley community met the 0.02 ppb standard because bottled water providers (i) are not required to report or declare the hexavalent chromium concentrations to the consumers or regulators and (ii) often use water from different plants and employ different treatment processes.

(c) Theoretically, PG&E could test the bottles for Cr6 after they leave the plant. But in doing so, PG&E would be confronted with an almost impossible testing protocol. Because bottled water under one label often comes from multiple sources and has undergone different treatment processes, PG&E would have to test all of the bottles. In doing so, PG&E would necessarily have to break the seals, thereby exposing the water to microbial activity. And if a shipment of bottled water failed to meet the 0.02 ppb standard, PG&E would be forced to switch suppliers. But the new supplier is likely to use multiple sources and treatment processes, thereby creating the same problems associated with the original supplier.

9. We considered the use of bulk water delivery to homes and business in Hinkley by tanker trucks to satisfy the requirements of the Draft CAO and, for the following reasons, I concluded that it is not a viable option:

(a) Depending on the source of the water, the hexavalent chromium concentrations will likely be significantly greater than 0.02 ppb, the exact concentration depending on the source of the water.

(b) The bulk water delivery strategy would create ancillary problems. Bulk water will age in the storage tanks, and its quality will deteriorate over time. This could be partially mitigated by the addition of disinfectants to maintain microbiological quality, but that can create other risks.

10. I concluded that using water from Golden State Water Company would not satisfy the requirements of the Draft CAO for the following reasons:

(a) The design, planning, permitting and construction of transmission mains and a new distribution system would take at least a year and probably more than two years.

(b) Golden State Water Company's groundwater likely contains hexavalent chromium concentrations in excess of 0.02 ppb. Thus, treatment would be required via ion exchange, reverse osmosis, or reduction, clarification, and filtration technologies, or some combination of these technologies. All of the obstacles and limitations of those technologies, which I address in the following paragraphs, would have to be overcome.

11. We considered whole-house treatment using ion exchange to satisfy the requirements of the Draft CAO. But this technology is still unproven to treat to the 0.02 ppb level and, in any event, would create other significant environmental, logistical, health and safety issues. Therefore, I have concluded that it is not a viable option:

(a) Multi-stage ion exchange system with pH adjustment capability using acid and caustic feed systems are likely needed to meet the 0.02 ppb standard, but extensive and lengthy testing would be needed to demonstrate this technology.

(b) Incorporating acid and caustic feed systems for the whole-house treatment poses health, safety and operational concerns. Ion exchange treatment would generate a liquid residual stream, either brine or caustic, that would contain elevated concentrations of hexavalent chromium and other constituents that could be classified as hazardous waste under federal law. There is also the practical problem that septic systems may not have the capacity to handle the flow from the ion exchange regeneration process, and the biological processes within the septic system would likely be negatively affected. Furthermore, effluent from the septic tanks entering a drain field would then likely reintroduce chromium to the environment.

(c) The ion exchange process can result in "chromatographic peaking" of other constituents, such as nitrate and sulfate. Chromatographic peaking is a phenomenon in which less preferentially absorbed ions appear in the effluent at higher concentrations than they appear in the influent as they are released from ion exchange resin when more strongly held ions (in this case, chromium) are adsorbed. Multiple ion exchange units in either series or parallel operation and frequent monitoring can help minimize chromatographic peaking occurrence, but this adds substantial levels of operational complexity that are beyond the capabilities of most homeowners.

(d) Additional engineering studies would be necessary to achieve low-level hexavalent chromium targets, because the systems currently on the market are not designed to achieve 0.02 ppb levels. I predict that such studies will reveal that other constituents – iron, manganese and arsenic – would require removal prior to chromium treatment. This would be particularly problematic in home-based units because of added operational complexity and the generation of waste streams that require special handling.

