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# Contamination and incomplete information: Bounding implicit prices using high-profile leaks

Dennis Guignet [a,*], Robin Jenkins [a], Matthew Ranson [b], Patrick J. Walsh [c]

[a] National Center for Environmental Economics, US Environmental Protection Agency, Mail Code 1809T, 1200 Pennsylvania Avenue, N.W., Washington, DC 20460, USA
[b] Abt Associates Inc., USA
[c] Landcare Research, New Zealand

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ABSTRACT

Incomplete information can lead households to underprice environmental disamenities in the housing market. To bound the true implicit prices, researchers sometimes study high-profile cases involving significant media and community attention. However, prior research finds that high-profile cases may lead to "stigma" effects that can confound interpretation of the results. This study compares these opposing effects at sixteen of the highest profile underground storage tank releases across the United States over the last thirty years. Using covariate matching and difference-in-differences hedonic regressions, we estimate the change in housing values around each site. We then conduct a cross-site meta-analysis to estimate the average treatment effects. We find an average housing price depreciation of 2–6% upon discovery of a release, which is an upper bound on the implicit price of contamination at more typical sites. Following cleanup, we find a housing price appreciation of a similar magnitude, suggesting that even in high-profile cases, surrounding neighborhoods do not experience persistent stigma.



## Introduction

To inform policy, economists often turn to property values to reveal homeowners' preferences regarding exposures to air, soil, and water contamination. However, incomplete information can lead households to underprice these disamenities in the housing market. Recent studies suggest that housing prices are affected by improved information and disclosure requirements (Pope, 2008a, 2008b; Walsh and Mui, 2017). At the same time, widely available information can lead to an opposite stigma effect, manifested in persistent negative price impacts even after cleanup. Evidence of stigma is strongest around high-profile contaminated sites, and weaker at less-publicized sites (Kiel and Williams, 2007; McCluskey and Rausser, 2003; Messer et al., 2006; Taylor et al., 2016). Stigma can confound any property price appreciation resulting from cleanup, and might suggest that households overreact to "too much" information, or that shifts in demographics lead to a broader decline in neighborhood quality (McCluskey and Rausser, 2003).

To address the challenge of incomplete information, this study estimates the implicit price of contamination at 16 of the highest-profile underground storage tank (UST) releases that have occurred in the United States during the last thirty years. At these high-profile sites, information levels are relatively high and market participants are likely to be informed. Although

* Corresponding author.
*E-mail address:* guignet.dennis@epa.gov (D. Guignet).

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previous research has estimated hedonic models using data for select high-profile release sites in particular counties (Zabel and Guignet, 2012), our paper is unique in covering a broad set of high-profile UST releases across the U.S. These cases have garnered significant press coverage and public concern, and help assure that we are studying sites where ample information was readily available. As a result, homebuyers are more likely to be informed about the presence of contamination.

At the same time, at least some of these well-known cases span decades between the discovery of a release and final cleanup, similar to the conditions at the Superfund sites studied by Messer et al. (2006). If there is any post-cleanup stigma capitalized in housing values around UST releases, then we would expect to find it among the high-profile sites analyzed in this study.

There are over half a million active USTs in the United States, and almost two million that are no longer in use (US Environmental Protection Agency, 2012). USTs are often located at gas stations and industrial facilities. More than half a million of these active and inactive USTs have leaked chemicals into the environment (US Environmental Protection Agency, 2014). While leaking USTs can pose risks to human health and the environment (Jenkins et al., 2014), most releases are detected early and are not widely publicized. In these cases, public information is sparse, especially among homebuyers.

Studies of other environmental disamenities suggest that sellers are better informed than buyers, as information regarding local disamenities is more readily available to those living nearby (Pope, 2008a, 2008b). Prior hedonic case studies suggest that surrounding residential property values are not adversely impacted by a typical UST release, but do find evidence of significant declines in the value of homes near a subset of releases that received attention from the surrounding community (and in some cases the media) (Zabel and Guignet, 2012), and in cases where households were explicitly informed of the disamenity (Guignet, 2013).

Based on our unique dataset of high-profile incidents, our analysis uses a two-step methodology to minimize the influence of confounding price effects. We first estimate site-specific difference-in-differences (DID) hedonic regressions, and then follow with an internal meta-analysis of the resulting estimates.

In the first step, we use hedonic regressions to estimate how house prices change following two types of milestone events: the initial discovery of the release and the completion of cleanup. We control for pre-existing site-specific housing market trends by employing a DID framework that compares the price changes in neighborhoods near the release site against the price changes in neighborhoods further away. Prior to estimating the hedonic regressions, we further ensure the comparability of our control and treated groups by matching housing transactions around each site using exact covariate and coarsened exact matching procedures (Blackwell et al., 2009; Iacus et al., 2012). We find considerable heterogeneity in how property values respond to both the discovery of a release and cleanup, sometimes appearing to cause very large property value changes, sometimes yielding negligible changes, and others times exhibiting counterintuitive effects.

The DID model used to estimate site-specific treatment effects relies on the assumption that in the absence of an UST-related event, the outcome of interest (in our case house prices) would have followed similar trends in both the control and treated groups (Gamper-Rabindran and Timmins, 2013), conditional on all observed characteristics, including the presence of uncontaminated gas stations. This assumption could be violated if unobserved influences on house prices are correlated with proximity to the site *and* the timing of events. Our diagnostic analysis of pre-event price trends suggests that for two sites in our sample, the estimated treatment effects could potentially be confounded by local trends in the housing market.

To address this concern, we synthesize the estimated property value impacts across the 16 sites using an internal meta-analysis. The meta-analysis combines the coefficients and statistical uncertainty from each hedonic regression to estimate an aggregate distribution of the percent changes in house prices. Analyzing multiple sites in a meta-analytic framework allows us to generate robust estimates of the average property value impacts (among high profile sites) and reduce the influence of local unobserved trends. Our 16 high-profile releases occurred in dispersed housing markets over a 30-year time period. This spatial and temporal variation in data for the release discovery and cleanup events allows us to use meta-analysis to reduce idiosyncratic biases associated with any individual site, lending greater confidence to a causal interpretation of the estimated average price effects.

Overall, households' revealed values of environmental risks appear rational in this information-rich setting. During the five-years following discovery of a release, on average, the value of houses as far as 2 or 3 km from the site decrease by 2–6%. This represents an upper bound on the implicit price of contamination from a more typical UST release. During the five-years following cleanup, property prices rebound by an average of 4–9%, suggesting that there is no lingering stigma after the threat is eliminated, even in the information-rich setting provided by these high-profile cases.

## Empirical strategy

To identify candidate high-profile release sites we consulted EPA's Office of Underground Storage Tanks (OUST), all ten EPA Regional Offices, state and local environmental agencies, and the Association of State and Territorial Solid Waste Management Officials (ASTSWMO). We supplemented these efforts with internet searches and by reviewing ASTSWMO (2012) and relevant academic literature.[1] We define "high-profile" releases as those that received significant attention from the media and/or the surrounding community, and used a consistent set of guidelines for identifying such releases (see

[1] See Guignet et al. (2016) for details.