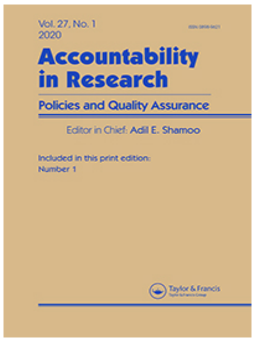

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Using routine, independent, scientific-data audits as an early-warning for potentially fraudulent toxic-site cleanup: PCE, TCE, and other VOCs at the former Naval-Ordnance Test Station, Pasadena, California

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ABSTRACT
Two of the most prevalent Superfund-site contaminants are carcinogenic solvents PCE (perchloroethylene) and TCE (trichloroethylene). Because their cleanup is difficult and costly, remediators have repeatedly falsified site-cleanup data, as Tetra Tech apparently did recently in San Francisco. Especially for difficult-to-remediate toxins, this paper hypothesizes that scientific misrepresentations occur in toxic-site assessments, before remediation even begins. To begin to test this hypothesis, the paper (1) defines scientific-data audits (assessing whether published conclusions contradict source data), (2) performs a preliminary scientific-data audit of toxic-site assessments by consultants Ninyo and Moore for developer Trammell Crow. Trammel Crow wants to build 550 apartments on an unremediated Pasadena, California site – once a premier US Navy weapons-testing/development facility. The paper (3) examines four key Ninyo-and-Moore conclusions, that removing only localized metals-hotspots will (3.1) remediate TCE/PCE; (3.2) leave low levels of them; (3.3) clean the northern half of soil, making it usable for grading, and (3.4) ensure site residents have lifetime cancer risks no greater than 1 in 3,000. The paper (4) shows that source data contradict all four conclusions. After summarizing the benefits of routine, independent, scientific-data audits (RISDA), the paper (5) argues that, if these results are generalizable, RISDA might help prevent questionable toxic-site assessments, especially those of expensive-to-remediate toxins like PCE/TCE.

KEYWORDS
military toxic waste; Ninyo and Moore; perchloroethylene; remediation; risk; scientific fraud; scientific-data audit; Pasadena; California; toxic-waste site; Trammell Crow; vapor intrusion; volatile organic compounds

Introduction

Two of the most widespread, deadly, and difficult-to-remediate contaminants at US Superfund sites are the chlorinated solvents, volatile organic compounds (VOCs) and degreasing agents, perchloroethylene (PCE) and trichloroethylene (TCE) (Yoshikawa, Zhang, and Toyota 2017). Yet their remediation remains a challenge because no one has yet developed timely,

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cost-effective PCE and TCE cleanup technologies (Sekar, Taillefert, and DiChristina 2016).

Widespread, potentially scientifically fraudulent, PCE and TCE cleanup

Partly as a consequence of expensive PCE and TCE cleanup, polluters, developers, and environmental remediators often have substantial financial incentives not to fully remediate PCE and TCE, yet to claim they have done so. As a result, at scores of US toxic-waste sites, PCE/TCE cleanups have fallen victim to apparent scientific fraud and research misconduct. From the US Navy shipyard at Hunter's Point in San Francisco (NAVFAC 2019; Gavaskar, Tatar, and Condit 2005; Gibbs Law Group 2019); to the Amphenol industrial property in Franklin, Indiana (US EPA 2019a, 2019b; Cosier 2019); to the W.R. Grace site in Woburn, Massachusetts (Costas, Knorr, and Condon 2002; MDPH 1997; Bair and Svitana 2016); to the US Marine Corps base at Camp LeJeune, North Carolina (Hamilton 2016); to the Jordan Downs project in Los Angeles (Andersen Environmental 2017; Chandler 2017), and especially at US military sites (Hamilton 2016), people have repeatedly been harmed by supposedly cleaned-up PCE and TCE sites.

One solution to fraudulent toxic-site remediation

At hundreds of US toxic sites, PCE and TCE are suspected of causing thousands of cancers, birth defects, and other health harm (Aschengrau et al. 2018; Hamilton 2016; Aschengrau et al. 2009). This widespread harm raises the question: How might scientists and regulators help to avoid research misconduct and scientific fraud in assessing the risks and doing cleanup of expensive-to-remediate toxins like PCE and TCE at contaminated sites?

This paper provides one potential and preliminary answer to this question. It hypothesizes that especially in cases of toxics cleanups that are difficult and costly, as with PCE and TCE sites, assessors are likely to misrepresent risk-assessment data in ways that routine, independent scientific-data audits (RISDA) might help detect or prevent.

Significance of these findings as a partial solution to fraudulent cleanups

The research findings of this article are significant for human health, as the US Environmental Protection Agency (EPA) says one in four Americans lives within 3 miles of a contaminated site that could pose "serious risks to human health and the environment" (GAO 2019). People are at risks from these sites, partly because of rampant fraud in toxic-site cleanup (eg, US EPA 2019c; US DOJ 2019, US OIG-DOT 2018; Robbins et al. 2017).

The Inspector General of the Department of Defense especially warned of fraud by environmental-cleanup contractors at US military toxic sites, calling it "one of the Pentagon's 'high risk vulnerabilities'" (Lustgarten 2017), mainly because of government inability to oversee thousands of site cleanups at once. Just the current cleanup of the US legacy from the Cold War is the largest environmental-cleanup operation in the world, "encompassing an area equal to the combined size of Rhode Island and Delaware" (OIG 2019, 10).

Even President Lincoln argued that the federal government could not adequately police powerful contractors. As a result, Lincoln insisted that the False Claims Act include "a provision to reward informers who assist the government in prosecuting fraud." He believed that otherwise, because of many disincentives, "informers would not come forward" (Morenberg 1995, 625).

The former naval ordnance test station, Pasadena, California

This article begins evaluating the preceding hypothesis, namely, that especially in cases of toxics cleanups that are difficult and costly, as with PCE and TCE sites, assessors are likely to misrepresent risk-assessment data in ways that RISDA might help detect or prevent. To begin to evaluate this hypothesis, the paper performs a brief scientific-data audit of assessments of a prominent, US Navy PCE-and-TCE-contaminated site in Pasadena, California. This 9-acre, toxic-waste site is known as the Naval Information Research Facility (DTSC 2019a), formerly the Naval Ordnance Test Station Pasadena (Kennedy/Jenks 2007).

For 30 years, from the mid-1940s through the mid-1970s, the US Navy used the Pasadena toxic-waste site to develop, test, and manufacture fire-control systems, Polaris (nuclear) missiles, torpedoes, anti-submarine, and other classified weapons systems. Full-scale weapons tests took place nearby at China Lake, but development, bench-scale tests, and weapons manufacturing all took place at the Pasadena site. It had two rail spurs to bring in raw materials and to ship out finished weapons (Kennedy/Jenks 2007, 4–5, 11, 15; Ninyo and Moore 2017b, 2–3; CPPCD 2018, 85).

Nearly all of the Navy's 29 buildings remain onsite, just as they were during World War II. Repeatedly prospective purchasers expressed interest in the toxic site, located beside the 10-lane I-210 freeway, then hired consultants to assess site toxicity, cleanup, and redevelopment. However, after reading the resulting assessments, all prior purchasers, to date, have backed out (Kennedy/Jenks 2007). As a result, the site has not been cleaned up – - only walled and then paved over. It is now used as a mini-rental-unit facility that has tiny, metal, temporary-storage units placed on the asphalt areas of the property that have no buildings on them (CPPCD 2018, 8, 134).

Recently consultants Ninyo and Moore performed toxicity, remediation, and redevelopment assessments of the Pasadena site on behalf of the largest US commercial developer ($65 billion in assets), Trammell Crow (TCC

2019a). After it purchases the toxic site, Trammell Crow wants to use it to build retail space and 550 small apartments. At least 20 percent of the apartments will be for affordable housing, and 40 percent of them will be for families. The Trammell Crow plan appeals to many people because of southern California's housing shortage (CPPCD 2018, 1–2, 41).

PCE and TCE contamination at the Pasadena toxic site

Given the secret, classified, military research, development, and testing that took place for 30 years at the site, its main "risk drivers" are trichloroethylene (TCE) and perchloroethylene (PCE) – -and also carbon tetrachloride, dibromochloromethane, and other carcinogenic volatile organic compounds (VOCs). These VOCs, chlorinated solvents, pose a carcinogenic-vapor-intrusion risk to site residents and those living nearby (Ninyo and Moore 2017b, 34).

Other site contaminants include heavy metals such as lead, mercury, cadmium, and hexavalent chromium, many from the onsite foundry and weapons-fabrication shop; dioxins and furans from the site's 5 former incinerators; Total Petroleum Hydrocarbons (TPH) from diesel, motor oil, gasoline, and unknown (likely solvent) hydrocarbons that were in multiple underground storage tanks; semi-volatile organic compounds such as polycyclic aromatic hydrocarbons (PAHs), especially benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene; PCBs; radioactive materials; rocket/missile/weapons propellants such as perchlorate; and fire-fighting contaminants such as polyfluoroalkyl substances (PFAS) (CPPCD 2018, 12–14).

Although the California Department of Toxic Substances Control (DTSC) called the Pasadena toxic site an "imminent and substantial" danger, and it remains on its official list of toxic sites that must be cleaned up (Kennedy/Jenks 2007, 8), Trammell Crow and Ninyo and Moore want to allow most site carcinogens, including TCE and PCE, to remain "in place" onsite (Ninyo and Moore 2017a, 4, 8). The only preconstruction site remediation that DTSC is requiring of Trammell Crow is removal of 11 small, localized, metals-hotspots (Ninyo and Moore 2017a, 8, 2017b, 20, 29).

After site construction, Ninyo and Moore and Trammell Crowe want to implement any needed removal actions for PCE, TCE, and other VOCs, in case these carcinogenic vapors are shown to enter the new site buildings (Ninyo and Moore 2017b, 38–39). Carcinogenic VOC contamination is "widespread" onsite, in all areas and depths tested (Ninyo and Moore 2017b, 38). At scores of onsite locations, carcinogenic soil vapors are hundreds of thousands of times above the allowed one-in-a-million-risk level of 1.0E-06; the highest PCE contamination is at least 743,480 times above this allowed level (Ninyo and Moore 2017c, Table 3).

In 2018, in a controversial split vote, the city of Pasadena, California approved the Trammell Crow redevelopment of the toxic site, partly because it includes hundreds of "affordable housing" units (CPPCD 2018). The California Department of Toxic Substances Control also approved the redevelopment (DTSC 2019b). However, the site developer has not yet bought the property.

