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Prevention, Cleanup, and Reuse Benefits From the Federal UST Program

Robin R. Jenkins, Dennis Guignet and Patrick J. Walsh

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TABLE OF CONTENTS

List of Tables

BACKGROUND

The United States has a vast infrastructure of retail gasoline stations that has evolved to support our heavy reliance on automobiles. The first motorists at the turn of the century transferred gasoline from large above ground storage tanks into smaller dispensers and then poured gasoline by hand – an overtly dangerous and risky process. In 1905, the gas pump was invented and improved the process significantly, allowing gasoline to be stored underground. As the years passed, gas stations and underground storage tanks (USTs) were scattered virtually everywhere throughout the United States (Randl 2008). At the same time, an increasing number of underground tanks stored petroleum products and hazardous substances at locations other than gas stations, including airports and federal military facilities. Until the mid-1980's, many USTs were constructed of bare unprotected steel which can corrode over time (US EPA 2014d). While risks were lower than managing fuels without pumps, new more obscure risks emerged - eventually, many USTs would leak.

Despite the localized nature of UST releases, the potential magnitude of the damages began to draw national attention in the early 1980s. In December 1983 for example, a popular TV news program, *60 Minutes*, aired a story about drinking water that had been contaminated by gasoline released from USTs in a Rhode Island neighborhood (US EPA 2009). A growing national concern led Congress to add Subtitle I to RCRA in 1984 to specifically address leaking USTs. The EPA Office of Underground Storage Tanks (OUST) was created in 1985 to implement a new federal program to prevent, detect, and clean up releases from USTs. EPA also set up requirements to assure that tank owners were financially responsible for any leaks that might occur (US EPA 2002a).

A wide variety of social benefits are associated with the regulatory program, running the gamut from health and ecosystem improvements to better aesthetics and increased land productivity. Not all of the benefit categories are applicable to all UST sites; indeed, the nature and magnitude of relevant benefits can vary significantly and should be considered case-by-case.

In the next sections we briefly describe the regulatory program and the population of regulated systems and facilities. We provide a detailed qualitative description of the social benefits possible from prevention and remediation of UST releases, and from reuse of formerly contaminated (or potentially contaminated) UST sites. While this list of potential types of social benefits is meant to be comprehensive, it is important to emphasize that the existence and magnitude of different benefit categories vary by site. In addition to this comprehensive qualitative discussion, four brief case studies of UST release sites are presented to illustrate the diversity of contamination events and associated social benefits.

UST REGULATIONS

The federal EPA UST regulations require owners and operators of new tanks and tanks already in the ground to prevent, detect and cleanup releases (US EPA 2014e). The rules are comprehensive and include technical standards aimed at tank installation and design, UST system operations and performance, spill and overfill controls, release detection, and more.

The regulations require facilities to notify the implementing agency, usually the state or territory, regarding installation of a new tank system. Typically the state has received EPA approval for its own UST program, however in states without approval, programs are implemented through cooperative agreements with EPA.[1] To obtain EPA approval, state programs must be at least as stringent as the federal requirements (US GPO e-CFR 2013). Cleanup standards are not federally determined, instead states have flexibility regarding their own standards.

UST regulations also address financial responsibility for corrective action and for compensating third parties for bodily injury and property damage (US GPO e-CFR 2013). In practice, many state governments have established trust funds, which are mostly funded through state gasoline taxes and tank registration fees, and are meant to cover cleanup costs and damages beyond a fixed deductible. The ability to access state funds is typically predicated on compliance with state regulations, frequently leak detection compliance (US EPA 1994). In addition to state funds, Congress established the federal Leaking UST Trust Fund in 1986 as part of Subtitle I to RCRA, which included a 0.1 cent federal tax per gallon of gasoline.[2] These funds are distributed to states after they have entered assistance agreements with the federal government. States and tribes use this federal trust fund money for such purposes as overseeing cleanups by responsible parties. The funds are also used for financing cleanups that require prompt action or where the responsible party is unknown, unwilling, or unable to perform the cleanup. (US EPA 2013c, US GAO 2007).

OUST includes a Release Prevention Division as well as a Cleanup & Revitalization Division. Revitalization was emphasized as early as 2000 when OUST launched a major initiative to encourage reuse of abandoned gas stations or other properties contaminated with petroleum from USTs. OUST also works with EPA's Brownfields Program to focus attention on petroleum brownfields.[3]

UST POPULATION AND PETROLEUM BROWNFIELDS

EPA regulates UST systems that are defined as including both tanks and connected underground piping or ancillary equipment. There are approximately 600,000 federally regulated active UST systems in the U.S. at over 200,000 facilities. Over 95 percent of these are conventional UST systems at gas stations. Some components of federal UST regulations also apply to emergency generator tank systems that store fuel as a backup supply (US EPA 2011b; US EPA 2013). Four additional categories of UST systems are currently deferred under federal regulation but may be covered by state rules: wastewater treatment, radioactive materials, airport hydrant fuel, and UST systems with fuel tanks so large they must be constructed on-site (40 CFR 280.10(c)).

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[1] As of March 2014, UST programs in 38 states had received federal approval (US EPA 2014).

[2] The current tax is the same (US EPA 2013c, US DoT 2014).

[3] For additional information on program activities, see http://www.epa.gov/oust/petroleumbrownfields/pbsuccess.htm

Since the beginning of the UST program, almost 2 million sub-standard UST systems have been permanently closed. Approximately 500,000 releases have been reported, of which 85 percent have been cleaned up. As of 2013, about 80,000 UST releases remain to be cleaned (US EPA 2011b, 2013). In a 2005 survey conducted by the U.S. Government Accountability Office (GAO), states reported having approximately 12,000 releases in their backlogs that were from tanks without viable owners known as orphan sites (US GAO 2007, pp 58-59).

While this paper focuses primarily on federally regulated UST systems, the nation is also populated with petroleum brownfields. Brownfields are properties where redevelopment is complicated by the presence or potential presence of a hazardous contaminant. If a brownfield is contaminated with petroleum then the site is designated a petroleum brownfield. The petroleum may have leaked from USTs as well as from aboveground storage tanks, pipelines, refineries, and so on. OUST works with EPA's Brownfields Program to focus attention and resources on petroleum brownfields. They make up half of the approximately 450,000 total brownfield sites in the US and often consist of old gas stations (US EPA 2014b). Case Study Four in the Appendix describes a petroleum brownfield.

NATURE OF THE CONTAMINATION

Releases from UST systems can contaminate ground water, soil, and surface water, and emit potentially toxic vapors through soil, air, and waterborne pathways. Releases can be recent, or in many cases have occurred years ago. Vacant gas stations or other leaking UST sites with older releases or suspected releases may be visually unappealing and reduce the desirability of a location for local redevelopment.

