Voluntary Cleanup Programs and Redevelopment Potential: Lessons From Baltimore, Maryland

Dennis Guignet
Anna Alberini
University of Maryland

Abstract

In the United States, policy has increasingly shifted toward economic incentives and liability attenuation for promoting cleanup and redevelopment of contaminated sites, but little is known about the effectiveness of such policies. These policies include, among others, state Voluntary Cleanup Programs (VCPs), which were established in the United States in the 1990s and, to date, have been implemented in nearly every state. This article focuses on 116 Baltimore properties that were enrolled and participated in the Maryland VCP from its inception in 1997 to the end of 2006 and examines what type of properties tend to participate in these programs, how these properties compare with other eligible but nonparticipating sites, and what the redevelopment potential of VCP properties and implications is toward open-space conversion.

We find that most applicants (66 percent) actually requested a No Further Requirements Determination directly, rather than proposing cleanup. Nevertheless, the VCP led to the identification and environmental assessment of 1,175 acres of contaminated land in the city of Baltimore alone. In Baltimore, VCP properties tend to be industrial, located in areas zoned as industrial, and away from residential neighborhoods. In more recent years, larger properties have increasingly enrolled in the program. Most participating sites are reused as industrial or commercial properties. In contrast with Alberini (2007), these findings suggest that, in Baltimore, pressure for residential development has not driven VCP participation to date. Based on differences in zoning requirements, the VCP may reduce demand for potentially contaminating activities on pristine land by as much as 1,238 to 6,444 acres, in Baltimore alone.

Introduction and Motivation

Many observers believe that the liability regime imposed by federal and state hazardous waste programs in the United States is at least partially responsible for discouraging the purchase and reuse of contaminated or potentially contaminated sites, which have remained idle or underused.[1] The resulting "brownfields"—industrial sites whose expansion, redevelopment, or reuse "may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant" (EPA, 2007), to the point that public intervention may be needed (Alker, Roberts, and Smith, 2000)—cover thousands of acres in many urban and rural areas of the country (GAO, 1995).

A number of recently established state programs and new federal legislation aim to reverse these disincentives and stimulate the cleanup and productive reuse of brownfields. For example, in the 1990s, several states established Voluntary Cleanup Programs (VCPs) offering liability relief, other economic incentives such as tax credits or low-cost loans, oversight and expedited approval of cleanup plans, and simplified cleanup standards in exchange for site remediation (Bartsch and Dorfman, 2000; Meyer and VanLandingham, 2000).

Under the Federal Brownfield Tax Incentive, established in 1997, environmental cleanup costs for eligible properties are fully deductible in the year in which they are incurred, as long as the property is used for trade or business or for the production of income. Likewise, state brownfield programs offer tax credits or other benefits in exchange for cleanup and investment at potentially contaminated properties located in blighted areas.

Finally, the federal Small Business Liability Relief and Brownfield Revitalization Act of 2002 offers conditional relief from environmental liability for property owners and purchasers of land. This law also establishes the U.S. Environmental Protection Agency (EPA) Brownfields Program, which provides assessment and cleanup grants to state and local governments and communities and grants that states can use to establish revolving loan funds.

Little is known about the effectiveness of these economic incentives and liability attenuation policies in promoting cleanup and redevelopment. Questions remain about whether these programs effectively provide public funding to redevelopment projects that would have occurred anyway (Alberini, 2007), and concerns exist about unspent dedicated public funding (Schoenbaum, 2002). Common perceptions—that most brownfield properties are former industrial sites, are located in central cities, and bear riskier, less profitable redevelopment potential than equivalent projects on pristine lands and in suburban areas—have been challenged (De Sousa, 2000; Page and Berger, 2006). Deason, Sherk, and Carroll (2001) analyzed urban redevelopment projects and computed

[1] The Superfund program was established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), passed in 1980 and amended and reauthorized in 1986. It is probably the best known among the public programs addressing hazardous waste sites in the United States. Under the Superfund program, the U.S. Environmental Protection Agency (EPA) has the authority to identify contaminated sites needing remediation, track down the responsible parties, and force them to pay for cleanup (or reimburse the Agency for the cleanups it initiated). Liability for the cost of cleanup is retroactive, strict, and joint and several, with potentially responsible parties to be sought among the owners and operators of the site and the transporters of the wastes. Liability in some cases has been construed to apply to property owners and lenders that foreclose on contaminated properties (Fogleman, 1992).

the size of equivalent projects in open and suburban areas, showing that because of differences in zoning the latter often take up considerably more land than infill redevelopment, thus contributing to sprawl and erosion of open space.