Materials

The two toxic-site assessments, on which the authors performed a scientific-data audit, are both authored by Ninyo and Moore, the contractor for the developer, Trammell Crow. One assessment is the roughly-500-page document, the Remedial Investigation and Feasibility Study. It argues that it is feasible to redevelop the site before doing any groundwater testing or VOC removal but, instead, to remove only 11 localized metals-hotspots (Ninyo and Moore 2017a, 8, 2017b, 20, 29). Its feasibility argument is that TCE, PCE, and other carcinogenic VOCs present an average unmitigated lifetime risk of only about 1 cancer in every 3000 persons exposed. They also argue that if these soil-VOCs are later shown to enter future site residences and present a vapor-intrusion risk, the soils can be remediated at that time (Ninyo and Moore 2017b, 34, 2019b, 46–51).

The second site-assessment document is the Removal Action Workplan, also roughly 500 pages. It identifies and evaluates 3 post-construction, candidate approaches to site cleanup for residential use.

The first alternative is no action. The second alternative is preconstruction removal of only 11 localized metals-hotspots, then post-construction remediation of TCE, PCE, and other carcinogenic solvents, if their vapors enter site apartment residences above the allowed one-in-a-million-risk level of 1.0E-06. However, the developer admits that the second alternative could cause "more than a year" of high cancer risks to site residents while the carcinogenic solvents are being remediated (Ninyo and Moore 2017b, 35–43; 2019b, 50). The third cleanup alternative is like the second, except that it includes soil-vapor extraction of carcinogenic VOCs like TCE and PCE during site construction. The developer admits that "such a process of removing VOCs from soil gas at the site would eliminate any potential vapor-intrusion threat to future residential site users, but would be a costly and time-intensive process" (Ninyo and Moore 2019b, 47). Given this "costly and time-intensive process," the developer plans to use alternative 2, and California Department of Toxic Substances Control has approved this plan (Ninyo and Moore 2019b, 51).

Methods

Recall that the main hypothesis, whose preliminary examination this article begins, is this: Especially in cases of toxic cleanups that are difficult and costly, as with PCE and TCE sites, assessors are likely to misrepresent risk-assessment data in ways that routine, independent, scientific-data audits

(RISDA) might help detect or prevent. The main method used to begin examination of this hypothesis is proposed in a classic article by Shamoo and Annau (1987, see 1990) in *Nature*, 32 years ago.

RISDA are analogous to financial-data audits, are completely non-obtrusive, don't interfere with the research process itself, and are conducted by an independent third party. RISDA simply check to see if the published conclusions agree with the source data – -from which those conclusions should be drawn (Shamoo 2013).

The benefits of RISDA are like those of financial audits for banks or audits by the Internal Revenue Service. On one hand, audits tell people that they may be audited and that, if there are irregularities, the perpetrators will be punished (Shamoo 1988, 1989, 2001, 2013). On the other hand, if there are no RISDA, and if the financial stakes in a toxic-waste cleanup are high, site assessors may reason that they are unlikely to be caught and punished. If so, they might be more likely to take chances by misrepresenting site science.

Results

Four published assessment conclusions to compare with source data

To conduct a preliminary data audit that compares published conclusions with source data, we chose four conclusions in the Remedial Investigation and in the Removal Action Workplan that seem most essential to allowing the site developer to conduct only a very quick, partial, inexpensive, pre-construction site cleanup. They allow the developer to perform no preconstruction groundwater testing and no cleanup of TCE, PCE, and other chlorinated solvents that drive site risks. These four conclusions are that removal of only 11 localized metals-hotspots, and no other preconstruction remediation, is defensible

(1) because "the excavation of hot-spots will remove [carcinogenic-solvent] VOC vapor intrusion risks from the site" (Ninyo and Moore 2019b, 46);
(2) because there are only "low level VOC concentrations in soil at the site" (Ninyo and Moore 2019b, 51);
(3) because "VOCs…are more focused in the southern and eastern portions" of the site (31), and "the northern section of the site…is considered to be clean soil" (California Department of Toxic Substances Control (DTSC) 2019b, 46);
(4) because the site has only "an unmitigated total excess cancer risk of 3.4 E-04," that is, 3.4 per 10,000 lifetime exposures, or lifetime risks of only about 1 in 3000 (Ninyo and Moore Consultants 2017b, 34).

Subsequent paragraphs compare each of the four preceding conclusions with the source data.

First questionable conclusion: Metals cleanup will remove carcinogens

Do source data support the first published assessment conclusion, that removal of only 11 localized metals-hotspots, and no other preconstruction remediation, is defensible because "the excavation of hot-spots will remove [carcinogenic-solvent] VOC vapor intrusion risks from the site" (Ninyo and Moore 2019b, 46)? Subsequent paragraphs show that the answer is no.

Chlorinated-solvent VOC carcinogens are the main site risks

As already noted, the site "risk drivers" or main contaminants are chlorinated-solvent carcinogens and VOCs such as PCE and TCE (Ninyo and Moore 2017a, 8, 2017b, 20, 29). However, the only preconstruction remediation that the developer is required to conduct will be cleanup of 11 small (about 15 feet by 15 feet) metals-hotspots (Ninyo and Moore 2019b, 54). This means the developer must explain how only-metals-hotspot removal will remediate the main site risks, namely "widespread" VOC carcinogens. The developer justifies his metals-only remediation by claiming: "the excavation of hot-spots will remove [carcinogenic-solvent] VOC vapor intrusion risks from the site" (Ninyo and Moore 2019b, 46). The developer says this

metals-only "removal [will]…cleanup the site…for future …residential use" (Ninyo and Moore 2019b, 19). When one examines the source data, however, they do not support this conclusion.

Source data on metals-hotspots contradict the first conclusion

In the assessors' Figure 7 (Ninyo and Moore 2017b) shows that the suspected 11 metals-hotspots, respectively, are at locations 011-SP01 (also called USC-SP11); NMSV10; USC-SP-18; USC-SP-103; NMSV8; 103-SP01; no data/location, but West of bldg. 5; V-19 (also called 007-SB01); V-8 (also called B-1); 131-SB01; and North of building 19 (no data, no precise location). Of these 11 suspected metals-hotspots, 5 are located along the site's southern boundary, at the SE corner, while 6 suspected metals-hotspots are at/near the center of the 9-acre site.

Note that, as Figure 7 (Ninyo and Moore 2017b) and our Figure 1 (our annotation of Figure 4 (Ninyo and Moore 2017b) annotated by plotting the assessors' sampling data on it) show, there are no suspected metals-hotspots in the northern 1/3 of the site; none in the eastern 1/3 of the site, except at the southern boundary; and no metals-hotspots in the western 1/3 of the

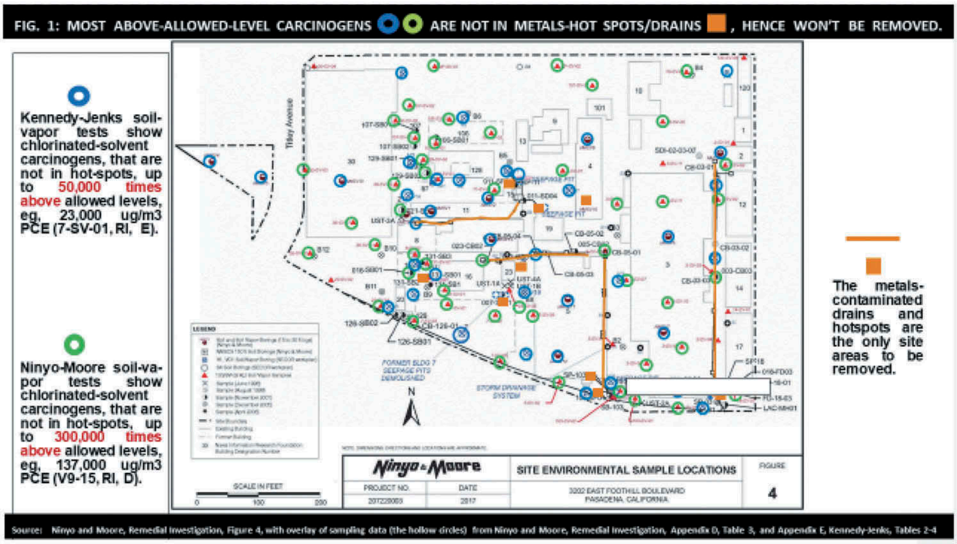

Figure 1. Most carcinogens, above allowed levels, are not in hotspots-drains (Ninyo and Moore 2017b).

site. Yet, there are at least 89 site-sampling locations that show VOC-carcinogens that exceed the allowed one-in-a-million-risk level of 1.0E-06.

The samples of the developer Trammell Crow's contractor, Ninyo and Moore (who claims that removing only 11 metals-hotspots would remove excess VOC-solvent-carcinogens) show at least 89 nonmetals-hotspot locations of VOC carcinogens that are present at levels up to 300,000 times above the allowed risk level of 1.0E-06 (Ninyo and Moore 2017d, Table 3). For instance, Ninyo and Moore's own 5-foot-depth, nonmetals-hotspot samples, such as V2-5, V10-5, V18-5, show PCE at levels that are up to 5 orders of magnitude – -hundreds of thousands of times – -above allowed levels. Ninyo and Moore's own 5-foot-depth, nonmetals-hotspot samples, such as NMSV7-5, NMSV6-5, V2-5 show carbon tetrachloride (CT) at levels that are 4 orders of magnitude – -tens of thousands of times above allowed levels. At depths less than 100 feet below ground surface – -depths at which carcinogenic, gaseous VOCs easily enter buildings to cause cancer (DTSC 2011b), nonmetals-hotspot, site-sampling locations such as NMSD3-84, NMSD1-85, NMSD3-60, reveal CT or PCE levels that are hundreds of thousands of times above allowed levels – -5 orders of magnitude above what is allowed (Ninyo and Moore Consultants 2017d, Table 3).

The soil-vapor-sampling source data, in the Remedial Investigation (Ninyo and Moore 2017d, Table 3), clearly show that the conclusion of developer Trammell Crow's contractor, Ninyo and Moore, is false. They err in claiming that "the excavation of [metals-]hot-spots will remove [carcinogenic-solvent] VOC vapor intrusion risks from the site" (Ninyo and Moore 2019b, 46).

Second questionable conclusion: Site soil has only "low level VOC concentrations"

Do source data support the second published assessment conclusion, that removal of only 11 localized metals-hotspots, and no other preconstruction remediation, is defensible because there are only "low level VOC concentrations in soil at the site" (Ninyo and Moore 2019b, 51) ?

Again, Ninyo and Moore's own source data contradict their published conclusion of only low-level site VOC concentrations, as our Table 1 illustrates. That is, their source data show that samples, for instance, at locations NMSV10-5, V9-15, VD2-30, V-5-15, V9-10, V10-5, NMSD3-60, VD1-20, for instance, have PCE at levels, respectively, that are 743,480 times; 298,000 time; 265,217 times; 172,00 times; 85,000 times; 79,000 times; 48,480 times; 43,913 times above the allowed site risk level of 1.0E-06. Indeed, 100 percent of Ninyo and Moore's hundreds of PCE samples show levels that are up to hundreds of thousands of times above the allowed risk level of 1.0E-06 (Ninyo and Moore 2019b, Table 3).