The most recognized sources of pollution associated with releases from underground tanks are petroleum-based and petroleum-derived fuels and oils, and fuel additives. Some examples of petroleum based/derived fuels and oils include gasoline, diesel fuel, jet fuel, and motor oil. The four organic chemicals - benzene, ethylbenzene, toluene and xylene (BTEX) - are a major constituent of the fuels, including the most popular, gasoline.[4] Each chemical has state and federally enforceable primary drinking standards referred to as Maximum Contaminant Levels (MCLs) (US EPA 2013). The Agency for Toxic Substances and Disease Registry has developed an interaction profile to highlight the joint risks posed by the chemicals in BTEX (US HHS 2004).

Examples of fuel additives include ethers and ethanol. Methyl tertiary-butyl ether (MTBE) was widely used in the US from the mid-1980s until the early 2000s as an octane-enhancing replacement for lead, and as an oxygenate to reduce ozone and carbon monoxide emissions. It helped gasoline burn more completely, reducing harmful tailpipe emissions from motor vehicles. MTBE has been a pollutant of concern at many leaking tank sites because it is relatively soluble and can be very difficult to remove (US EPA 1998). Recently, however, it is rarely added to gasoline. Indeed, MTBE has been banned or restricted by many states (US EPA 2014c) and is on a list of candidate contaminants for drinking water standards (US EPA 2013b). Thus, MTBE is primarily an issue for past leaks that may or may not have been

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[4] There are hundreds of chemicals in gasoline, all of which pose risks.

discovered yet. As residual MTBE-related leaks are remediated, MTBE is anticipated to be a diminishing issue over the long term.[5]

Ethanol was the typical replacement for MTBE and is another potential contaminant. Its use increased steadily and by 2011, a little over 75 percent of gasoline in the U.S. contained ethanol (Weaver et al., 2010, 2005). A number of published sources have assessed ethanol for its interactions with gasoline that might have possible effects on soil and groundwater contamination during release events. The studies conclude that for ethanol blended fuels, the rate of biodegradation of BTEX compounds will be decreased, and fuel plumes in soil are likely to spread more widely. However when ethanol makes up 10 percent or less of the blend, these effects may be negligible (Kirstine and Galbally 2012).

Benefit Categories

Benefits of UST regulations are derived from prevention, detection, cleanup/corrective action, and reuse of formerly tainted land - all activities of the EPA UST Program. Benefit categories include improvements in human health, ecosystem functions, aesthetic values, and the productivity of land. If cleanup of an UST release increases the availability of useable urban land, and this reduces pressure for development at the urban boundary, then the preservation of green space on the fringe of urban areas may add additional value to these same benefit categories.

USTs are numerous and widely dispersed across the country, thus it is likely that the benefits of preventing and cleaning UST system releases are widely dispersed as well. UST sites themselves are typically small, about a quarter acre. However, because they are usually former or current retail outlets, they are frequently located near people. When there is a release, the extent of its impact is often relatively local, affecting on-site employees as well as people in nearby residential buildings, schools, or businesses. Indeed, a study of three counties in Maryland found evidence that contaminated plumes migrated to adjacent properties at approximately 20 percent of the release sites investigated (Zabel and Guignet, 2012; Guignet 2013). Other studies of sites in California (Rice et al., 1995) and Ohio (Simons et al., 1997) came to similar conclusions. There are, however, many examples of extraordinarily large UST releases. For example, the groundwater contamination plume from an UST release in Baltimore County, Maryland contaminated private residential groundwater wells over half a mile away (Zabel and Guignet, 2012). In a different case, discussed in the Appendix (see Case Two), a release from three abandoned UST facilities led to a contamination plume reaching about 45 groundwater wells and extending beneath 80 to 90 parcels (Burton, 2012; Miner, 2012). There are also many instances of a region addressing UST releases at multiple sites at once. In these cases, benefits might be concentrated and substantial in the region hosting those sites.

Table 1 summarizes the social benefit categories associated with the EPA UST Program. It offers examples of each, and identifies potential methods that might be used by economists to

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[5]

estimate values for them.[6] The table distinguishes between benefits derived from release prevention (p), site cleanup (c), and site reuse (r). Health improvements are associated mostly with prevention and cleanup while the other benefit categories involve more overlap with reuse.

Reuse values can follow assessment if no cleanup action is required, or can be contingent on cleanup. For example, cleaning up and redeveloping a vacant gas station by converting it to a small nature park, or pocket park, can reduce health risks and improve a neighborhood's visual appearance, generating aesthetic benefits. If the park reduces the amount of paved surface relative to the prior use, then absorption of surface waters may be improved thereby generating ecosystem benefits. If the park is recreation-oriented, it can generate recreational benefits. Finally, by replacing the vacant land with a park that people use and enjoy, the productivity of the land will be improved.

The following sections describe the various categories of benefits that may accrue from preventing and cleaning up contamination releases from USTs. The potential benefits of reusing and redeveloping remediated sites are also addressed. Table 1 is not an exhaustive list of sources of health benefits from cleaning up and preventing UST releases, it merely offers examples. USTs may contain hazardous substances other than MTBE or BTEX and can certainly pose health risks not discussed here.

Table 1
Potential Benefits of UST Release Prevention (p), Clean Up (c), and Land Reuse (r) Activities

Benefit Category	Examples	Potential Valuation Methods
Human Health Improvements		
Mortality	Reduced risk of: • Cancer fatality (p)(c) from benzene and ethylbenzene in BTEX • Acute fatality (p)(c) from petroleum vapors leading to fire or explosion	• Averting behaviors • Property value models • Stated preference
Morbidity	Reduced risk of: • Cancer including leukemia (p)(c) from BTEX and MTBE • Blood disorder (p)(c) from benzene • Neurological Impairment (p)(c) from BTEX • Accident & injury (p)(c) from petroleum vapor migration	• Averting behaviors • Cost of illness • Property value models • Stated preference

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[6] For more information on categories of social benefits associated with land cleanup and reuse, and methods to estimate them, see EPA's *Handbook on the Benefits, Costs, and Impacts of Land Cleanup and Reuse* (US EPA 2011a). For information on social benefits of environmental protection more generally see EPA's *Guidelines for Preparing Economic Analysis* (US EPA 2010).