A better understanding of what types of properties tend to be enrolled in VCPs is crucial in evaluating programs offering incentives and assistance for brownfield cleanup and redevelopment.[2] This article examines the VCP of Maryland and poses three related questions: (1) What types of properties tend to participate in the Maryland VCP? (2) How do these properties compare with other eligible but nonparticipating industrial and commercial properties? (3) What is the redevelopment potential of VCP parcels and can the VCP enroll enough acreage to be an alternative to the conversion of greenfields?

To answer the first two questions, the article examines the parcels enrolled in the VCP from its onset in 1997 to late December 2006. To ensure a relatively homogeneous legal and tax environment, attention is restricted to enrolled properties in the city of Baltimore.[3] The enrolled set of parcels is supplemented with a sample of comparably sized parcels drawn at random from the universe of industrial and commercial properties in the city of Baltimore, which are used as a "control" group. The newly formed sample—enrolled properties plus similar nonenrolled properties—enabled us to establish whether the VCP tends to attract parcels that are systematically different from other industrial and commercial properties in Baltimore.

During the study period, in response to questions (1) and (2), the VCP identified 1,175 acres of potentially contaminated land in Baltimore, most of which were not identified through other programs, and thus, before the VCP, were likely unknown to city and state regulators. Simple univariate analyses suggest that VCP properties in general are larger, less capital intensive, and have a higher probability of prior contamination than nonparticipating parcels. Probit regressions confirm that VCP enrollment and participation is more likely among industrial sites located in industrial areas and less likely at heavily built sites close to residential areas. Even more important, the probit regressions point to the changing nature of the program—or of the sites that tend to be attracted to the program. In the first few years of the VCP, smaller properties tended to be enrolled in the program. Most recently, however, enrollment has been more likely among larger properties.

To answer the third question, the article examines the restrictions imposed on the property when the state agency granted a No Further Requirements Determination (NFRD) or issued a Certificate of Completion (CoC). In most cases, residential uses are not allowed, some physical maintenance is required to avoid exposure to contaminants, and use of groundwater on the premises for drinking purposes is prohibited. There is very little evidence of changes in land use at enrolled sites, and enrolled properties tend to be located primarily away from residential areas. Taken together, these facts suggest that VCP sites will likely continue to be used in an industrial or commercial manner. These conclusions are in sharp contrast with Alberini (2007), who finds that the Colorado VCP tends to attract sites under residential development pressure.

[2] Throughout this article, the terms "enrollment" and "participation" in the VCP are used synonymously.

[3] By "the city of Baltimore," we mean the independent city that has Federal Information Processing Standards code 24510. This area does not include the surrounding and more suburban Baltimore County.

Finally, the article uses the figures presented in Deason, Sherk, and Carroll (2001) to compute the area that would be reasonably required if, instead of redeveloping the Baltimore VCP properties, equivalent projects were undertaken in more rural or suburban areas of the state. Under alternate assumptions, this total area is estimated to be between 1,238 and 6,444 acres. We conclude that if the VCP properties are redeveloped, if redevelopment can be attributed exclusively to participation in the VCP, and if the land requirements for these redevelopment projects are similar to those in Deason, Sherk, and Carroll (2001), the VCP holds promise as a good tool for reducing pressure on the conversion of open space and agricultural land. This finding should be interpreted with caution, however, because comparing the findings of this article with previous research (Alberini, 2007) suggests that, until further analysis is done, extrapolation will be difficult from one specific program and its achievements to another.