Similarly, Ninyo and Moore's own source data contradict their claim that the site has only low-level VOC concentrations, as our Table 2 illustrates. For

Table 1. Onsite perchloroethylene (PCE) levels: Up to 5 orders of magnitude above allowed levels.

Sample Location	PCE (ug/l) Concentration	÷ **by**0.00046 ug/l (screening level) = times above allowable limit	Located in Metals-Hotspot?
NMSV10-5	342	743,480	yes
V9-15	137	298,000	no
VD2-30	122	265,217	no
V-5-15	79	172,000	no
V9-10	39.1	85,000	no
V10-5	36.3	79,000	no
NMSD3-60	22.3	48,480	no
V6-15	20.5	45,000	no
VD1-20	20.4	44,347	no
NASD3-113	17.9	38,913	no
V2-15	16.7	36,304	no
NMSV12-15	14.5	31,522	no
NMSV15-15	14.2	30,870	no
NMSV11-15	13.5	29.348	no
V18-15	13.5	29,348	yes
NMSV14-15	11.6	25,217	no
VD1-30	10.8	23,500	no
V8-15	10.5	23,000	no
NMSV2-15	10.2	22,174	no
V2-5	9.47	21,090	no
V18-5	8.32	18,090	no
NMSV13-5	5.51	11,978	no
NMSV4-15	1.29	2,804	no

All of Ninyo and Moore's PCE samples violate US EPA screening (allowable) levels (indicating a lifetime cancer risk of 0.000001), including the 25% of PCE samples above (Remedial Investigation, Appendix D, Table 3)

Table 2. Onsite carbon tetrachloride (CT) levels: Up to 5 orders of magnitude above allowed levels (Ninyo and Moore 2017d).

Sample Location	CT (ug/l) Concentration	÷ 0.000067 ug/l (screening level = times above allowable limit)	Located in Metals-Hotspot?
NMSD3-113	28.4	424,000	no
NMSD3-84	24.3	363,000	no
NMSD3-150	20.6	307,463	no
NMSD3-150	18.5	276,119	no
NMSD2-150	13.2	197,015	no
NMSD2-130	12.9	193,000	no
NMSD2-150	9.83	146,700	no
NMSD3-60	8.39	125,224	no
NMSO1-85	7.53	112,388	no
NMSD1-99	5.95	90,806	no
NMSD2-63	2.67	40,000	no
VD1-30	2.27	34,000	no
NMSD2-130	2.27	33,881	no
NMSV7-5	1.82	27,164	no
VD3-20	1.45	21,642	no
VD3-30	1.42	21,200	no
V2-5	1.39	21,000	no
NMSV6-5	1.38	20,600	no
V8-15	1.36	20,300	yes
VO12-15	1.19	18,000	no

instance, their samples at locations NMSD3-113, NMSD3-84, NMSD3-150, NMSD3-150, NMSD2-150, NMSD2-130, NMSD1-85, NMSD1-99, NMSD2-150, NMSD3-60, for instance, have carbon tetrachloride at levels, respectively, that are 424,000 times; 363,000 times; 307,463 times; 276,119 times; 197,015 times; 193,000 times; 112,388 times; 90,806 times; 146,700 times; and 125,224 times above the allowed site risk that would cause cancer in one person in a million exposed people over a lifetime (Ninyo and Moore 2019b, Table 3).

Indeed, 60 percent of Ninyo and Moore's hundreds of carbon tetrachloride samples show levels that are up to hundreds of thousands of times above the allowed risk level of 1.0E-06 (Ninyo and Moore 2019b, Table 3).VOC contaminants this high, able to cause ten percent of exposed people to get cancer, arguably are not "low level VOC concentrations" (Ninyo and Moore 2019b, 51), as Ninyo and Moore claim.

Third questionable conclusion: Soil in the northern half of the site is clean

The third questionable conclusion, assessed in our preliminary data audit, is that removing only 11 localized metals-hotspots, doing no other preconstruction remediation, and using northern soil for site grading are defensible because site VOCs are "focused in the southern and eastern portions" of the site (Ninyo and Moore 2019b, 31), and northern soil "is considered to be clean soil" (DTSC 2019b, 46). Note that the developer wants to say northern soils are clean because this toxic-site redevelopment is in the foothills of the

Table 3. Health-screening evaluation, soil gas, Pasadena toxic site.

VOC CARCINOGEN[a]	MAXIMUM IN SOIL GAS,[b] ug/l	SCREENING LEVEL[c] (SL),ug/l (10^{-6} risk)	(MAXIMUM IN SOIL GAS ÷ SL)[d] = HOW MANY TIMESABOVE GOVERN-MENT LIMITS ?	EXCESS CANCER RISK[e]
1,1-Dichloroethane	1.56	0.0018	867	8.67E-04
1,1-Dichloroethylene	1.95	0.073	27	2.67E-05
1,1,1-Trichloroethane	0.063	1	0	6.30E-08
cis-1,2-Dichloroethylene	2.53	0.0083	305	3.05E-04
Carbon Tetrachloride	28.4	0.000067	4,38,801	4.39E-01
Chloroform	1.12	0.00012	9,333	9.33E-03
Dibromochloromethane	0.998	0.00013	7,677	7.68E-03
Dichlorodifluoromethane	9.32	0.1	93	9.32E-05
Trichlorotrifluoromethane (Freon 113)	17.6	31	0	5.68E-07
Tetrachloroethylene (PCE)	342	0.00046	7,43,478	7.43E-01
Toluene	0.244	0.31	17,896	7.87E-07
Trichloroethylene	8.59	0.00048	0	1.79E-02
Trichlorofluoromethane	14.7	1.3	7	1.13E-05
Xylenes, total	0.718	0.1	11	7.18E-06
				TOTAL = 1

Table 3 shows that getting 1 cancer from site soil gas is a certainty, as this risk = 1, which is 1,000,000 times higher than allowed. Because Ninyo and Moore's Human Health Screening Evaluation violates four rules of California Department of Toxic Substances Control for calculating risk (see note b below), it underestimates this risk as 3.4E-04 (10,000 times too low). (Soil-gas data (col 2) are from Ninyo and Moore 2017d, Table 3).

[a]Contaminant list is from developer's contractor, Ninyo and Moore 2017b, Table 6, www.envirostor.dtsc.ca.gov

[b]Maximum values are from Ninyo and Moore 2017d. When Ninyo and Moore did the Table 6 (human health risk evaluation) of the Remedial Investigation, they failed to follow CA DTSC directions for health risk assessments. They incorrectly (1) used average, not maximum, contaminant levels, contrary to specific DTSC directives (2011b, iv). They incorrectly (2) ignored soil-gas risk, outdoor air, and groundwater risk, contrary to specific DTSC directives (2011b, iv). They incorrectly (3) failed to calculate and add together the risk over all four exposure pathways (indoor air, outdoor air, water, soil) and instead used only 1 exposure-pathway, air, contrary to specific DTSC directives (2011b, 19). They incorrectly (4) calculated indoor-air risks based on the false assumption of 1000-times-lower indoor-air risk, although the site violates at least 3 necessary conditions for using the 1000-reduced-risk factor, namely, geological heterogeneity, utility corridors, and fractures (2011b, 16–17). Ninyo and Moore then (5) calculated site indoor-air risk based on their errors (1)-(4) – that contradict specific DTSC rules – - without ever calculating full cancer risk for all exposure pathways and all contaminants of concern.

[c]Screening levels are from Ninyo and Moore 2017d.

[d]To determine each contaminant's cancer risk, CA DTSC mandates dividing the maximum contaminant level by the screening level (the latter of which meets the target risk of 1.0E-06, a cancer risk of one-in-a-million). DTSC mandates use of this ratio when determining excess toxic-site cancer risk (DTSC, HERO Note 4, 14 May 2019, p. 14).

[e]To determine excess cancer risk, DTSC mandates multiplying the ratio in note d by 1.0E-06.(DTSC, HERO Note 4, 14 May 2019, p. 14)

San Gabriel Mountains and slopes downward, from North to South. Because of this slope, the developer needs to level the ground by moving the site's northern soils to the southern part.

Do source data support the second published assessment conclusion, that the northern soils are clean? For at least three reasons, site source data do not support this conclusion. It contradicts Ninyo and Moore's source data and the source data of other researchers. It also begs the question because there are no isoconcentration data for at least 8 of the highest site VOCs. Consider each of these three problems with the third conclusion.

Ninyo and moore contradict the source data in claiming clean northern soil

The Ninyo and Moore/Trammell Crow conclusion about VOCs being concentrated in the South, not the northern part of the site, is contradicted by their own source data. This can be seen in Figure 1 (the authors' annotation of Ninyo and Moore's Figure 4, which plots their own sampling data from the Remedial Investigation onto their own Figure 4). The authors' annotation on their Figure 1, using every recorded Ninyo and Moore sample that shows soil-vapor above allowed risk levels of 1.0E-06 (Ninyo and Moore 2017d, Table 3), clearly shows that Ninyo and Moore's own VOC soil-vapor data indicate that at least 40% of site locations having excess levels of VOCs (that violate state standards) are in the northern half of the site. For instance, Ninyo and Moore's own sampling data show that northern sample location VD1-30 has PCE at levels 23,500 times above the allowed risk level of 1.0E-06, and northern sample location NMSD2-63 has carbon tetrachloride at levels 40,000 times above what is allowed (Ninyo and Moore 2017d, Table 3).

Similarly, the Ninyo and Moore/Trammell Crow published conclusion that VOCs are concentrated in the South, not the northern part of the site, also is contradicted by Kennedy-Jenks source data, provided in the Ninyo and Moore (2017e) study. If one annotates Ninyo and Moore's own Figure 4 from their Remedial Investigation (Ninyo and Moore 2017b, Figure 4), by plotting every recorded Kennedy-Jenks sample that shows soil-vapor above the allowed one-in-a-million-risk level of 1.0E-06 (Ninyo and Moore 2017e, Tables 2–3), the authors' resulting Figure 1 clearly shows that Kennedy-Jenks VOC soil-vapor data indicate that at least 40% of site locations having excess levels of VOCs are in the northern half of the site (Ninyo and Moore 2017e, Tables 2–3).

Finally, see the authors' Figure 2. It clearly shows that the Ninyo and Moore/Trammell Crow published conclusion that VOCs are concentrated in the South, not the northern part of the site, is contradicted by additional Ninyo and Moore source data. The authors' Figure 2 plotted source data from all four Ninyo and Moore isoconcentration maps (that clearly show PCE and carbon tetrachloride sources) onto Ninyo and Moore's Figure 4. Their PCE and carbon-tetrachloride isoconcentration maps show that half of the PCE and carbon tetrachloride contaminant-sources are in the northern half of the site (Ninyo and Moore 2017b, Figures 9–12). Obviously the northern part of the site is not clean, contrary to Ninyo and Moore's second conclusion.