Table 1
Potential Benefits of UST Release Prevention (p), Clean Up (c), and Land Reuse (r) Activities

Benefit Category	Examples	Potential Valuation Methods
Ecological Improvements		
Valued ecosystem functions	• Reduced surface water contamination (p)(c) leading to protection of fish and wildlife • Reduced surface water runoff (r) from redevelopment of a parcel as a pocket park • Cleaning and reusing a sizable set of UST sites in an urban center may reduce the development of greenfields elsewhere and thereby preserve nutrient cycling and carbon sequestration (c)(r)	• Stated preference • Production/cost function • Averting behaviors • Recreation demand models
Nonuse values	• Protected species or ecosystems (c)(r) by providing habitat for pollinators in pocket park • Protected underground aquifers (p)(c) for future generations	• Stated preference
Aesthetic and Recreational Improvements		
Aesthetic	• Nature or gateway pocket parks can improve neighborhood appearance and create new outdoor activities and exercise (c)(r) • Restoring old gas stations as historic landmarks improves neighborhood appearance and generates historical preservation values (c)(r) • Improved drinking water taste and odor (p)(c)	• Production/cost function • Averting behaviors • Property value models • Stated preference • Recreation demand models
Recreational	• Recreation-oriented (basketball court) parks can create new locations for recreation and exercise (c)(r)	
Land Productivity Improvements		
Productivity	• Improved information regarding contamination can increase transaction rates so that businesses more quickly move into their highest valued use. (p)(c) • Businesses at sites given a "clean bill of health" can more efficiently produce goods and services (p)(c)(r) • Reuse activities in urban centers may enjoy agglomeration benefits stemming from close geographic proximity, due for example to shared market access.(r)	• Land values minus remediation and redevelopment costs • Production/cost function • Property value models

Adapted from the EPA *Guidelines for Preparing Economic Analysis* (US EPA 2010) and the EPA *Handbook on the Benefits, Costs, and Impacts of Land Cleanup and Reuse* (US EPA 2011a).

1. Human Health Benefits

Prevention, detection, and cleanup of UST releases reduce human exposure to contaminants, both on- and off-site. Reduced mortality and morbidity risks might be experienced by gas station employees as well as nearby residents consuming well water or exposed to vapors.

These two pathways - well water and vapor intrusion - are probably the most critical threats to human health from UST releases.

Regarding contaminated well water, the exposure routes of concern include ingestion, skin contact, and inhalation of fumes (Paustenbach et al, 1993). Each component of BTEX can produce neurological damage (US HHS 2004). BTEX can also affect the kidneys and liver (US EPA 2013a). Benzene poses risks of hematological effects that can lead to blood disorders or even leukemia. Ethylbenzene is carcinogenic to other tissues (US HHS 2004). Additionally, EPA considers the fuel additive, MTBE, a potential human carcinogen (US EPA 1998).

Groundwater contamination posed health concerns in 1997 when an underground release was discovered at the local gas station in the rural town of Glennville, CA. The gas additive MTBE polluted or threatened drinking water at over 25 wells in the area. The state delivered bottled water to at least 15 homes and 8 with the worst contamination received external water tanks that were refilled by truck (Grossi 1997, Weiser 2003). A different, more recent example occurred in 2006 when an underground gasoline leak in Jacksonville, MD led to monitoring at over 200 private wells. Deliveries of free bottled water were provided to reduce health risks (Madigan 2010). Twelve homes and businesses suffered contamination, with MTBE detected at levels above the state action standard (Hirsch 2011). A final example is from 2012 when a Cullman County, Alabama gas station discovered a leaking UST system and contaminated groundwater that was migrating to the nearby Indian Creek. The release was contained before migrating to groundwater (ASTSWMO 2012).

The second familiar threat to human health associated with UST releases is vapor intrusion. Vapors associated with petroleum pose health risks from inhalation and risks of injury from fire or explosion (US HHS 2004). Vapors can travel through soil, sewer lines, storm drainage systems, and other pathways to enter homes or buildings resulting in an accumulation of flammable gases and significant risks to building occupants or passersby. An UST release in Richmond, Virginia in 2010 led to explosive vapor levels detected in sewer lines and from gasoline odors emanating from a restaurant floor drainage system. State consultants and the fire department kept the site safe while vapors were dissipated and the leak addressed (ASTSWMO 2012). The risk of fire can also be posed by intruding liquid gasoline. In 2006 gasoline leaked from rusting USTs in Lawrence, Kansas and traveled underground toward nearby houses. Investigators hypothesized that from there free product was drawn into a five-apartment house possibly via a sump pump. Evidence suggested that either the gasoline or its vapors were ignited by a sparking sump pump, a hot water heater pilot light, or a furnace. The five-apartment house burned to the ground. This case is the subject of Case One in the Appendix.

Due to more compact human development, redeveloping an urban brownfield instead of a greenfield may reduce or shorten automobile trips and thereby improve air quality. This is another potential source of public health benefits (US EPA 2007).

Measuring the health benefits associated with reduced levels of contamination from UST releases can be challenging, especially for individual sites. The circumstances surrounding the contamination event, the nature and extent of the contamination, and the proximity and density of human populations will vary from site to site. Table 1 offers a variety of potential valuation approaches that may hold promise for these cases.[7] In practice, only the property value and stated preference approaches have been applied to UST releases.[8] Assessing property value changes associated with contamination or cleanup is advantageous because it examines actual behavior. An important caveat, however, is that the estimated price differentials will likely capture several of the other benefit categories in Table 1 (aside from non-use). Disentangling only the health benefits, or any other single benefit category, is a challenge for future research.

Stated preference methods are survey-based and enable researchers to isolate specific benefit categories. However, the hypothetical nature of survey questions has led critics to question the validity of resulting estimates. In response, there is a vast literature that explores approaches to compensate for this hypothetical bias. (See Boyle (2003) for more information).

Consumer (not government) spending on averting behaviors such as bottled or filtered water to avoid exposure to contaminated drinking water is another possible approach to learn more about values of health benefits. The approach is more targeted than the property value method but may capture the aesthetic benefits of improved taste, odor and appearance, as well as health benefits.[9]

While the methods identified in Table 1 are possibilities, the resources necessary to conduct an original property value, averting behavior, or survey-based study in order to estimate benefit values for a single site, or even a cluster of sites, will usually be prohibitive. A more practical option would be to transfer the property value estimates existing in the literature from the study cases to a policy case. Yet, as with any benefit transfer, a high degree of caution is warranted due to the individual nature of each UST release as well as the surrounding housing market and population (US EPA, 2010).

2. Ecological Benefits

Ecological benefits are improvements in ecosystems that contribute to human welfare. More than one ecological benefit category is relevant to release prevention, cleanup and site reuse. Cleanup might prevent contamination from reaching surface water and affecting fish and other wildlife. For example, during the 2010 UST release in Richmond, VA mentioned above, gasoline leaked into a nearby creek and traveled downstream. Booms were put in place to prevent the contaminants from migrating further (ASTSWMO, 2012). Or redeveloping formerly contaminated UST sites into small pocket parks or green spaces and removing old impervious surfaces could improve ecological services by reducing storm water runoff or providing better habitat for valuable pollinator species such as bees, though the magnitude of such effects at each UST site may be quite small. The city of Tacoma in Washington addressed petroleum contamination from an UST release at the Tacoma Gas Station Park. The community worked to redevelop the site into a pocket park which

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[7] For more detail, please see *The Handbook* (US EPA 2011).

[8] To our knowledge, there are four published studies analyzing the property value impacts from proximity to UST releases and the related groundwater contamination (Guignet 2013; Zabel and Guignet 2012; and Simons et al. 1997, 1999). Two stated preference studies have targeted UST releases. Both pose hypothetical questions within the context of housing (Guignet, 2012; Simons and Winson-Geideman, 2005).