The remainder of the article is organized as follows: the next section presents background information and describes the Maryland VCP; the Previous Literature section reviews the literature that addresses brownfields and VCPs; the Model, Sample, and Data Sources section presents our econometric model of participation in a VCP and the data used to estimate this model; the next three sections (The Data, Estimation Results, Sales and Redevelopment) provide answers to our research questions; and the Conclusion section concludes the discussion.

Background

This section examines the emergence of brownfields and the subsequent policies that encourage the cleanup and reuse of these sites. It includes the general history of VCPs and specific information about the Maryland VCP. It also outlines several concurrent brownfield revitalization programs and local initiatives that may influence VCP participation.

Brownfields and Voluntary Cleanup Programs

The United States has a large supply of properties where prior industrial uses have resulted in contamination of soil, surface water, and groundwater with pollutants that are noxious to human health and ecological systems. The U.S. Government Accounting Office (GAO; 1995) estimated a nationwide total of 130,000 to 450,000 contaminated commercial and industrial sites.

Site contamination, or even suspicion of contamination, is widely believed to seriously hamper the redevelopment and reuse of land. Many observers argue that merely placing a property on federal or state registries of sites needing investigation about possible contamination inherently changes their designation to brownfields. Removal from such registries (the so-called "de-listing") would automatically remove any contamination stigma (Bartsch, Collaton, and Pepper, 1996).

Starting in the 1990s, state regulators realized that enforcement-based programs did not have sufficient funding to address the large number of contaminated sites requiring remediation and began developing an alternative approach involving voluntary cleanup programs (GAO, 1997). It has recently been suggested that states lacking financial support from EPA and states experiencing a slow progression at Superfund sites, among other factors, are more likely to adopt a VCP (Daley, 2007). By 2000, more than 90 percent of the states had a VCP in place (Meyer, 2000).

VCP offerings and requirements vary widely across states (EPA, 2005; Meyer, 2000). Many state-level VCPs grant liability relief in exchange for voluntary cleanup, provided that the cleanup is approved by the state agency in the form of a letter of no further action, a certificate of completion, or a covenant not to sue.[4]

VCPs often spell out simplified or variable cleanup standards linked to land use to protect residents and workers from exposure to contaminants. Some states allow for engineering controls, such as caps, fences, or other physical means of preventing contact with pollution, and offer institutional controls, such as permanent land use restrictions or monitoring of the contamination plume, in lieu of a more permanent cleanup. The GAO (1997) surveyed 17 states with VCPs and found that in many states more than 50 percent of the cleanups used nonpermanent remedies and selected industrial land use standards.

In addition, states frequently offer fast-track oversight of cleanup plans. This approach helps reduce the time it takes before remediation is undertaken and the uncertainty associated with stringency of cleanup standards (Meyer, 2000). At many locales, completion of voluntary cleanups at eligible sites can be combined with local, state, and federal brownfield programs that offer subsidies in the form of tax credits or low-cost loans. State VCP managers believe these programs have revealed previously unknown contaminated sites to the state agency and have encouraged cleanups when the program requirements are not too burdensome to the applicants.[5]

The Maryland VCP

The Maryland VCP was established in 1997. Any property that is or is perceived to be contaminated by controlled hazardous substances or oil (since October 2004) is eligible for enrollment and participation, including sites on federal or state registries. Sites listed on the EPA's National Priorities List (NPL), sites under active enforcement by the Maryland Department of the Environment (MDE), currently operating RCRA sites,[6] and sites contaminated after October 1, 1997 (if the applicant is the responsible party) are not eligible. Certain exceptions may apply to sites under MDE enforcement.

Eligible applicants include property owners, commercial lenders, developers, prospective purchasers, lessees, innocent purchasers, and operators. The application must contain a Phase I and Phase II environmental site assessment, a $6,000 application fee, and any other information about the property required by the Maryland VCP. The applicant may request an NFRD, which, if granted, implies no need to do remedial work, or, upon approval of the response plan and of remediation, a CoC. Both options include certain liability assurances and are recorded in the Land Records. Enrolled parcels that are underused, vacant, or located in blighted areas can also obtain tax credits from the state.