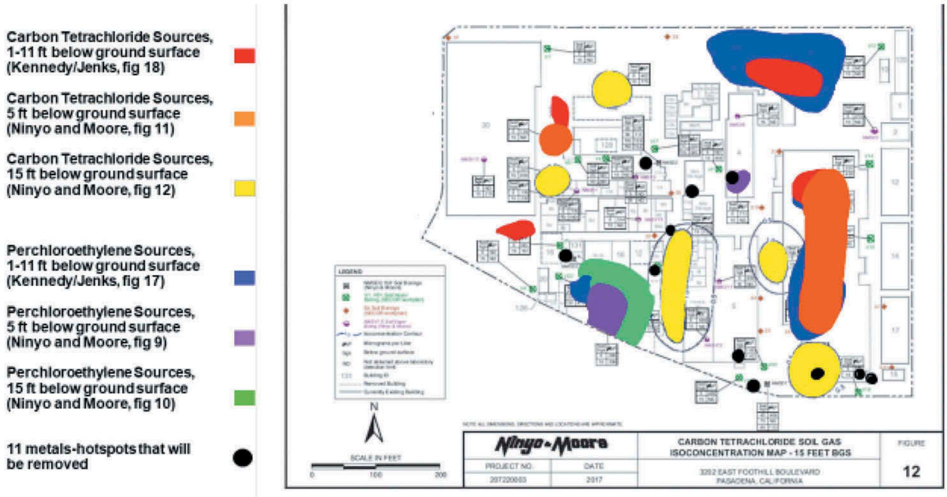

Figure 2. How could site soil, containing many contaminant sources such as carbon tetrachloride, be safely removed, post-construction (Ninyo and Moore 2017b)?

Ninyo and moore “trim the data” then claim clean northern soil

Other ways that Ninyo and Moore apparently try to show that the site’s northern soils are clean is by trimming the data of the other main site VOC-vapor research group, Kennedy-Jenks, who also conducted soil-vapor samples at the same time (2007) as Ninyo and Moore. Tellingly, when Ninyo and Moore presented their four isoconcentration maps for shallow-soil PCE and carbon tetrachloride, they never included any Kennedy-Jenks data on them – -which clearly showed VOC contaminant-sources in the northern part of the site – -much more so than did Ninyo and Moore (2017b, Figures 9–12).

Yet Kennedy-Jenks sampling shows northern levels of carbon tetrachloride, such as those at locations 129-SV-02, 3-SV-8, 11-SV-1, and 3-SV-11, respectively, that are 18,000; 15,000; 15,000; and 28,500 times higher than the allowed one-in-a-million-risk level of 1.0E-06. Kennedy-Jenks samples also shows northern levels of PCE, such as those at locations V-2-15 and VD1-20 that, respectively, are 16,700 times and 20,200 times higher than allowed (Ninyo and Moore 2017e, Tables 2–3).

Similarly, when Ninyo and Moore presented their four isoconcentration maps for shallow-soil PCE and carbon tetrachloride, they never included any of the source data clearly annotated on the Kennedy-Jenks isoconcentration maps (Ninyo and Moore 2017e). These maps showed that about half the PCE and carbon tetrachloride sources are in the northern part of the site, In particular, both Kennedy-Jenks isoconcentration maps show there are both carbon tetrachloride sources and PCE sources in the far NE corner of the site, clearly falsifying the Ninyo and Moore claim about VOCs being focused in the South (Kennedy/Jenks 2007, Figures 17, 18).

Ninyo and Moore beg the question, ignoring most VOC contaminants

In addition, note that Ninyo and Moore's own source data show that besides TCE, PCE, and carbon tetrachloride, 7 other VOC carcinogens drive site risks. These are dichlorodifluoromethane (68 percent of samples were above allowable risk levels of 1.0E-06), chloroform (10 percent of samples were above allowed levels), trichlorofluoromethane (10 percent of samples were above allowed levels), 1,1-Dichloroethylene (8 percent of samples were above allowed levels), 1,1-Dichloroethane (6 percent of samples were above allowed levels), cis-1,2-Dichloroethylene (6 percent of samples were above allowed levels), and total xylenes (5 percent of samples were above allowed levels) (Ninyo and Moore 2017d, Table 3).

Yet for 8 of the 10 worst site VOC contaminants (all except perchloroethylene and carbon teterachloride), Ninyo and Moore developed no isocentration maps using these source data. However, Ninyo and Moore claimed that excess VOCs were not mainly in the northern part of the site. Again, the third published conclusion appears unsupported by source data. Instead it begs the question regarding whether site isoconcentration data support it.

Fourth questionable conclusion: Lifetime cancer risk is only 0.00034

Do source data support the fourth published Ninyo and Moore/Trammell Crow assessment conclusion, that removal of only 11 localized metals-hotspots, and no other preconstruction remediation, is defensible because the site has only a lifetime "unmitigated total excess cancer risk of 3.4 E-04," that is, 3.4 cancers per 10,000 people exposed over a lifetime, or about 1 in 3000 (Ninyo and Moore 2017b, 34)?

In four ways Ninyo and Moore use manipulated, not measured, source data

Source data do not support the preceding site cancer risk because Ninyo and Moore manipulate the source data in a variety of ways – -instead of using actual measured values of contaminants, then adding all contaminant and pathway contributors to obtain total site cancer risk. That is, Ninyo and Moore's conclusions about unmitigated site cancer risk contradict their source data because they manipulate the source data in at least 4 different ways, contrary to the precise directions of California Department of Toxic Substances Control (DTSC). DTSC says health-risk screening evaluations, like that done by Ninyo and Moore in Table 6 of their Remedial Investigation (2017b), should calculate the "unmitigated total excess cancer risk" at toxic sites by using

(1) "the maximum detected concentrations of COPCs" [contaminants of potential concern] "because of the screening-level nature of such evaluations and because the screening-level sampling is usually limited" (DTSC 2019c, 15; 2011, iv).
(2) "the maximum detected concentration of each COC [contaminant of concern] in soil gas…as the exposure point concentration" in assessing "vapor intrusion" " (DTSC 2010, 19; 2011, iv), because "soil gas data provide a direct measurement of the VOCs that may migrate to indoor air" (DTSC 2019c, 8).
(3) "multiple lines of evidence, such as soil gas, indoor air, and groundwater data…for preliminary screening evaluations of vapor intrusion" (DTSC 2019c, 8; 2011, iv).
(4) "the total site risk and hazard index," obtained by summing all risks and hazards from all contaminants and all exposure pathways – air, soil, water, etc (DTSC 2019c, 9).

However, instead of following the four preceding DTSC guidelines for calculating "total excess cancer risk" at toxic sites, Ninyo and Moore

(i) ignored the DTSC directive to give "the maximum detected concentration" of each contaminant and instead gave mean contaminant levels for carcinogenic chlorinated-solvent VOCs, total petroleum hydrocarbons (TPHs), polyaromatic hydrocarbons (PAHs), and metals in Table 6, their health screening evaluation (Ninyo and Moore 2017b, Table 6).
(ii) ignored the DTSC directive to give "direct measurement of the VOCs" in soil gas, and instead gave theoretical, indoor-air, "exposure point concentrations" that were 1000 times lower than the direct measurements (Ninyo and Moore 2017b, Table 6).
(iii) ignored the DTSC directive to give "multiple lines of evidence" and "all exposure pathways," such as from soil, outdoor air, and groundwater, and instead gave only partial exposures from some contaminants, in some indoor air; they ignored all outdoor air, soil, and groundwater contributions to total site cancer risk (Ninyo and Moore 2017b, Table 6).
(iv) ignored the DTSC directive to give "the total site risk" from all toxins such as VOCs, TPHs and PAHs, from toxic soil, from toxic groundwater, from outdoor air, and from indoor air when buildings fail to block toxin entry, as US EPA says they often do (EPA 2015). Instead, Ninyo and Moore's own source data reveal that although they claimed to have given a "total excess cancer risk," they really gave only a partial cancer risk, only for some VOCs, only in some site

indoor air, namely those of blocked contaminant migration (Ninyo and Moore 2017b, Table 6).

Yet as DTSC (2019c, 7) warns, if maximum exposures and directly measured exposures are ignored, and "If [exposure or contaminant] pathways [are] not considered… a screening level risk evaluation may underestimate risk." The net effect of every one of these of these four Ninyo and Moore violations (of DTSC cancer-risk-calculation mandates) is to underestimate site risk, thus underestimate needed site remediation, thus financially benefit the site remediator-developer, Trammell Crow.

Ninyo and Moore's source-data manipulations underrepresent site risk

Consider several effects of Ninyo and Moore's violation of only one DTSC directive (1) for only one class of contaminants, carcinogenic chlorinated-solvent VOCs. This one violation for only one class of toxins results in a gross underestimate of site risk in their Remedial Investigation, Table 6. This is their health-screening evaluation, and it claims to show an onsite lifetime "unmitigated total excess cancer risk of 3.4 E-04," that is, 3.4 per 10,000 lifetime exposures, or about 1 in 3000 (Ninyo and Moore 2017b, 34).

First, their cancer-risk calculation violates preceding DTSC directive (1), to use maximum contaminant levels. Because they instead use average concentration levels, and because these average levels sometimes fail to violate standards, Ninyo and Moore completely exclude the cancer risks from 21 percent (3 of 14) of soil-gas contaminants, namely, the gray-shaded contaminants listed in the author's (1,1-dichloroethane; 1,1-dichloroethylene; and cis-1,2-dichloroethylene). Yet as our Table 3 shows, these three uncounted soil-gas carcinogens together can cause 1 cancer in every 833 exposed people (1.2E-03). Yet Ninyo and Moore completely excluded this extraordinarily high site risk.

Second, Ninyo and Moore's calculations in their Remedial Investigation, Table 6, violate DTSC directive (1) above and instead use only average, not maximum, concentration levels for another 50 percent (7 of 14) of soil-gas carcinogens listed in Table 1. These are carbon tetrachloride, chloroform, dichlorodifluoromethane, trichlorotrifluoromethane (freon 113), tetrachloroethylene or perchloroethylene (PCE), trichloroethylene, and trichlorofluoromethane. As a result of counting only average levels of these contaminants, Ninyo and Moore grossly undercount their respective peak risks by 13 times (28.4/2.27), 16 times (1.12/0.072), 9 times (9.32/1.09), 6 times (17.6/2.87), 3 times (342/137), 11 times (8.59/0.811), and 4 times (14.7/3.88). Thus Ninyo and Moore's failure to follow DTSC directive (1) means that they completely ignore about 21 percent of site carcinogen contaminants, then undercount – -by a factor of about 9 – -another 50 percent of contaminants.