(e) The California Department of Public Health ("CDPH") allows the use of whole-house treatment systems for specific contaminants removal only on a limited basis, and there must be fewer than 200 connections. PG&E would need to apply to CDPH for a permit, and CDPH would not issue it until a pilot project was designed and completed. That process would take two to six months. Even then, CDPH typically only allows the use of whole-house treatment systems as an interim measure, perhaps for three years or less, until an alternative source is in place. CDPH would likely conclude that potential unforeseen risks of a new or untested technology would outweigh any public health benefit achieved by lowering Cr6 concentrations below natural background levels.

12. We considered whole-house treatment using reverse osmosis (RO) membranes to satisfy the requirements of the Draft CAO and, for the following reasons, I concluded that it is not a viable option:

(a) Assuming hexavalent chromium in the influent of 3.2 ppb and a treatment goal of 0.02 ppb, the RO membrane treatment needs to achieve 99.5 percent removal. A single-pass RO treatment system cannot likely remove the necessary quantities of hexavalent chromium to meet the 0.02 ppb goal. Consequently, a multi-pass RO system would be necessary.

(b) A multi-pass RO system will generate a significant quantity of rejected water that would require disposal. Approximately 50 to 75 percent of the feed flow will likely be rejected. Disposing of large volumes of RO reject to septic tanks is likely impossible, and would likely have deleterious impacts on the biological activities within the septic tanks. Furthermore, effluent from the septic tanks entering a drain field would then likely reintroduce chromium to the environment.

(c) The energy required to operate multi-pass RO systems will increase electrical power consumption and lead to higher electric utility bills. For example, a device utilizing 1,000 watts operating for twelve hours per day, with a $0.10/kilowatt-hour would cost $33.60 per month to operate. Were RO systems to be operating in multiple homes at the same time, there could be a significant load on the electrical power grid, depending on the number of homes utilizing a RO system. Also, separate breakers and adequate power services would be required to provide electricity for the operation of these RO systems. In older homes, this may require substantial upgrades to electrical services, which requires adequate time to plan, acquire and install the required components for an electrical service upgrade.

(d) The presence of other scale-forming compounds – such as silica, sulfate, barium and strontium – will limit the product water to feed water ratio.

(e) The RO systems currently on the market are not designed to achieve 0.02 ppb levels, so engineering advancements would likely be required to achieve 0.02 ppb levels.

(f) Pretreatment of waters prior to the use of RO may also be required to address the removal of performance-impacting constituents, which further complicates utilizing this technology for whole-house treatment to reliably meet the 0.02 ppb goal.

13. We considered the implementation of reduction, clarification and filtration (RCF) technologies via centralized treatment to satisfy the requirements of the Draft CAO, and primarily because the technology has not been demonstrated to produce effluent with a level of 0.02 ppb Cr6 or less, I concluded that they are not a viable option:

(a) The RCF process has been used only on a pilot-project scale, and those projects have demonstrated substantial logistical and process control issues.

(b) Separate unit processes are required to convert hexavalent chromium to the trivalent form (reduction), followed by oxidation to form large particles for settling (clarification), and also granular media extracted by low-pressure membrane filters (filtration). Extensive pilot testing would be required and could take a year or more to demonstrate. Furthermore, system operators would require advanced skills and extensive certifications that would require substantial training and CDPH approval, further lengthening the approval process for such a technology.

(c) Given RCF's present limitations, the effluent from this process would likely require RO treatment to achieve the 0.02 ppb goal for hexavalent chromium, which further complicates treatment. Those considerations, as well as RO's associated design and operational complications, are described above.

14. We considered the implementation of a central treatment and distribution system to satisfy the requirements of the Draft CAO, but a centralized treatment scheme itself would not achieve the 0.02 ppb goal. Central treatment would likely employ one or more of the technologies analyzed above: Ion exchange, multiple stage RO and/or RCF. The technologies

have simply not been proven to be able to achieve 0.02 ppb Cr6 concentrations. Furthermore, implementing a central treatment system would take far longer than the Draft CAO would allow because of the need to test, plan, obtain permits, design, obtain operator certification, and construct a central water supply, treatment and distribution system.