[4] A covenant not to sue is generally regarded as the strongest form of assurance, because, for all practical purposes, it is a contract by which the state commits not to sue over contamination at the site, as long as certain conditions are met.

[5] For example, the 1997 GAO study notes that public involvement requirements are generally judged inappropriate and, hence, a hurdle to remediation for the type of sites usually targeted by VCPs—industrial sites with light contamination.

[6] These sites are regulated by the laws enacted in the Resource Conservation and Recovery Act of 1976.

The liability relief offered is not absolute: so-called reopeners are possible if new contamination occurs at the property, cleanup efforts exacerbate the existing contamination, undiscovered contamination is found, or an imminent and substantial threat to human health exists. At the time of this writing, however, only two reopeners have occurred since the inception of the program (MDE). A CoC does not provide protection against third-party suits but does provide contribution protection against a party suit.[7]

Other Programs and Factors Potentially Affecting VCP Enrollment

Properties will be enrolled in the VCP if the benefits of doing so exceed the costs (see the Model, Sample, and Data Sources section). Enrollment in the Maryland VCP should, therefore, depend on the demand and supply of potentially contaminated sites in Baltimore, which, in turn, may have been shaped by a number of concurrent federal and state programs, local initiatives, and the general conditions in the real estate market.

One such federal program is the Federal Brownfield Tax Incentive, which became effective in 1997. Between 1997 and 2000, real estate developers and investors who (1) incurred cleanup costs at properties meeting certain geographic requirements or with residents of low socioeconomic status,[8] and (2) used the property to generate income, were able to write off the cleanup costs in the very same tax year and obtain a tax credit from the Internal Revenue Service. In 2000, geographical and community requirements were relaxed and developers were allowed to avail themselves of the Federal Brownfield Tax Incentive tax credits at all properties where (1) and (2) apply, regardless of location. At the end of 2006, President Bush extended the Federal Brownfield Tax Incentive.

Properties in the city of Baltimore have met the geographical and community eligibility requirements since the onset of the program, but very few census tracts met the requirements in the adjacent counties—Baltimore and Anne Arundel Counties, which can be considered natural substitutes for the city of Baltimore for investment and business purposes. This natural substitution suggests that, between 1997 and 2000, the federal tax incentives may have conferred contaminated and underused properties in the city of Baltimore a relative advantage, all else the same, over similar properties in these neighboring counties, but this comparative advantage may have become less pronounced after 2000.

Observers argue that the Small Business Liability Relief and Brownfield Revitalization Act of 2001 (enacted in January 2002) plays an important role in making property owners and developers more willing to invest in redevelopment projects at contaminated sites. This law has three main

[7] In other words, the recipient of a CoC can be sued by a third party directly, but another responsible party who has been sued by parties other than the state or a federal agency cannot demand reimbursement from the recipient of a CoC.

[8] The geographical and community characteristics requirements were as follows. For the tax incentive to apply, the property must be in (1) census tracts with poverty rates of 20 percent or more; (2) census tracts with populations of less than 2,000, where more than 75 percent of the tract is zoned for commercial or industrial use and the tracts are adjacent to one or more census tracts with poverty rates of 20 percent or more; (3) federally designated Empowerment Zones (EZ) and Enterprise Communities (EC); and (4) EPA-designated brownfields pilot sites announced before February 1, 1997. For expenses incurred from August 5, 1997, to December 21, 2000, the eligible property need only meet one of the four listed criteria. Sites listed, or proposed for listing, on the NPL are not eligible for the incentive. In addition, only expenses that are paid or incurred in connection with the abatement or control of a hazardous substance qualify for the incentive.

features. First, it provides a statutory definition of brownfields, effectively broadening the universe of properties that qualify for program assistance to include, among others, properties with petroleum contamination. Second, it establishes funding for assessment and cleanup grants and for cleanup revolving loan funds to be awarded to communities and states under the auspices of the EPA Brownfields Program. Environmental assessment studies funded with EPA grants have been considered acceptable as part of the Maryland VCP application packages since 2004, when a memorandum of understanding was signed between EPA and the State of Maryland. Third, the law provides liability relief for contiguous property owners, prospective purchasers, and innocent landowners, and it spells out the conditions for subsequent reopeners, enforcement actions, and information and public participation requirements for VCPs. The act was thus expected to substantially reduce uncertainty about liability associated with potentially contaminated sites.