[9] See Abrahams, Hubbell, and Jordan (2000) for a discussion of water expenditures and joint production of aesthetic values along with health.

integrated landscaping as well as recreational uses (US EPA 2002b; Matthews 2012).[10] Nutrient cycling and biological carbon sequestration are other potential ecological benefits of converting a concrete-dominated petroleum brownfield into a park or other green space. These types of ancillary benefits of the UST program could be important in locales with unmet demand for green spaces and ecological services.

In urban areas with scarce supplies of undeveloped land, cleaning up UST sites and making them usable could reduce pressure for development at the urban boundary. This could prevent or delay the development of outlying greenfields such as pasture or forest, and preserve their ecological benefits. This effect is more likely if a cluster of UST sites is cleaned up and made available for redevelopment. As we will discuss in the next section, targeting sets of UST sites is not uncommon. These cleanups effectively increase the supply of land at the urban core and reduce demand to develop land elsewhere. Preserving outlying green space improves welfare through the same set of ecological functions already mentioned, although now the impacted ecosystems are not near the contaminated site but instead at the outer edges of cities. The magnitude of such benefits varies according to at least two variables - the amount of greenfield space that would otherwise have been developed,[11] and the specific ecosystem services provided by the undeveloped greenfield area.

Nonuse or preservation values often fall under ecological benefits.[12] These values are sometimes enjoyed by people who gain welfare simply by knowing that resources, ecosystems, or species are being preserved or restored, without ever directly coming into contact or even viewing them. For example, consumers may have willingness to pay for cleaning up a contaminated groundwater plume that is not presently a source of drinking water so that it will be preserved for possible future use or for use by future generations. Social welfare is improved even though consumers themselves may never directly use the resource. Measuring such benefits is a challenge and requires survey-based or stated-preference research, instead of revealed-preference (market- or nonmarket-based) approaches (US EPA 2011a).

3. Aesthetic and Recreational Improvements

Remediating and redeveloping contaminated UST sites can generate highly valued aesthetic benefits by leading to more attractive or more appealing neighborhoods. This is especially true if the site is redeveloped as a nature park, a recreational area, or to preserve a historic building. Many old gas stations are situated in quite visible locations within towns or neighborhoods. The reuse chosen for many cleaned up tank sites is a gateway, town center, or pocket park for which an old gas station is demolished and landscaping and/or recreational equipment is installed. Such redevelopment opportunities improve a locality’s appeal and create recreational values. The town of San Pedro, CA addressed an UST release located at the entrance to the town with plans to convert it to a gateway park, while the town of

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[10] See US EPA 2002b for brief descriptions of 40 pilot projects to clean up and reuse petroleum brownfields, including multiple examples of redevelopment as parks.

[11] This depends on the substitutability of brownfields for greenfields, which reflects in part the differences in zoning and building requirements (e.g., setbacks, building height limits). Deason et al. (2001) referred to this trade-off as the “brownfield/greenfield offset.”

[12] Our language follows Walsh, Loomis, and Gillman (1984) which defined willingness to pay for “nonuse satisfactions” as “preservation benefits” and included option, existence, and bequest values as subcategories.

Bradford, New Hampshire planned to assess a leaking tank site covering 20 acres and situated near the town center to convert it to a baseball field (US EPA 2002b).

A recent effort by the National Park Service encourages preservation of historic gas stations, " . . . historic stations are increasingly appreciated for their contribution to the character of a neighborhood, and the way they are easily adapted for new uses" (Randl 2008). Historic preservation funds have been successfully applied by communities to restore historic gas stations with significant architectural features and convert them to new uses such as a repair shop, ice cream parlor, or to meet a location-specific need. For instance, the current field office for the nonprofit, Preservation North Carolina, is housed in a memorable 1936 Shell station that has a bright yellow seashell façade (Randl 2008).

Improving the taste and smell of drinking water is also an aesthetic benefit. For example, as a result of MTBE pollution from an UST release in the rural town of Glennville, CA, residents complained of tap water that smelled like turpentine. Remediating contaminated groundwater that contains the odor of gasoline or MTBE can improve the taste and smell of drinking water.

Visual aesthetic and recreational benefits associated with reuse and cleanup would be reflected in property value estimates though they would be aggregated with health, ecological, and all other use benefits accruing to nearby property owners. Stated preference approaches could enable isolation of these benefit values. Recreation demand models are possibilities to gauge recreational values. Aesthetic benefits associated with the appearance, taste and smell of drinking water on the other hand, may better be measured by analyzing averting behaviors; for example, how much are respondents willing to pay for filters or substitute water supplies. However, we were unable to identify any studies of averting behaviors that were focused on UST sites.

4. Increased Land Productivity Including Information, Agglomeration, and Peer-group Effects

Cleaning up a leaking UST at a former gas station makes it safer and a better host for productive land use activities. Old gas stations frequently occupy prime locations on main streets and suburban corners that can be ideal locations for commercial, residential, or public sector activities. With contamination assessed and removed, the land sometimes moves into these new higher-valued activities. The net social benefits of the cleanup and reuse of the land will be capitalized in its value and can easily be estimated by the increase in the land's value following cleanup, minus the remediation and redevelopment costs (US EPA 2011a).

Assessing and when necessary remediating vacant or underused federal UST sites and petroleum brownfields creates social benefits by providing information that is the impetus for moving land into more economically optimal, and hence higher valued, uses. This easing of property market transactions may also be enjoyed at nearby parcels suffering from suspicion or concern regarding proximity to the contamination. Reducing liability concerns and informational gaps or asymmetries in the land market will encourage optimal land uses more quickly. Recent research concludes that liability concerns reduce the likelihood that contaminated or potentially contaminated property will be purchased.[13] Site assessment and

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[13] For a useful discussion on how improved information can increase property transactions see US EPA 2011a which cites Lange and MacNeil 2004a, b; Alberini et al. 2005; and Wernstedt et al. 2006a, b. For examples specific to

cleanup activities can address uncertainties faced by site owners or potential owners regarding future liability.

Sometimes there are no viable responsible parties and relatively low risk petroleum brownfields sit vacant for lengthy periods. Such orphan sites might be associated with a responsible party who has either gone out of business or simply cannot afford the cleanup. Another type of orphan site is an area with contaminated drinking water wells where the source of contamination is unknown (Oregon Department of Environment Quality 2004).[14] After assessment and/or cleanup, investing in such sites is less encumbered and transaction rates may increase, improving the efficiency of property markets and increasing the number of sites in productive use.