Besides violating DTSC directive (1) and using average, rather than maximum, levels of contaminants to calculate site risk, Ninyo and Moore's violating directive (2) causes them to undercount all site contaminants by a factor of 1000. In their Remedial Investigation (2017b), Table 6, they use a theoretical estimate of the hypothetical indoor-air exposure-point concentration, rather than the mandated, 1000-times-larger, directly measured levels of carcinogenic soil gases.

Using source data, as DTSC directs, shows total site cancer risk is 1, certainty

Once one corrects only the Ninyo and Moore violations of DTSC directives (1) and (2) above, the site cancer risk from toxic soil gas, alone, can be seen to be at least 10,000 times larger, having a probability of 1, a certainty of cancer for all exposed people (10,000 cancers per 10,000 people). Yet in their Remedial Investigation, Ninyo and Moore (2017b, Table 6) claim that the total site excess cancer risk is only (3.4E-04 or 3.4 cancers per 10,000 people). See the authors' Table 3 for the corrected health-screening evaluation that corrects only Ninyo and Moore errors (1) and (2), but not errors (3) and (4).

Currently one cannot correct Ninyo and Moore's errors (3)-(4), namely, their failure to use multiple lines of evidence, all exposure pathways, and total site cancer risk. It's impossible to calculate total excess site cancer risk, because no site groundwater testing has ever been done; no site testing of any soils 180 feet above the water table has been done; and no site testing of most propellants, energetics, and perfluoralkyls has been done. Thus one cannot calculate either the cancer risk from multiple-exposure pathways or from total site contaminants. This means the real site cancer risk is likely even higher than 1 lifetime cancer for each exposed person. The real risk could be 1 cancer for each exposed person, but over a much shorter time. For a partially corrected site cancer risk, based only on limited site testing and available site source data, see the authors' Table 3.

Discussion

The preceding preliminary data audit shows that although developer Trammell Crow repeatedly promised Pasadena a safe toxic-site cleanup (eg, AGD-TCC 2018, 2; PCC 2019), the developer's remediation documents underestimate site risks and needed remediation because all four of their critical published conclusions contradict source data. Given these contradictions, at least 5 questions come to mind.

(1) What scientific benefits accrue from routine, independent, scientific-data audits (RISDA) – -that might have prevented harm from flawed Pasadena-remediation documents?
(2) What public benefits arise from RISDA – -that might have prevented harm from flawed Pasadena-remediation documents?

(3) Were developer Trammell Crow and assessor Ninyo and Moore warned about data-audit problems?
(4) Why did Ninyo and Moore ignore Kennedy-Jenks soil-sampling showing high VOC site risks?
(5) Why did Ninyo and Moore say site VOC risks would be removed by removing only 11 small, localized metals-hotspots, after admitting that site VOC risks were "widespread" and not localized?

First Question: What scientific benefits accrue from routine, independent, scientific-data audits (RISDA) – -that might have prevented harm from flawed Pasadena-remediation documents?

Scientific benefits of RISDA

As already mentioned, key RISDA benefits include deterring flawed science (Shamoo 1988, 1989, 2001, 2013), something important because science is often done for hire, in large operations that serve primarily private, before public, interests (Shamoo and Annau 1990, 87). Perhaps that's why the US Food and Drug Administration found that 67 percent of drug-investigator inspections require corrective action (Morgan-Linnell, Stewart, and Kurzrock 2014).

Such data suggest that important RISDA benefits arise from exposing flawed science stemming from potential financial conflicts of interest. RISDA thus deter (1) scientific fraud, (2) scientific error; and (3) questionable scientific practices, eg, not performing uncertainty analyses. RISDA also might cut questionable R&D studies by half, saving $5-$10 per audit-dollar spent (Glick 1992, 153). RISDA's deterring flawed science (1)-(3) thus promotes (4) better R&D standards; (5) public confidence in science; (6) efficient, better-administered science; and (7) wiser research-funds use (Baldwin and Hoover 1989; Glick 1989, Glick and Shamoo 1989; Pincus 1989; Shapiro 1992; Shamoo and Resnik 2003).

RISDA might have deterred Trammell Crow's apparent fraud/errors

The authors' preliminary data audit particularly shows RISDA might have deterred (1) scientific fraud, intentional misrepresentation, or (2) scientific error, unintended mistakes in Pasadena-toxic-site remediation documents (Shamoo and Resnik 2003, 42ff). Why? It suggests that assessors Ninyo and Moore, working for Trammell Crow, committed (1) or (2) because source data contradict four published conclusions that underestimate site risks and that benefit Trammell Crow.

RISDA might have deterred Trammell Crow's questionable scientific practices

The preliminary audit also revealed (3) questionable scientific practices in the Pasadena-site human-health-risk-screening assessment. It underestimate cancer risks by four orders of magnitude, misrepresenting/misapplying 6 DTSC risk-assessment rules (see Note 2, Table 3).

This preliminary-audit exposure of Trammell-Crow questionable scientific practices is significant because it suggests RISDA could uncover similar practices at many toxic sites. Just in California, Trammell Crow's "Brownfields Acquisition and Development" division, which uses the acronym BAD (TCC 2019b; Li 2015; see US EPA, 2019d), appears to have toxic-site projects Alameda Point, Chatsworth/Porter Ranch, Cleantech, Corporate Point, Pasadena Gateway, and West Midway – -that exhibit similar questionable practices and therefore severely limit toxic-site testing/cleanup. These practices include

(a) using 10-or-more-years-old data, instead of updating contaminant/migration/risk-testing (Abel 2012; CRA-LA 2012; LACPC 2014; CPPCD 2018; Ninyo and Moore 2017d, 2017e, 2019b).
(b) getting excused from performing environmental-impact reports (that require extensive testing) (LACPC 2009; ER 2009a, 2009b; Tucker 2013; CPPCD 2018; ER 2019a, 2019b).
(c) performing no groundwater or offsite-contaminant-migration testing (LACPC 2009; Collins 2009a, 2009b; Abel 2012; CRA-LA 2012; LACPC 2014; CPPCD 2018; EnviroReporter (ER) 2019a, 2019b; DTSC 2019e, 2019f, 2019h), thus violating California (DTSC 2011b) and US EPA (2015) toxics-remediation rules.
(d) conducting no soil-testing/cleanup below 3–30 feet (Abel 2012; CRA-LA 2012; LACPC 2014; Ninyo and Moore 2017d, 2017e; DTSC 2019e, 2019f, 2019h), thus violating California (DTSC 2011b) and US EPA (2015) toxics-remediation rules.
(e) negotiating toxic-site land-use controls/deed restrictions, then leaving above-regulatory-level contaminants on residential properties (Abel 2012; CRA-LA 2012; E2ManageTech 2014; LACPC 2014; CPPCD 2018; Ninyo and Moore 2019b), thus violating California EPA (DTSC 2011b) and US EPA (2015) rules.

RISDA, however, might have deterred at least practices (c)-(e) above. They violate regulatory rules and, despite no data for some contaminant-media, nevertheless draw conclusions that sites are safe.

Besides deterring fraud and potential scientific error, the Pasadena case suggests RISDA of Pasadena-toxic-site-remediation documents would have promoted trickle-down scientific benefits – -enhanced (4) R&D standards,

(5) public trust in science, and (6) scientific efficiencies. For instance, because scientifically questionable Pasadena-site-remediation documents garnered little public trust, citizens forced city councilmembers (most of whom voted for limited cleanup) to ignore Pasadena's $2 billion budget deficit and hire $74,000 consultants to review site-remediation documents (Barkman and Cassidy 2019). Had Trammell Crow known it would face RISDA, it might have conducted better science – -which would have promoted RISDA benefits, including improved (4) R&D standards and (5) public trust in science.

Second Question: What public benefits arise from RISDA – -that might have prevented harm from flawed Pasadena-remediation documents?

Public benefits of RISDA

Besides scientific benefits, RISDA promotes public benefits, including improved (8) regulatory compliance; (9) harm-prevention; (10) government regulation; (11) democratic accountability/transparency; (12) equal protection of the poor; (13) toxic-site-liability apportionment, (14) cost-savings; and (15) citizen trust (Baldwin and Hoover 1989; Dye 2007; Glick 1992; Glick and Shamoo 1989; Johnston et al. 2000; Mazer 2004; Shamoo and Resnik 2003; Shapiro 1992; Stewart 2006).

For instance, because RISDA encourages (9) harm-prevention, such as fraud-prevention in toxics-remediation documents, RISDA promotes (11) democratic accountability and (12) equal protection for the poor. Why? Fraud in welfare-affecting science has devastating effects, especially for those least able to protect themselves. It also undermines democratic accountability and equal protection because it robs the public of essential resources (most needed by the poor), such as defensible toxics-remediation documents (Dye 2007).

RISDA might have helped DTSC deter harm, boost trust, and ensure equitable liability

In Pasadena, failure to conduct RISDA thwarted Pasadena benefits such as (13) equitable site-liability apportionment and (15) public trust. Why? Flawed toxic-site-remediation documents are jeopardizing site-cleanup. Yet cleanup is required by liability-protection contracts that Trammell Crow negotiated with DTSC (2011a, 2017). Such contracts give toxic-site developers liability against harm from site toxins, provided they are "willing to cleanup contaminated sites" (DTSC 2001, 3).

Although the preliminary data audit showed site-remediation documents underestimated risk/remediation – -thus won't ensure required cleanup, nevertheless DTSC gave Trammell Crow liability protection, even before the company wrote site-remediation documents. Partly because there was no RISDA to expose site-risk/remediation underestimates, DTSC negotiated an apparently illegitimate liability-transfer from the largest US-commercial developer (assets of $65 billion) to Pasadena, a city whose poverty rate is 15 percent above the national average (Data-USA 2019).

Given no RISDA, DTSC failed in (13) equitable site-liability apportionment and caused loss of (15) public trust. Local citizens say it's unfair for Trammell Crow to promise site-safety-through-remediation, but to allow DTSC to remove Trammell-Crow liability for flawed remediation; if the developer needs liability protection, so does the public; if the public needs no protection, as the developer/DTSC claim, neither does the developer (DTSC 2019b, 52, 148).

More generally, RISDA for toxic-site-remediation documents might deter fraud, (9) prevent harm and promote (13) equitable liability apportionment. How? Developers like Trammell Crow say they always want toxic-site liability-releases, "escape from liability" (Holdridge 2015, 17–18, 49–50). If so, by making RISDA a necessary condition for developers' receiving liability protections, regulators like DTSC might promote more equitable site-liability apportionment.

RISDA might have protected Pasadena from flawed DTSC oversight

RISDA of Pasadena-toxic-site-remediation documents also might have improved (10) regulatory oversight. As already noted, the preliminary audit revealed four major scientific errors in site-remediation documents. In May 2019, one author officially notified DTSC of these errors (DTSC 2019b). Yet in August 2019, DTSC officials Nicholas Ta and Patrick Hsieh specifically defended all four erroneous claims – -about PCE/TCE cleanup (DTSC 2019b, iv); low carcinogen concentrations (DTSC 2019b, iv); northern-soil contaminants (DTSC 2019b, 55); and human-health risks (DTSC 2019b, 38). They failed in (10) regulatory oversight. Arguably such failures would be less likely if DTSC always had to take account of official RISDA findings.