Before both of these programs, which addressed incentives to private developers and property owners, EPA sought to create conditions favorable to the cleanup and redevelopment of brownfields and to economic growth in blighted areas through the Brownfield Assessment Demonstration Pilot Program, which started in 1993 and provided grants to states and local governments for site assessment, identification, characterization, and cleanup plans (but not for actual cleanup). The city of Baltimore was selected in the early rounds of grant allotment as a brownfields pilot site.[9]

Larger redevelopment efforts put forth by the city may also influence VCP participation, especially in Baltimore. In 1991, the Baltimore Development Corporation (BDC), a quasipublic organization, was formed to provide economic development services for the city (BDC, 2010). The BDC strategically buys and aggregates parcels for industrial and commercial parks to establish natural connections between city hubs and to implement the city's Urban Renewal Plans. The BDC is involved with more than 120 redevelopment projects; has focused attention on revitalizing a number of neighborhoods, including at least two former industrial areas (Carroll and Fairfield); and has established brownfield redevelopment as one of its major initiatives.

Since 1996, the BDC has completed more than 30 brownfield redevelopment projects. In fact, out of the 116 VCP sites analyzed in this article, the applicants for 6 VCP properties were either BDC or the city of Baltimore. Records from the Maryland State Department of Assessments & Taxation (SDAT) show that the city owned an additional 6 VCP properties. BDC is thus directly involved with a small number of VCP properties. Seeing the city's involvement may also encourage other private developers to participate in the VCP. Since the BDC offers resources and services to small and up-and-coming businesses, including assistance with preparing business plans, getting credit, and dealing with the tax and regulatory environment, BDC may have indirectly stimulated redevelopment of brownfields. It remains very difficult, however, to establish the extent of the effects from these influences.

Finally, as per the 1997 Maryland Smart Growth Areas Act, Baltimore is a designated priority funding area, and, as such, it is targeted for state and county funding for infrastructure and investments

[9] See Greenberg and Hollander (2006) for an examination of city and county characteristics associated with (earlier) receipt of EPA assistance under this program and Solitare and Greenberg (2002) for evidence of program generosity to economically distressed areas.

that encourage and support its growth. It is interesting to note that industrial areas, even those located outside of Baltimore, can be designated as priority funding areas.

Although it is difficult to identify the effects of local initiatives, the econometric models described later in this article account for these concurrent programs and events by interacting time period dummies with key determinants in VCP participation. These interaction terms may also account for changes in the market. One would expect the demand for contaminated sites to be stronger during periods of economic expansions, when more real estate (re)development occurs. In contrast, the supply of brownfields may increase when the economy is slow and industrial plants go out of business or relocate to other areas. Aggregate construction permit figures for the Baltimore metropolitan area from 1998 through 2006 suggest that (1) residential and nonresidential construction trends are often at odds in these areas and (2) nonresidential construction permits spiked in 1999, 2002, and 2004 and declined in other years of the 1998-through-2006 period (BMC, 2010). Residential construction in the Baltimore metropolitan area was strong for most of the study period, suggesting that this housing market was attractive and profitable.

Previous Literature

We are aware of only a handful of previous studies that have examined the economic incentives at play in VCPs. Alberini (2007) focused on the Colorado VCP, restricting attention to the Front Range counties of the state. Much like the Maryland VCP, the Colorado VCP has two participation modes. Applicants may apply for a no further action decision, or submit an actual cleanup plan. After cleanup is completed and approved, the state agency issues a no further action letter.

Alberini found that (1) actual cleanups accounted for only one-third of all applications and (2) participating properties are almost never previously listed on federal registries of contaminated sites. The program seems to attract properties that are very likely to be redeveloped soon. She also found that property values tend to be lower in truly contaminated properties but rebound almost completely after participation.