We offer just a few examples from the plethora of cases that may illustrate greater productivity of land.[15] Townhouses, a coffee shop, and restaurant were opened in Rochester, NY, following cleanup of a 2.2 acre multi-use parcel that included a former gas station. Contamination at a petroleum brownfield in Moorehead, MN was cleaned up and the property developed into commercial spaces and apartments. A parcel in Albertville, Alabama that had previously hosted a gas station and tractor sales business was converted to a Walgreens store (US EPA 2009b). In Clearwater, FL a brownfield property was purchased by the city with state funds and contaminated soil and USTs were excavated and removed. Consultation with the local community helped identify needs and led to construction of the North Greenwood Health Resources Center (US EPA 2005). In all these cases, reduced concerns about proximity to contamination may also have improved the ease with which nearby properties changed ownership, thus facilitating the movement of land into its highest valued use (Guignet 2014).

In urban areas, cleaning up petroleum brownfields may pose opportunities for agglomeration effects, a type of benefit that occurs when firms experience productivity improvements because of geographic concentration. Cleaning up old gas stations so that formerly unused urban land is put to productive use can increase economic activity (and value), not just of the cleaned up lot but of nearby properties as well. Reasons may include shared infrastructure, labor pools with enhanced opportunities, or better retail market access (US EPA 2011a). Cleaning up a set of sites can multiply this effect. Indeed, by the late 1990s, coalitions were formed consisting of state, federal, nonprofit, private, and other agencies that targeted cleanup and redevelopment of corridors or regions littered with many leaking USTs. A partnership including all of these entities and more, formed in Southeast Florida to address a 115-mile coastal strip host to approximately 2,100 brownfield sites, including many suspected UST releases. The objective was to restore land and funnel people back into the urban areas of Southeastern Florida (US EPA 2005).

Benefits that may be accrued from agglomeration are also demonstrated by the Arizona Route 66 Partnership. Route 66 was a popular highway for travelers from the 1930s through

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USTs see a series of papers that examine the impact of tanks, contamination, and no further action determinations on commercial property transaction and financing rates (Sementelli and Simons; Simons and Sementelli, 1997; Simons et al., 1999) and residential property transaction rates (Guignet 2014).

[14] Similar definitions of an orphan site are offered by other states and the federal EPA. For example, “An orphan site is generally defined as a property where the responsible party has either not been identified, cannot be located, or is unwilling or unable to fund cleanup.” (California State Auditor 2003).

[15] See Case Study Four for another example.

1970, at which point most of it was bypassed by interstate divided highways. By 2000, many communities along the old route were in need of economic revitalization. In 2004, Arizona targeted approximately 100 leaking USTs along the 200-mile section of Route 66 running through the state. A coalition was formed to address orphan sites as well as provide assistance to owners wishing to remediate and reuse their own sites. By 2010, more than 40 of these sites had been remediated, and the state points to the effort as successful at rejuvenating towns. By targeting a lot of sites along the same corridor, the effort created a driving destination designated in 2006 as a National Scenic Byway. The hope was that the new businesses would have positive spillover effects on one another and on existing nearby businesses, thus providing an agglomeration of local economic benefits (US EPA 2011c, Arizona Department of Environmental Quality 2013).There are many other examples of successful coalitions, including a project directed at the I-710 corridor in Los Angeles County which targeted seven petroleum brownfields located in underprivileged areas (US EPA 2012b); or an effort directed at the National Historic Voting Rights Trail along Highway 80 from Selma to Montgomery, Alabama which addressed 18 brownfields including numerous former gas stations (US EPA 2011d).

Creating new businesses or jobs from restoring old gas stations or redeveloping them to a new use could potentially have positive peer-group effects on the wider community. Peer-group effects occur when redevelopment reduces illegal or undesirable activity through indirect means such as role-modeling or peer pressure. Abandoned or vacant areas are sometimes associated with vandalism, drug use, or other crime. When redevelopment of such sites creates job opportunities, not only is land productivity directly improved by displacing criminal activity, but positive indirect effects on the local population might be experienced through neighborhood peer-group effects. These positive effects might reduce criminal activity still further.

Like agglomeration effects, peer-group effects might be more pronounced when corridors or clusters of (potentially) contaminated sites are addressed. Ogden, Ohio was burdened with an abandoned gas station situated at its gateway to downtown. In an effort to revitalize the town, and perhaps spur positive peer-group effects, plans were made to remediate this site and three nearby brownfields and put them back into productive uses (US EPA 2011d). Similar to agglomeration effects, separate measurement of peer-group effects is the purview of future research since the existing economics tool kit falls short of isolating such subtleties.[16]

CONCLUSION

The social benefit categories in Table 1 may result from prevention and remediation of UST releases, and from reuse of formerly contaminated (or potentially contaminated) UST sites. We have attempted to be comprehensive in identifying relevant benefit categories, but the suggestion is not that all the categories are associated with all UST sites. Instead, there is a great deal of variability, and a site-by-site assessment is warranted. Each of the four case studies presented in the Appendix ends with a brief discussion of relevant benefit categories which helps demonstrate the degree of divergence. Table 2 maps the case studies to the different benefit categories. The table does not indicate the relative importance of the different categories since differences across cases could be quite large. For example, the

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[16] For more discussion, see the sections on agglomeration and peer-group effects in EPA's *Handbook on the Benefits, Costs, and Impacts of Land Cleanup and Reuse* (US EPA 2011a).

magnitude of property value changes in Santa Monica would probably far outweigh those in Helena. Without quantitative measures, which are beyond the scope of the current paper, we avoided discussing the relative magnitudes of benefits. Table 2 does show that aesthetic benefits were always present in all four cases, while health effects were present in all but the petroleum brownfield.

The UST program benefit categories overlap significantly with benefits associated with other EPA regulatory programs (see Chapter 7 in EPA's *Guidelines for Preparing Economic Analysis*). One difference of note is the benefit category associated with land productivity which is emphasized here and in The EPA *Handbook on the Benefits, Costs, and Impacts of Land Cleanup and Reuse* (US EPA 2011a). This important category largely affects a privately held asset (property) and has a readily accessible methodology for valuation (changes in on site property values minus cleanup and remediation costs). Land productivity may also improve when remediation or assessment information improves transaction rates of nearby properties, a component of land productivity benefits that would be harder to measure.

Finally, while the magnitude of benefits associated with remediating and redeveloping a single UST site may be relatively small, adding benefits from the thousands of sites across the US may lead to significant benefit measures. Many communities have chosen to target clusters or corridors of sites. This practice is more likely to produce significant benefits.

Table 2
Categories of Potential Benefits at Four UST Release Cases

Benefit Category	Case 1	Case 2	Case 3	Case 4
Human Health Improvements	✓	✓	✓	--
Ecological Improvements	✓	--	--	--
Aesthetic and Recreational Improvements	✓	✓	✓	✓
Land Productivity Improvements	✓	--	--	✓

Note: Details for each Case Study appear in the Appendix. To understand why a specific benefit category is checked, see the relevant Case Study and especially the discussion appearing under the heading, "Social Benefits."