RISDA also might discourage DTSC's tendency to violate DTSC testing rules. For instance, DTSC (2011b) and US EPA (2015) specify carcinogenic-soil-gas-testing rules; yet DTSC allowed Pasadena-site assessors to violate these rules in multiple ways, including doing no groundwater, no offsite-contaminant, no contaminant-migration-route, no contaminant-migration extent, no contaminant-source-location, no vertical-profile, no year-long-duration soil-gas, and no 100-feet-from-buildings testing DTSC (2011b, 7–8,14,22)

RISDA likewise could enhance (10) regulatory oversight by countering "regulatory capture" (Krimsky 2019). Since at least 1997, DTSC has received intense criticisms for pro-developer-polluter bias that has caused massive (7) public-health harm and (15) undermined public trust (Tucker 2013; JCOC 2019). Since 2006, the California legislature's multi-committee, DTSC-oversight, super-committee has repeatedly tried and failed to reform DTSC. This super-committee warned that

- DTSC continues to have "an inadequate and unresponsive regulatory program," especially problems with "transparency, accountability, and….cleanup," despite legislative "statutory changes… to help DTSC better achieve its mandates." This has caused "decreased… public trust in DTSC" (JCOC 2019, 7, 4–6).
- "DTSC is not properly enforcing state and federal law and is allowing… numerous violations of state law and regulations…[and use of] outdated technologies, practices, and safeguards…[that] are potentially releasing hazardous wastes into the environment" (JCOC 2019, 5).

Yet if toxic-site studies (that DTSC oversees) faced RISDA, DTSC might improve. RISDA might give DTSC leverage to counter powerful developers/polluters, reduce scientific fraud/error – -thus promote (8) regulatory compliance, (9) public-harm prevention, (11) accountability, (13) equitable toxic-site-liability apportionment, and (15) citizen trust.

RISDA might have prevented Pasadena officials' democratic-accountability flaws

RISDA of Pasadena-toxic-site-remediation documents also might have prevented (11) democratic-accountability lapses among Pasadena's elected officials. Why? California's housing shortage (Taylor 2016), Pasadena's $2-billion budget deficit, and Pasadena's needed tax-base expansion (Pasadena 2018a, 11) all encouraged city leaders' uncritical acceptance of new toxic-site housing. RISDA might have counterbalanced these pressures, promoting accountability.

RISDA also might promoted (11) accountability by counterbalancing city-officials' potential financial conflicts of interest. Pasadena's mayor Terence Tornek is a developer, and he and city-council members accept campaign donations from developers – -whose local projects they approve/disapprove (eg, Pasadena 2019). Because other cities, like Los Angeles, prohibit donations from developers to city decisionmakers (Pampanin 2019), RISDA is especially needed in Pasadena to encourage greater accountability of officials.

RISDA might have improved city-officials' protection of the poor

RISDA also might have encouraged Pasadena officials to provide more (12) equal protection of the poor, not just approve toxic-site-remediation documents that disproportionately threaten the poor. As already mentioned, Pasadena's toxic-site apartments will disproportionately house, thus disproportionately harm, the poor. Why?

These 550 apartments will abut the heavily trafficked, 10-lane, Interstate 210; have interspersed commercial spaces; and be in high-density buildings. The average size of each apartment will be 800 square feet, with 40 percent of units having two-or-three bedrooms, designed for families; 20 percent of units reserved for affordable-housing-voucher residents; and 40 percent reserved for moderate-income residents (CPPCD, 2018) – -all features that wealthy people often avoid. Such features suggest the poor will bear most of Pasadena's toxic-site risks (eg, Boehmer et al. 2013; Tinsley and Bishop 2006).

Yet RISDA of toxic-site-remediation documents might have prevented this environmental injustice. By deterring flawed science, RISDA could have promoted many public benefits, including (12) equal protection of the poor.

Third question: Were the developer and assessor warned about problems ?

The first data-audit problem, that source data directly contradict the published conclusion that "the excavation of [metals] hot-spots will remove [carcinogenic-solvent] VOC vapor-intrusion risks from the site" (Ninyo and Moore 2019b, 46), is surprising because Ninyo and Moore and the site developer were warned earlier about this problem but appear to have done nothing about it. Years ago, in an official written report, the California DTSC warned, in response to the draft Remedial Investigation, published in 2017, that widespread "VOCs in soil gas are the chemicals of concern [not metals] that require remediation" (Ninyo and Moore 2017a, 4). Yet in response, Ninyo and Moore changed no cleanup plans so as to include VOCs.

Why did the developer's contractor not provide for VOC-carcinogen cleanup, in response to the preceding DTSC criticism ? Cost may be one reason. The developer admits that full cleanup is "technologically feasible" (Ninyo and Moore 2019b, 51). However, the developer says full cleanup "would be a costly and time-intensive process" (Ninyo and Moore 2019b, 47).

Ninyo and Moore (2019b, 54) go on to say: The cost of removing even some of the soil VOC carcinogens "is likely to be approximately double the cost of implementing" the developer's plan of removing only 11 small metals-hotspots. They conclude that, "based on…cost analysis…the preferred remediation" is metals-hotspot removal (Ninyo and Moore 2019b, 55). Why? "[R] emoving [carcinogenic] VOCs…would eliminate any potential…threat to future residential site users, but would be a costly and time-intensive process" (Ninyo and Moore 2019b, 47).

Fourth question: Why did Ninyo and Moore ignore Kennedy-Jenks data?

Ninyo and Moore's ignoring the Kennedy-Jenks sampling data is puzzling for several reasons. *First*, Kennedy-Jenks conducted sampling at depths not covered by Ninyo and Moore, such as one foot and 10–11 feet. They also sampled many site locations that Ninyo and Moore never examined, particularly in the northern part of the site. As a result, they provided additional data, not found anywhere else (Ninyo and Moore 2017e; Kennedy-Jenks 2007).

It seems strange for researchers to ignore contemporary data – -data that supplements their own, data that also appear in Appendix E of their own site assessment.

Second, Kennedy-Jenks arguably know more about the site than anyone. They not only conducted expensive soil and soil-vapor studies of the site, but also developed the classic environmental summary and detailed analysis of all site documents to date. As a result, the know the strengths and liabilities of all site documents (Kennedy/Jenks 2007).

Third, it's puzzling that the developers themselves admit that "concentrations of…compounds [carcinogenic VOCs] in soil gas are relatively uniform across the site," at all locations/depths tested, not only on the south side of the site (Ninyo and Moore 2017b, 34). If so, it is inconsistent to claim that site VOCs either are not on the northern part of the site or would be remediated by metals-hotspot removal. Why did site assessors ignore this risk?

Fifth question: Why did assessors say removing 11 localized metals-hotspots would also remove "widespread" site VOCs?

Sheldon Krimsky has one answer to this question. When research is tainted by financial conflicts of interest, the conclusions of that research are more likely to serve the interests of those who fund the research. Since at least the 1980s, it has been confirmed, again and again, that the "funding effect" is statistically correlated with research outcomes. That is, if private companies or corporations fund research on the safety of their chemicals or drugs, the research is likely to show safety. If nonprofit or government agencies fund research on the safety of the same chemicals or drugs, the research is much less likely to show safety. This funding effect has been established in environmental-health studies, tobacco research, climate-change studies, chemical-toxicity studies, and so on. Analogously, if the industry responsible for cleanup of a toxic site funds site-safety documents, they are more likely to say the cleanup will be safe – -than if a nonprofit or government group conducts the same study to assess the safety of proposed cleanup (Krimsky 2019, 2004, 2013).

Conclusion

The infamous Woburn, Massachusetts PCE/TCE-induced cancers came to light in 1971, nearly 50 years ago. The flawed Pasadena site-remediation assessments suggest that, despite the long history of lessons that should have been learned from PCE and TCE contamination and resulting cancers and deaths at other US toxic sites, communities have not yet understood these risks. As a result, they are likely to make the same mistakes. As Santayana warned, those who forget history are condemned to repeat it.

Right now, we seem to be repeating history, repeating earlier mistakes about PCE and TCE risks and cleanup. RISDA could be one way to help avoid repeating earlier mistakes.

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References

Abel, D. 2012. "Trammell Crow Finally Acquires LA City's Old Crown Coach Site." The Planning Report. https://www.planningreport.com/2012/09/04/trammell-crow-finally-acquires-la-city-s-old-crown-coach-site

Alameda, California, City of (Alameda). 2014. "Resolution No. 14891 Certifying the Final Environmental Impact Report, and Adopting Findings and a Statement of Overriding Considerations, Mitigation Measures, and a Mitigation Monitoring and Reporting Program for the Alameda Point Project." https://www.alamedaca.gov/files/sharedassets/public/alameda/base-reuse/environmental/eir-resolution-14891.pdf

Alameda, California, City of (Alameda). 2018. "West Midway Project." https://www.alamedaca.gov/files/sharedassets/public/alameda/base-reuse/main-street/west-midway-rfq_final-with-exhibits_reduced.pdf

Andersen Environmental. 2017. "Draft Final Remedial Action Plan." https://www.envirostor.dtsc.ca.gov/public/community_involvement/8884541153/Draft%20Final%20RAP%20For%20Public%20Review%2005-04-2017.pdf

Armbruster, Goldsmith, & Delvac for Pasadena Gateway [Trammell Crow Company] (AGD-TCC). 2018. "Re: 3200 East Foothill Boulevard," May 4, p. 2. https://ww5.cityofpasadena.net/commissions/wp-content/uploads/sites/28/2018/05/2018-05-09-Planning-Commission-Item-3B_3200-E.-Foothill-Blvd.-Planned-Development-Attachment-G.pdf

Aschengrau, A., J. M. Weinberg, P. A. Janulewicz, L. G. Gallagher, M. Winter, V. M. Vieira, and T. F. Webster, and D. M. Ozonoff. 2009. “Prenatal Exposure to Tetrachloroethylene-Contaminated Drinking Water and the Risk of Congenital Abnormalities.” *Environmental Health* 8 (44): doi:10.1186/1476-069X-8-44.

Aschengrau, A., L. G. Gallagher, M. Winter, L. Butler, M. P. Fabian, and V. M. Vieira. 2018. “Modeled Exposure to Tetrachloroethylene-contaminated Drinking Water and the Occurrence of Birth Defects: A Case-control Study from Massachusetts and Rhode Island.” *Environmental Health* 17 (1): 75. doi:10.1186/s12940-018-0419-5.