15. In summary, I have concluded that it is not feasible to install and operate a replacement water system for the Hinkley area to treat to the 0.02 ppb Cr6 level, and in the time frame required by the Draft CAO:

(a) Bottled water would be the best option in the short term, but even then the logistical, analytical and treatment requirements – including the inevitable negotiations and certifications with bottled water vendors and the process of demonstrating the capability to consistently achieve the 0.02 ppb goal – would take considerably longer than the deadlines established in the Draft CAO.

(b) The bulk delivery option would require at least six months to analyze the treatment technologies proposed by the vendors, implement those technologies and verify the quality of the water delivered.

16. I estimate that it would take approximately two and a half years before a central treatment and distribution system could be fully functional. The requisite pilot testing to demonstrate the feasibility of achieving 0.02 ppb Cr6 concentrations would consume six to

twelve months depending on the scalability of the facilities. An environmental impact report would likely be required for a centralized system, and that process alone could take a year, assuming no litigation-related delays. The design and construction of a small-scale system would take another six months. A system large enough to comply with the Draft CAO would likely take a year to design and construct.

(a) I reviewed the June 24, 2011 letter from David Loveday and Pauli Undesser of the Water Quality Association (the "WQA") to Harold Singer commenting on the Draft CAO. According to the letter, the WQA promotes sales of water treatment devices. I have several comments about the WQA letter: According to the letter, the technologies "readily available" to address Cr6 reduction include "reverse osmosis (using TFC or CTA membranes), distillation, strong base anion resin, and weak base anion resin." But the assertion that these technologies are "readily available" is contradicted by the next sentence of the WQA letter, which states: "However, California requires testing of such technologies to validate performance according to national standards and at this time, none of the best available technologies in a whole house format are [*sic.*] is tested and certified." Thus, none of the technologies can be considered "readily available."

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct, and that this Declaration was executed on July 8, 2011, at State College, PA.

[signature] 7/8/11
James DeWolfe

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EXHIBIT A

Declaration by:

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Education:
United States Navy Nuclear Propulsion Program, Submarine Service, 1976-1982
BS, The Pennsylvania State University – Environmental Engineering, 1987
MS, The Pennsylvania State University – Environmental Engineering, 1990

Professional Affiliations:

American Water Works Association (AWWA)

- Member, AWWA Water Resources and Source Water Protection Technical Advisory Workgroup of the Water Utility Council (WUC)
    - **Mission:** To monitor and interact with USEPA, USDA and other federal agency activities on regulations that affect source water protection to protect drinking water supplies; compile, develop and analyze date related to source water protection; and develop draft official comments and testimony on source water protection regulatory activities and proposals.
- Member, Coagulation and Filtration Committee, Water Quality and Technology Division of the Technical and Educational Council (TEC)
    - **Mission:** To advance and disseminate knowledge which promotes the effective and economical application of coagulation and filtration in water treatment.
- Member, B100 Standard Committee for Granular Filter Media of the Standards Council
    - **Mission:** To develop and maintain standards and related manuals, reports, etc., for filtering materials for water treatment. Specific media covered include: silica sand, support gravel, anthracite coal, high density media, and granular activated carbon.
- Past Chair, Pennsylvania Section AWWA Research Committee
- Past Trustee, Pennsylvania Section AWWA North Central District

Professional Summary

- Senior member of Water Planning Division staff, providing services internationally to municipal and private sector clients.
- 22 years of experience in drinking water, wastewater, and industrial water planning, design, research and operations, gained through work in engineering consulting and private industry.
- Senior technical advisor to PG&E on ex-situ chromium remediation project in Topock, CA utilizing the reduction, clarification and filtration (RCF) process
- Leader of Water Planning Group's Operations and Process Specialist (OPS) team