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APPENDIX

FOUR CASE STUDIES

To provide specific examples of release events associated with USTs, and to illustrate a variety of contamination events and associated social benefits, this Appendix summarizes four case studies. Each case describes a different set of circumstance that are not atypical among UST release events. There is a release event that involved a fire (Lawrence, Kansas); and another in which the neighborhood suffered from legacy contamination (Hopkins, South Carolina). In the third case, MTBE was the contaminant of concern and public well fields were affected (Santa Monica, California). Finally, the fourth (in Helena, Montana) was a petroleum brownfield for which an assessment facilitated movement of land into commercial use.

The cases were selected in part from a set of release events for which information had been gathered for a different study. Simultaneous with the production of this paper, the co-authors conducted a property value analysis of high-profile UST release events at locations across the country. In order to be considered high profile, a release event had to be characterized by: (1) media attention or significant concern from the nearby community; (2) a major milestone such as discovery, cleanup, or publicity within the last 15 years; and (3) close proximity to a residential neighborhood. Three of the four case studies in this Appendix met the “high profile” release criteria, although two of those three - Old West Lawrence, Kansas and Hopkins, South Carolina - were ultimately dropped from the property value study because the density of their host neighborhoods was not high enough to enable meaningful regression analysis. Santa Monica, California met the criteria for high profile and was included in the property value study. The fourth case study, Helena, Montana, was never thought to be high profile but was included to illustrate a case in which contamination is not discovered.

Case Study One

Presto Phillips 66 Gas Station, Old West Lawrence, Kansas; Spring 2006

Old West Lawrence is a neighborhood consisting of approximately thirty blocks in Lawrence, Kansas.

Lawrence Statistics (US Census State and County QuickFacts)
Population (2010): 87,600
Population density (2010): 2,611/sq mi
Race identified as White alone (2010): 86%
Median household income (2008-2012): $44,700

Background

In Spring 2006, a leaking underground gasoline tank at Presto Phillips 66 Gas Station was suspected of contaminating groundwater and soil beneath two city blocks of Old West Lawrence, Kansas. The leak was discovered because of a house fire at 838 Louisiana Street on April 30, 2006. Local and state investigators concluded that gasoline had migrated through the groundwater and had been sucked up through a sump pump into the house where it was ignited by either a spark from the pump, a furnace pilot light, or the hot water heater. No people were harmed, though the house which contained five apartments was burned to the ground. The house was located across the street and cattycorner from the Presto Phillips 66 Gas Station and convenience store. After the fire, there were petroleum odors in the neighborhood and high levels of petroleum vapor were detected in the sewer. This prompted the Lawrence Fire Department to contact the Kansas Department of Health and Environment (KDHE). Thereafter the state managed the incident (Knox 2006, Larsen and Associates 2006, Ranney 2006b).

An investigation proceeded in order to confirm the source of the gasoline leak. The suspected Presto USTs had been installed in 1978 and were embedded in clay rather than sand. Concerns were voiced that clay can facilitate the development of rust on USTs. Before concluding the source was Presto, KDHE required that all other sources that might have contributed be ruled out. Besides the tanks at Presto, there were seven registered USTs within a half mile radius of the fire: three at a business called Diamond Shamrock; two at the Jayhawk Food Mart; and two at the Kwik Shop. In addition, there was an examination of historical data on old fuel tanks in case an old spill was the source of the problem. An old city directory showed that in the mid-70s, a now-closed gas station had been located near where the fire had occurred. The KDHE required both Presto and Diamond Shamrock to cease operations until they had provided inventory records. (Ranney 2006a, Larsen and Associates 2006).

In spite of initial pressure tests that indicated the Presto tanks and associated piping were in good shape, there was evidence of small amounts of missing petroleum from their inventory. Three soil borings, one near a Presto UST and on the property where the house burned, turned up soil contaminated with petroleum. State officials detected fresh gasoline near the Presto USTs on May 3rd and ordered the owner to remove the tanks. The owner readily agreed. Approximately three feet of gasoline was observed by KDHE in the bottom of the pit surrounding the tanks.

Within a few days, KDHE had pumped over 30,000 gallons of gas-laden water and 1,700 gallons of pure fuel from trenches near where the underground tanks were located. KDHE tested 43 homes for the presence of leaked gasoline. The Lawrence Fire Chief held an online chat on May 5, 2006. At that point, he was able to confirm the sanitary sewer and storm water systems were free of combustible gases and liquids (Ranney 2006a, Larsen and Associates 2006, Knox 2006, Toplikar 2006). On May 9, workers completed removal of three underground tanks. The following day, KDHE revealed the extent of the area affected by the leak – two city blocks. Officials gathered in Lawrence to answer questions from potentially affected residents. They estimated it would take over a year for the remaining gas to naturally dissipate.

The leak affected soil deep in the earth, approximately sixteen feet underground. Neighbors near the Presto Gas Station were quoted expressing concern about property values and landscape plants dying. They were also concerned about gas entering their homes, especially during periods of heavy rain. Because of the relatively large depth of the contamination plume, officials urged residents not to panic and suggested that the leaking gas would not affect top soil or the water system. The state distributed basement gas detectors to all residents in the affected area (Mathis 2006, Knox 2006).

Seven wells were dug by state crews to monitor gas levels. Ultimately 25 monitoring wells and 20 water-level sensors were installed on or near the Presto Gas Station. A vapor extraction system was installed by KDHE to remove vapors from the soil. A building, essentially a large shed, was constructed on the vacant lot where the house burned to contain the blower for the vapor extraction system (Knox 2006, Larsen and Associates 2006, Ranney 2006b, Mathis 2006).

Lawrence residents generally obtained their drinking water from a public water supply system that drew from multiple sources including the Kansas River and a reservoir. A review of well locations provided information about potential health effects from drinking water. Records showed one private domestic well located within a quarter mile of the Presto station. However, the address listed for the well did not exist. One well was located on the property where the house burned. No other wells were known to exist though wells installed before 1975 weren't required to register with the state. The Kansas River was located approximately 3000 feet north of the leaking tank (Larsen and Associates 2006).

Cleanup was initially paid for by the Kansas Petroleum Storage Tank trust fund; a taxpayer-funded account designated for leaking USTs. The account was funded by a one cent gas tax. As of mid June 2006, the cleanup had cost KDHE a little over $500,000 of which Presto was expected to pay $5,000 and the remainder from the Kansas Petroleum Storage Tank Release Trust Funds. KDHE also fined Presto $4,900 for not detecting the fuel tank leak suspected of causing the fire. Presto agreed to upgrade its tank-monitoring equipment and manager training at all 41 of its stores in Kansas (Knox 2006, Ranney 2006b).

The owners of the house that caught fire and at least one tenant sought damages against the owners of Presto Oil Inc. The house was valued at almost $200,000 plus the owners suffered a loss of revenue from the apartment rental income. The station was required to have a $1 million insurance policy which could be drawn down to cover law suits over property damage (Knox 2006).