Bair, S., and K. Svitana. 2016. “TCE and PCE Toxicity, Uses, and Properties. Science in the Courtroom: The Woburn Toxic Trial.” Science Education Resource Center at Carleton College. https://serc.carleton.edu/woburn/issues/tce_toxicity.html

Baldwin, J. K., and B. K. Hoover. 1989. “Data Audit as a Management Tool.” *Accountability in Research* 1 (1): 71–75. doi:10.1080/08989628908573775.

Barkman, J., and M. Cassidy. 2019. *Proposal for Environmental Consulting Services*. Long Beach, CA: Alta Environmental.

Boehmer, T. K., et al. 2013. “Residential Proximity to Major Highways — United States, 2010.” *Morbidity and Mortality Weekly Report* 62 (03): 46–50, November 22.https://www.cdc.gov/mmwr/preview/mmwrhtml/su6203a8.htm

Boerner, D. 2019. “Residential Construction Underway On $1B East Bay Waterfront Project.” Bisnow of San Francisco Reporter. https://www.bisnow.com/oakland/news/mixed-use/residential-construction-underway-on-1b-east-bay-waterfront-project-99726

California Department of Toxic Substances Control (DTSC). 2001. “Brownfields Remediation.” https://dtsc.ca.gov/wp-content/uploads/sites/31/2016/01/SMP_Brownfields_Brochure.pdf

California Department of Toxic Substances Control (DTSC). 2010. *Proven Technologies and Remedies Guidance: Remediation of Chlorinated Volatile Organic Compounds in Vadose Zone Soil*. Sacramento, CA: DTSC. https://dtsc.ca.gov/wp-content/uploads/sites/31/2018/11/cVOC_040110.pdf

California Department of Toxic Substances Control (DTSC). 2011a. “Amendment to Agreement and Covenant Not to Sue.” https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/8377835929/Final%20PPA%20Pasadena%20Gateway%20PPA.pdf

California Department of Toxic Substances Control (DTSC). 2011b. *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air*. Sacramento, CA: DTSC. https://dtsc.ca.gov/wp-content/uploads/sites/31/2018/01/Final_VIG_Oct_2011.pdf

California Department of Toxic Substances Control (DTSC). 2015. “Notice of Determination, Crown Coach Clean up Plan, CleanTech.” https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/5251896739/Notice%20of%20Determination%20Crown%20Coach%2012072015.pdf

California Department of Toxic Substances Control (DTSC). 2017. “Amendment to Agreement and Covenant Not to Sue.” https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/5340940713/Executed%20Amendment%20to%20PPA12.2017.pdf

California Department of Toxic Substances Control (DTSC). 2019a. *Naval Information Research Foundation*. Sacramento, CA: DTSC. https://www.envirostor.dtsc.ca.gov/public/profile_report?global_id=19970020

California Department of Toxic Substances Control (DTSC). 2019b. *Response to Public Comments: Pasadena, Cypress, California*. Sacramento, CA: DTSC.

California Department of Toxic Substances Control (DTSC). 2019c. *Human Health Risk Assessment Note #4*. Sacramento, CA: DTSC. https://dtsc.ca.gov/wp-content/uploads/sites/31/2019/05/HHRA-Note-Number-4-May-14-2019.pdf

California Department of Toxic Substances Control (DTSC). 2019d. *California Environmental Quality Act Notice of Determination*. Sacramento, CA: DTSC. https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/4368376016/20190806%20Final%20NOD%20Filed.pdf

California Department of Toxic Substances Control (DTSC). 2019e. "Land-use Covenant and Agreement, Environmental Restrictions, Former Crown Coach Facility [CleanTech Industries]." Los Angeles, CA: Northern Parcel. https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/3829070150/Final%20Recorded%20LUC%20Northern%20Parcel%20Crown.pdf

California Department of Toxic Substances Control (DTSC). 2019f. "Land-use Covenant and Agreement, Environmental Restrictions, Former Crown Coach Facility [CleanTech Industries]." Los Angeles CA: Southern Parcel. https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/2431623160/Final%20Recorded%20LUC%20Sourthern%20Parcel%20Crown%20Coach.pdf

California Department of Toxic Substances Control (DTSC). 2019g. "Prospective Purchaser Agreements and Liability Relief." https://dtsc.ca.gov/brownfields/prospective-purchaser-agreements-and-liability-relief/

California Department of Toxic Substances Control (DTSC). 2019h. "Termination of Voluntary Cleanup Agreement, Crown Coach Clean up Plan, CleanTech." https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/9844059586/Crown%20Coach%20VCA%20termination_rallen_08022019.pdf

Chandler, J. 2017. "Toxic Soil at Jordan Downs: Massive Cleanup Fails Where LA Plans to Build New Shops, Restaurants." *Curbed LA*. https://la.curbed.com/2017/7/14/15746194/jordan-downs-redevelopment-contamination-retail-center

City of Pasadena Planning & Community Development (CPPCD). 2018. "Sustainable Communities Environmental Assessment." https://ww5.cityofpasadena.net/planning/wp-content/uploads/sites/56/2018/01/3200-E-Foothill-SCEA.pdf

Collins, M. 2009a. Eating Trammell Crow, EnviroReporter. https://www.enviroreporter.com/2009/08/eating-trammell-crow/

Collins, M. 2009b. Your Journalistic Practices, EnviroReporter. https://www.enviroreporter.com/2009/08/your-journalistic-practices/

Community Redevelopment Agency, City of Los Angeles (CRA-LA). 2012. "Acquisition Loan for the Purchase of the Cleantech Manufacturing Center." http://www.crala.org/internet-site/Meetings/Board_Agenda_2012/upload/Mar_29_2012_Item_12.pdf

Cosier, S. 2019. "With Dozens of Sick Children, Parents Took a Hard Look at Their Town's Toxic Legacy." *Earth Island Journal*. Earth Island Institute. http://www.earthisland.org/journal/index.php/articles/entry/sick-children-cancer-parents-indiana-towns-toxic-legacy/

Costas, K., R. S. Knorr, and S. K. Condon. 2002. "A Case–Control Study of Childhood Leukemia in Woburn, Massachusetts: The Relationship between Leukemia Incidence and Exposure to Public Drinking Water." *Science of the Total Environment* 300 (1–3): 23–35. doi:10.1016/S0048-9697(02)00169-9.

Data-USA. 2019. "Pasadena." https://datausa.io/profile/geo/pasadena-ca/

Dye, K. M. 2007. "Corruption and Fraud Detection by Public Sector Auditors." *EDP Audit, Control, and Security Newsletter. EDPACS* 36 (5–6): 6–15. doi:10.1080/07366980701805026.

E2ManageTech. 2014. "Underground Storage Tank Closure Report." *Cleantech*. https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/7575793206/FINAL%20UST%20Removal%20Report%204000.pdf

EnviroReporter (ER). 2009. "San Fernando Valley's Galaxy of Goo." https://www.enviroreporter.com/ValleysGalaxyofGoo

EnviroReporter (ER). 2019a. "Corporate Pointe." https://www.enviroreporter.com/investigations/corporate-pointe/

EnviroReporter (ER). 2019b. "Corporate Pointe Documents and Links." https://www.enviroreporter.com/CorporatePointeDocuments-Links

Gavaskar, A., L. Tatar, and W. Condit. 2005. "Cost and Performance Report Nanoscale Zero-Valent Iron Technologies for Source Remediation." Contract Report CR-05-007-ENV. Port Hueneme, CA: Naval Facilities Engineering Command. https://pdfs.semanticscholar.org/a601/2e12016f931ce0fd7ba25d971ab5e53c70b9.pdf?_ga=2.242764166.548012722.1573428399-1390458848.1573428399

Gibbs Law Group. 2019. "Hunters Point Class Action Lawsuit (2019): Tetra Tech Lawsuits." Gibbs Law Group LLP. Accessed 10 October 2019. https://www.classlawgroup.com/hunters-point-contamination-lawsuit/

Glick, J. L., and A. E. Shamoo. 1989. "Data Audit as a Management Tool, 85-110." In *Principles of Research Data Audit*, edited by A. E. Shamoo, 102, Routledge.

Glick, J. L. 1989. "On the Potential Cost Effectiveness of Scientific Audits." *Accountability in Research* 1 (1): 77–83. doi:10.1080/08989628908573776.

Glick, J. L. 1992. "Scientific Data audit—A Key Management Tool." *Accountability in Research* 2 (3): 153–168. doi:10.1080/08989629208573811.

Government Accountability Office (GAO). 2019. "Hazardous Waste." https://www.gao.gov/key_issues/hazardous_waste/issue_summary

Hamilton, J. W. 2016. "Contamination at US Military Bases: Profiles and Responses." *Stanford Environmental Law Journal* 35: 223. https://law.stanford.edu/wp-content/uploads/2017/01/hamilton_0.pdf

Holdridge, Neal, Environmental Manager, Trammell Crow Company. 2015. "The Special Challenges of Increased Urban Migration." http://www.nareim.org/wp-content/uploads/2015/10/03b-2015-NAREIM-presentation-slides-10-16-15-combined.pdf

Johnston, G., I. K. Crombie, H. T. Davies, E. M. Alder, and A. Millard. 2000. "Reviewing Audit: Barriers and Facilitating Factors for Effective Clinical Audit." *Quality in Health Care QHC* 9 (1): 23–36. doi:10.1136/qhc.9.1.23.

Joint California Oversight Committee for California Department of Toxic Substances Control (JCOC). 2019. "California State Senate and Assembly, Hearing Report: California Department of Toxic Substances," Sacramento, February 27. https://sbud.senate.ca.gov/sites/sbud.senate.ca.gov/files/Feb.%2027%20-%20Jt.%20DTSC%20Oversight%20Hearing%20%28002%29.pdf

Kennedy/Jenks Consultants. 2007. "Environmental Summary Report: Former Naval Information Research Foundation (NIRF) Site/Space Bank." https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/4649860978/Environmental%20Summary%20Report%20Jenks%20May%2022%202007%20.pdf

Krimsky, S. 2004. *Science in the Private Interest: Has the Lure of Profits Corrupted Biomedical Research?*. Rowman & Littlefield.

Krimsky, S. 2013. "Do Financial Conflicts of Interest Bias Research? an Inquiry into the "Funding effect" Hypothesis." *Science, Technology, & Human Values* 38 (4): 566–587. doi:10.1177/0162243912456271.

Krimsky, S. 2019. *Conflicts of Interest in Science: How Corporate-funded Academic Research Can Threaten Public Health*. Simon and Schuster.