Social Benefits

Remediation of the Presto Phillips 66 Gas Station in Lawrence generated a variety of social benefits falling into the categories in Table 1. Likely the largest in magnitude were the human health risks, including possible acute fatality, presented by vapor intrusion and the risk of fire and explosion. While less of a concern in this case since residents did not rely on wells for drinking water, human health was also at risk via groundwater and surface water contamination and the possibility of eventual drinking water exposure. Recall, for example, that benzene in drinking water poses risks of hematological effects that can lead to blood disorders or leukemia. Ecosystem services of concern included landscaping plants, though some assurances were made that the contamination was deep enough not to damage surface plants. Aesthetic values were affected by petroleum odors and by at least one burned house, perhaps partially addressed by constructing a small building to house the remediation technology that was eventually installed. The property hosting the gas station itself largely maintained productivity as a service station, with at least one brief interruption. Interruption of business at another suspected facility occurred, as well as the lost productivity at the burnt down apartment housing. With petroleum odors in the neighborhood, transactions of nearby properties might have been inhibited. With cleanup, land productivity improved especially at the suspected facility and potentially in the future at the site where the house burned.

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Case Study Two

Brazzels Grocery, Brooks Grocery, and Joseph Brooks Grocery, Hopkins, SC; ~1988

Hopkins is part of the Columbia, SC Metropolitan Statistical Area
and consists of 17 square miles.

Statistics for Hopkins Census Designated Place
(US Census State and County Quickfacts; City-Data.com)
Population (2010): 2,882
Population density (2010): 170/sq mi
Median Household income (2011): $36,000
Race identified as White alone (2010): 15%

Background

In the late 1980s, foul tasting and smelling well water were reported by residents of Hopkins, SC. Unsafe levels of gasoline contamination were confirmed at a large number of household wells.[17] At least one resident reported that strong odors of gasoline even made bathing unpleasant. The suspected contamination coincided closely with federal and state requirements for permitting USTs which began in 1988. The SC Department of Health and Environmental Control (DHEC) investigated the source of contamination and identified a single leaking UST located at Brazzels Grocery, a business that had closed years before. The leak was attributed to old rusting USTs (Fretwell and Monk 2008, Presley 2003).

During an initial round of cleanup activities from the late 1980s to early 1990s, the level of gasoline at some of the affected wells increased when it was expected to have decreased. DHEC undertook a more expansive assessment, installing multiple monitoring wells, checking private water supplies, and testing more than a dozen additional sites suspected of hosting USTs. By 2001, DHEC confirmed that leaks from three old gas stations including Brazzels Grocery, Brooks Grocery, and Joseph Brooks Grocery, all located on Cabin Creek Road in Hopkins, had contaminated about three dozen wells. Like Brazzels, the two Brooks establishments had been out of business for years and the owners were deceased. Rusty old tanks were suspected at all three stations (Presley 2003). The sites, having no viable responsible parties, are examples of orphan sites.

In December 2002, DHEC finished their assessment of gasoline contamination in Hopkins. Reports indicated that about 26 wells were contaminated. MTBE was identified as the fastest spreading contaminant while the most concentrated chemical in Hopkins seemed to be benzene. The underground area of contamination was assessed at about 1,200 square feet (Presley 2003), although more recent information has suggested larger areas (Burton 2012, Miner 2012). To date, about 45 wells have had confirmed contamination, with the plume extending beneath 80 to 90 parcels (Burton 2012, Miner 2012).

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[17] One source reported that about 94 households in Hopkins had unsafe levels of lead or gasoline in the late 1980s (Staff Reports 2012).

In 2002 and 2003, to remove human exposure to the contamination, DHEC installed charcoal water filters at individual wells, with filters needing replacement every one to three months. It built new wells for some households. Some suggested that the remedy was late on arrival and that DHEC should have provided residents with bottled water early on (Presley 2003).

To better understand the Hopkins case, a good example of an orphan site, a bit of context is helpful. In general, releases in SC that meet certain criteria are eligible for cleanup funding through the state assurance fund, labeled the State Underground Petroleum Environmental Response Bank (SUPERB). By the 2000s, the fund was insufficient to address the backlog of old leaking UST sites in SC (Fretwell and Monk 2008). The backlog of sites was large in part due to an amnesty offered by SC from 1988 to 1993 to encourage people to report releases. While successful at identifying previously unknown USTs, the amnesty created a large inventory of releases that contributed to a significant backlog in SC, still persisting in 2011 (US EPA 2011). According to a 2005 Sierra Club report, SC had cleaned up 59% of its polluted sites, while the national average was higher at 71% (Fretwell and Monk 2008). In late 2008/early 2009, the federal EPA threatened SC with sanctions if it didn't direct more money to its leaking tank backlog. EPA threatened to declare SUPERB insolvent for most UST cleanups, which would cause gas stations to shoulder responsibility for cleanup. Under this pressure from the federal EPA, and from SC petroleum marketers, by 2011 the state had contributed an additional $36 million to tackle cleanup of old leaks such as those in Hopkins (Kittle 2007, Fretwell and Monk 2008, Fretwell 2009, US EPA 2011).

The long term remediation plan involved hiring workers to drill holes in over half the polluted wells and connect them to a high pressure air blower to force chemicals out of the water. The remediation also involved bio-injection, in which nutrients were pushed into the water table to attract and become food for organisms that can break down gasoline contaminants (Presley 2003). This cleanup process was expected to take many years. By 2008 DHEC had spent $2.3 million cleaning up the contaminated groundwater (Fretwell and Monk 2008).

Eventually a proposal surfaced that would eliminate human risk from exposure to contaminated groundwater in Hopkins. The proposal was to connect residents to public water from Columbia, SC about 10 miles away. The new water system was dedicated in February 2012 and cost almost $5 million, paid for mostly with federal funding (Staff Reports 2012).

Social Benefits

Long-term cleanup of contaminated wells in Hopkins, SC generated human health benefits by reducing risks from exposure to contaminated groundwater. Many household drinking water wells in Hopkins were reported to contain lead and gasoline at unsafe levels. These are contaminants known to be associated with cardiovascular and neurological health effects, as well as other risks, especially pronounced for children and pregnant women. Potential health effects from dermal contact with gasoline in bathing water were also reduced or removed. Aesthetic benefits stemmed from improved taste and smell of tap water. While more speculative, remediation might have improved transaction rates and land productivity at old commercial establishments where underground tanks had leaked and at homes with contaminated and potentially contaminated wells.

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Eligibility depends on the site being in significant operational compliance at the time of release or when the release was reported. The SUPERB fund has a substantial deductible of $25,000 (US EPA 2011). A half cent is collected for the fund per gallon of gasoline sold, and tank owners pay an annual fee of $100 per tank.

Case Study Three

MTBE plume at Charnock public well field in Santa Monica, CA; 1995

Santa Monica is a beachfront city located in western Los Angeles County and abutting Los Angeles.

Statistics for Santa Monica (US Census State and County Quickfacts)
Population (2010): 89,736
Population density (2010): 10,664/sq mi
Median Household income (2008-2012): $72,271
Race identified as White alone (2010): 77.6%

Background

In Fall 1995, a routine water quality test by the city of Santa Monica identified the presence of MTBE in its Charnock well fields, a groundwater source that served approximately half of the city's residents. Contamination was confirmed in 1996 and the water was initially ineffectively treated by mixing contaminated with uncontaminated water - ineffective because soon MTBE showed up in more Charnock wells. Compared to other gasoline constituents, MTBE has unique chemical properties. It is more water soluble so it travels quickly in water and it doesn't readily biodegrade (Linder 2006, Helperin et al 2001). Levels of MTBE between 3.1 ppb and as high as 610 ppb were detected in 7 of the city's 11 wells. In response, the City shut down the contaminated wells (Adams 2000, Wheeler and Staff 2004, Linder 2006) and rerouted clean drinking water from a neighboring supply. The Charnock wells had provided the public with fresh water since 1924.

The shutdown was precautionary since health effects of MTBE contamination were not well understood. There were no state or federal guidelines on how much was safe in drinking water. Indeed it was the late 1990's when California set primary and secondary maximum contaminant loads for MTBE of 13 and 5 ppb respectively (Helperin et al 2001, California Code of Regulations 2000), the strictest in the nation. California's law required a phase-out to a complete MTBE ban by the end of 2003 (Wheeler and Staff 2004, US EPA 2004). Several sources highlighted concerns that it was a carcinogen (US Water 1996, Adams 2000, Wheeler and Staff 2004). MTBE certainly imposed aesthetic costs since it produced a distasteful odor even at low levels. In December 1997, EPA issued a Drinking Water Advisory setting a taste threshold of 40 ppb and odor of 20 ppb. To date health effects of MTBE contamination have not been conclusively identified and, as mentioned in Section 1.6, EPA has placed MTBE on a list of candidate contaminants for drinking water standards (US EPA 2013b).

An effort to identify responsible parties for the Charnock well field contamination led to an investigation of 30 UST sites, mostly gas stations within a mile and a half of the well fields. All but two were associated with UST releases containing MTBE. Cleanup costs were estimated according to one source at $200 million (DoJ 2005, Adams 2000, Linder 2006). Initial efforts to convene the responsible parties to cooperate on cleanup decisions were unsuccessful, producing "little other than denial and finger pointing." In the summer of 2000, the city filed suit against seven or eight major oil companies including Shell, Chevron, Exxon and others (Wheeler and Staff 2004, Adams 2000). To replace the portion of city water that had been supplied by Charnock, construction of an expensive pipeline to bring fresh water from the Colorado River was begun. To run this system would cost more than $3 million per year, eventually paid for by the oil companies but initially by a 25% rate increase placed on residents of Santa Monica (US DoJ 2005, Wheeler and Staff 2004).

Settlements were paid by up to twelve oil companies to federal EPA and to the city of Santa Monica to compensate for past cleanup expenses. The settlement with the city was made in 2003 and was large - $120 million. Shell, Chevron, and Exxon also signed agreements to clean the well field by building treatment systems to remove the MTBE (Crofton 2004, US DoJ 2005). Responsible parties were also compelled to remediate the sources of pollution (e.g., tank releases) (Linder 2006).

Santa Monica celebrated full restoration of local groundwater at Charnock and renovation of the city water treatment plant in February 2011. The Charnock wells were shut due to MTBE contamination for fifteen years. The remediation technology used pressure to force water through membranes that filter out pollutants. This was followed by an air stripping technology to remove any remaining contaminants. Settlement payments from the oil companies covered the cost of cleanup (Santa Monica News Release 2011).

Social Benefits

MTBE contamination of the Charnock well fields in Santa Monica posed health risks to individuals who relied on the public wells as a source of drinking water. MTBE also produced an odor and bad taste in the drinking water, a typical outcome associated with MTBE contamination. Addressing the contaminated well fields yielded human health and aesthetic benefits among the categories in Table 1. Provision of alternative sources of safe drinking water and remediation of the well fields provided reassurance regarding drinking water safety. More speculative is that the cleanup improved transaction rates and facilitated the movement of properties into their highest valued uses.

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Case Study Four

Former gas station, Euclid Avenue, Helena, Montana; Spring/Summer 2012

Helena is a small city consisting of approximately 16 square miles in Montana.

Helena Statistics (US Census State and County QuickFacts)
Population (2012): 30,000
Population density (2010): 1,724/sq mi
Race identified as White alone (2010): 93%
Median household income (2008-2012): $49,445

Background

In the early 2010's, Lewis and Clark County, Montana, conducted a community-wide assessment of brownfield sites throughout the county. Assessments of a former Texaco gas station at 1901 Euclid Avenue in Helena were conducted in March, and again in July, 2012. The assessments did not discover contamination and provided information sufficient to facilitate transfer of the petroleum brownfield property to an active business (Lewis and Clark County 2013).

In addition to the Texaco gas station, the assessed location had also hosted a grocery store, tourist cabins, and eventually an auto service station, from the 1930s through the mid-1960s. At the end of this period, the Highway Department took a portion of the site to enable widening of a highway. When the gas station closed, it reportedly hosted two underground tanks and did not remove them. From the late-1970s through the mid-1990s, multiple businesses operated in the dilapidated buildings that remained on the site. The buildings were razed in the mid-1990s and the site was for sale but vacant when it was assessed by the county in 2012 (Lewis and Clark County 2013).

While the property was for sale, it was owned by an out-of-state-resident. The owner did not have resources to assess the potential contamination at the site, thus the property remained vacant for many years. With at least partial federal funding, the county brownfield project offered to conduct an environmental assessment and try to locate the USTs; determine whether they had leaked; and learn if other activities at the site had led to contaminated soil or water (Lewis and Clark County 2013).

The assessments included installation of 12 soil borings which located a single UST. Soil samples submitted to a lab turned up no evidence of contamination. A separate private contractor paid by the owner removed the UST. Assessors concluded that the second UST, indicated in records, had been excavated during the highway expansion. This concluded the brownfields work at the site (Lewis and Clark County Brownfields 2012).

The new information gathered by the assessment along with removal of the UST enabled the owner to successfully sell the property to a furniture business that was expanding beyond an adjacent property (Lewis and Clark County Brownfields 2014). The expansion onto the former petroleum brownfield consisted of a new show room that reportedly led to the employment of four new employees (Thomi 2014).

Social Benefits

Assessment of the former gas station on Euclid Avenue in Helena found no contaminated soil or water and thereby provided valuable information. This information, combined with removal of a long-unused UST, was reassuring to prospective purchasers of the land, possibly reducing any previous concerns or misperceptions regarding contamination. The property transferred from an "absentee" owner to a local business. As the land moved from vacant into productive use as a furniture showroom, land productivity was improved. Instead of languishing and unused, the plot became an asset on which income was generated. There may also have been agglomeration effects from its proximity to other existing businesses, especially the furniture store that expanded. Finally, aesthetic benefits may have been generated as the land moved from a vacant un-usable lot to a new showroom.

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