Li, R. 2015. "Partnership Launches $500 Million Fund for New Bay Area Housing." *San Francisco Business Times*. https://www.bizjournals.com/sanfrancisco/morning_call/2015/05/trammell-crow-thompson-dorfman-housing-bay-area.html

Los Angeles City Planning Commission (LACPC). 2009. "Corrected Determination: Corporate Pointe." Chatsworth-Porter Ranch. http://clkrep.lacity.org/onlinedocs/2009/09-1510_rpt_cpc_6-15-09.pdf

Los Angeles City Planning Commission (LACPC). 2014. "Letter of Correction." CleanTech Manufacturing Center. http://clkrep.lacity.org/onlinedocs/2014/14-0258-s1_MISC_z_12-05-14.pdf

Lustgarten, A. 2017. "How Military Outsourcing Turned Toxic." *ProPublica*. https://features.propublica.org/military-pollution/military-pollution-contractors-scandal-toxic-cleanups/

MacPherson, J. 2019. "State Refuses Mayor's Request, Won't Extend Public Comment Time on Cleanup of Contaminated Development Site past Mid-May." *Pasadena Now*, April 29. http://www.pasadenanow.com/main/state-refuses-mayors-request-wont-extend-public-comment-time-on-cleanup-of-contaminated-development-site-past-mid-may/#.XcmowDNKg2w

Massachusetts Department of Public Health (MDPH). 1997. "Woburn Childhood Leukemia Follow-up Study." https://www.mass.gov/files/documents/2016/07/pu/woburn-childhood-leukemia-follow.pdf

Mazer, M. S. 2004. "Ten Business Benefits of Effective Data Auditing." *Enterprise Systems Journal*, February 18. https://esj.com/articles/2004/02/18/ten-business-benefits-of-effective-data-auditing.aspx

Morenberg, P. 1995. "Environmental Fraud by Government Contractors." *Boston College Environmental Affairs Law Review* 22 (3): 623–669. https://lawdigitalcommons.bc.edu/ealr/vol22/iss3/6/

Morgan-Linnell, S. K., D. J. Stewart, and R. Kurzrock. 2014. "U.S. Food and Drug Administration Inspections of Clinical Investigators." *Clinical Cancer Research* 20 (13): 3364–3370. doi:10.1158/1078-0432. July 1.

Ninyo and Moore. 2019a. "About Us." https://ninyoandmoore.com/about

Ninyo and Moore. 2019b. "Removal Action Workplan: Former Naval Information Research Foundation Undersea Center." https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/1932116448/Revised%20RAW%2012.12.2017.PDF

Ninyo and Moore Consultants. 2017a. "Appendix A to Remedial Investigation and Feasibility Study: Former Naval Information Research Foundation Undersea Center." https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/3954603433/Final%20RI.FS%20report11.2018.pdf

Ninyo and Moore Consultants. 2017b. "Remedial Investigation and Feasibility Study: Former Naval Information Research Foundation Undersea Center." https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/3954603433/Final%20RI.FS%20report11.2018.pdf

Ninyo and Moore Consultants. 2017c. "Appendix C to Remedial Investigation and Feasibility Study: Former Naval Information Research Foundation Undersea Center." https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/3954603433/Final%20RI.FS%20report11.2018.pdf

Ninyo and Moore Consultants. 2017d. "Appendix D to Remedial Investigation and Feasibility Study: Former Naval Information Research Foundation Undersea Center." https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/3954603433/Final%20RI.FS%20report11.2018.pdf

Ninyo and Moore Consultants. 2017e. "Appendix E to Remedial Investigation and Feasibility Study: Former Naval Information Research Foundation Undersea Center." https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/3954603433/Final%20RI.FS%20report11.2018.pdf

Office of the Inspector General (OIG), US Department of Energy. 2019. "Management Challenges." https://www.energy.gov/sites/prod/files/2018/11/f57/DOE-OIG-19-07.pdf

Office of the Inspector General (OIG), US Department of Transportation (OIG-DOT). 2018. "California Waste Water Company Official Pleads Guilty to State Charges Related to a Hazardous Materials Fraud Scheme." https://www.oig.dot.gov/library-item/36305

Pampanin, M. 2019. "Press Release: City Council Approves Campaign Finance Reform." *Los Angeles City Hall*, May 22. http://davidryu.lacity.org/press_release_city_council_approves_campaign_finance_reform

Pasadena City Council (PCC). 2019. "Meetings: AV Archives," July 9. https://www.cityofpasadena.net/city-clerk/audio-video-archives/

Pasadena, City of (Pasadena). 2018a. "Budget in Brief," 11. https://www.cityofpasadena.net/finance/wp-content/uploads/sites/27/FY-2018-Budget-in-Brief-1.pdf

Pasadena, City of (Pasadena). 2018b. "City Council Minutes," July 16 2018. http://ww2.cityofpasadena.net/councilagendas/2018%20Agendas/Jul_16_18/agenda.asp

Pasadena, City of (Pasadena). 2019. "Public Portal for Campaign Finance Disclosure." https://public.netfile.com/pub2/(X(1)S(vsaixjlxn1z5iw1qnfa1a1sm))/Default.aspx?aid=PSDA&AspxAutoDetectCookieSupport=1

Pincus, K. V. 1989. "Financial Auditing and Fraud Detection: Implications for Scientific Data Audit." *Accountability in Research* 1 (1): 53–70. doi:10.1080/08989628908573774.

Robbins, R., P. Geller, S. Rudman, and M. Dowd. 2017. "First Class Action Lawsuit Filed against Wolverine Worldwide and 3M over Toxic Waste Dumping in Michigan." https://www.rgrdlaw.com/news-press-Class-Action-Lawsuit-Filed-Against-Wolverine-3M-Over-Toxic-Waste-Dumping-in-Michigan120517.html

Sekar, R., M. Taillefert, and T. J. DiChristina. 2016. "Simultaneous Transformation of Commingled Trichloroethylene, Tetrachloroethylene, and 1,4-dioxane by a Microbially Driven Fenton Reaction in Batch Liquid Cultures." *Applied and Environmental Microbiology* 82 (21): 6335–6343. doi:10.1128/AEM.02325-16.

Shamoo, A. E. 1988. "We Need Data Audit." *AAAS Observer*: 2.

Shamoo, A. E. 1989. "Auditing Laboratory-based Data." In *Principles of Research Data Audit*, 79–93. New York, NY: Gordon and Breach.

Shamoo, A. E. 2001. "Adverse Events Reporting—The Tip of an Iceberg." *Accountability in Research* 8: 197–218. doi:10.1080/08989620108573974.

Shamoo, A. E. 2013. "Data Audit as a Way to prevent/contain Misconduct." *Accountability in Research* 20 (5–6): 369–379. doi:10.1080/08989621.2013.822259.

Shamoo, A. E., and Z. Annau. 1987. "Ensuring Scientific Integrity." *Nature* 327 (6123): 550. doi:10.1038/327550b0.

Shamoo, A. E., and Z. Annau. 1990. "Data Audit—Historical Perspective." *Accountability in Research* 1 (2): 87–95. doi:10.1080/08989629008573779.

Shamoo and Resnik. 2003. *Responsible Conduct of Research*. Oxford U Press.

Shapiro, M. F. 1992. "Data Audit by a Regulatory Agency: Its Effect and Implication for Others." *Accountability in Research* 2 (3): 219–229. doi:10.1080/08989629208573818.

Society for the Preservation of Downtown Los Angeles (SPDLA). 2017. "The Rebels Strike Back: Preservation Group Files Lawsuits against Mega-Developer Trammell Crow and the City of Los Angeles." *Cision PR Newswire*. https://www.prnewswire.com/news-releases/the-rebels-strike-back-preservation-group-files-lawsuits-against-mega-developer-trammell-crow-and-the-city-of-los-angeles-300563379.html

Stewart, J. 2006. "Auditing as a Public Good and the Regulation of Auditing." *Journal of Corporate Law Studies* 6 (2): 329–359. doi:10.1080/14735970.2006.11419955.

Taylor, M. 2016. *Considering Changes to Streamline Local Housing Approvals*. Sacramento: Legislative Analyst's Office. https://lao.ca.gov/reports/2016/3470/Streamline-Local-Housing-Approvals.pdf

Tinsley, K., and M. Bishop. 2006. "Poverty and Population Density: Implications for Economic Development Policy." *Journal of Higher Education Outreach and Engagement* 11 (1): 195–208. https://files.eric.ed.gov/fulltext/EJ1093003.pdf

Trammell Crow Company (TCC). 2018. "Alameda Point." West Midway Project. https://alamedamgr.files.wordpress.com/2019/02/2019-02-05-ex.-4-to-staff-report-statement-of-qualifications.pdf

Trammell Crow Company (TCC). 2019a. "Corporate Information." Accessed 10 October 2019. https://www.trammellcrow.com/en/about/corporate-information

Trammell Crow Company (TCC). 2019b. "Environmental Services." https://www.trammellcrow.com/en/products-and-services/environmental-services

Tucker, L. 2013. *Golden Wasteland, Regulating Toxics, or Toxic Regulation?* Santa Monica, CA: Consumer Watchdog. https://www.consumerwatchdog.org/sites/default/files/resources/goldenwasteland.pdf

US Department of Justice (DOJ). 2019. "US Attorney's Office, District of Minnesota." Guilty Pleas Entered In Fraud Scheme Involving Local Environmental Company's Improper Disposal Of Toxic Chemicals. https://www.justice.gov/usao-mn/pr/guilty-pleas-entered-fraud-scheme-involving-local-environmental-company-s-improper

US Environmental Protection Agency (US EPA). 2019d. "Smart Growth, Brownfields, and Infill Development." https://www.epa.gov/smartgrowth/smart-growth-brownfields-and-infill-development

US EPA. 2019c. "Superfund History." https://www.epa.gov/superfund/superfund-history-printable-version

US EPA (Environmental Protection Agency). 2015. *Oswer Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. Washington, DC: U.S. Environmental Protection Agency. https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf

US EPA (Environmental Protection Agency). 2019a. "Amphenol/Franklin Power Products in Franklin, Indiana." Washington, DC: U.S. Environmental Protection Agency. Accessed 9 October 2019. https://www.epa.gov/in/amphenolfranklin-power-products-franklin-ind

US EPA (Environmental Protection Agency). 2019b. Report: Management Alert - Certain Risk Communication Information for Community Not Up to Date for Amphenol/Franklin Power Products Site in Franklin, Indiana. Washington, DC: US Environmental Protection Agency. Accessed 9 October 2019. https://www.epa.gov/office-inspector-general/report-management-alert-certain-risk-communication-information-community

US Naval Facilities Engineering Command (NAVFAC). 2019. "Former Naval Shipyard Hunters Point." https://www.bracpmo.navy.mil/brac_bases/california/former_shipyard_hunters_point/documents1.html

US Navy. 2000. "Memorandum of Agreement with Alameda Reuse and Redevelopment Authority." https://alamedapointinfo.com/sites/default/files/edc_moa-2.pdf

Yoshikawa, M., M. Zhang, and K. Toyota. 2017. "Integrated Anaerobic-aerobic Biodegradation of Multiple Contaminants Including Chlorinated Ethylenes, Benzene, Toluene, and Dichloromethane." *Water, Air, & Soil Pollution* 228 (1): 25. doi:10.1007/s11270-016-3216-1.