Using data from Ohio for 1989 through 1992, Sementelli and Simons (1997) found that receiving a letter of no further action from the state does not improve transaction rates for sites with leaking underground storage tanks, which continue to be bought and sold much less frequently than nontank commercial properties.

Page and Berger (2006) examined properties that entered into the VCPs in Texas and New York, emphasizing that these are only a subset of the entire universe of brownfields in those states. They empirically tested four common beliefs about brownfields, namely, that they are (1) the result of past industrial land use, (2) in abundant supply in older industrial regions, (3) primarily an urban problem, and (4) created by pollution events that took place before the Superfund statute (or similar state legislation). Texas and New York lend themselves to these research questions because of their different histories of industrial development and recent population and employment trends.

Page and Berger (2006) distinguished between previous industrial or commercial use and the brownfield's use at the time of entry into the program, finding that Texas actually has a higher percentage of sites with prior and current industrial uses than New York and that a higher share

of the New York brownfields were abandoned or vacant at the time they entered the program (21 percent versus 8 percent, respectively). Most of the Texas sites are in urban areas and in central cities (87 and 64 percent of the total, respectively, versus 49 and 30 percent for New York). They concluded that industrial uses account for most—but not an overwhelming majority (53 percent)—of the properties enrolled in the New York and Texas VCPs, and that suburban properties are surprisingly more common in the New York program. They also found that half of the properties enrolled in the New York VCP were 1 acre or less, but more than three-fourths of the properties in the Texas VCP were at least 1 acre or larger.

Since VCPs often have explicit land revitalization goals, this research is also related to the literature that has examined developer interest in reusing brownfield properties. Stated-preference surveys in Europe (Alberini et al., 2005) and in the United States (Wernstedt, Meyer, and Alberini, 2006) suggest that developers can be attracted to contaminated sites by offering them subsidies, liability relief, and less stringent regulation.[10] The appeal of these incentives varies with the developer's prior experience with contaminated properties.

De Sousa (2000) interviewed a small number (N = 18) of developers, landowners, and city officials about their perceptions of redevelopment opportunities and economic incentives for brownfields, finding that liability is judged the most important obstacle to brownfield projects. VCPs that offer protection from liability are likely to attract primarily landowners and developers, who share similar views, especially on liability attenuation.

Meyer and Lyons (2000) suggested that low property prices have played a larger role than subsidies in stimulating entrepreneurial redevelopment activity on contaminated sites and that obtaining subsidies may entail significant transaction costs that offset their value. McGrath (2000) found that contamination risk—that is, the probability that a previously used site is contaminated, based on the previous use—affects urban industrial redevelopment in Chicago both directly, and indirectly, via the differential in price before and after redevelopment.

Deason, Sherk, and Carroll (2001), De Sousa (2000), and Sigman (2005) studied the potential for substitution between infill redevelopment and development of pristine or agricultural lands—the so-called greenfields. Basing their analysis on zoning and land use ordinances for several cities, Deason, Sherk, and Carroll (2001), estimated that an industrial, commercial, and residential development project requires an average of 6, more than 2, and more than 5 times more land, respectively, in greenfield areas than they do at urban brownfield properties. These differences are

[10] Economic incentives have been advocated as potentially effective for stimulating cleanup and redevelopment of brownfields (Bartsch, Collaton, and Pepper, 1996; De Sousa, 2004; Howland, 2000, 2004; Yount and Meyer, 1999). The effectiveness of economic development incentives remains a controversial matter, even with noncontaminated properties. For example, studies suggest a statistically significant, positive relationship between tax incentives and regional and local growth and property values (Bartik, 1991; Greenstone and Moretti, 2003; Newman and Sullivan, 1988; Wasylenko, 1997), but researchers dispute the magnitude of the impacts of incentives on overall economic gains in targeted areas (Fisher and Peters, 1998; Fox and Murray, 2004; Peters and Fisher, 2002). Research in this area is afflicted by the problem that concurrent incentives make it very difficult to disentangle the effects of each, a problem that can be remedied only by deploying very careful quasiexperimental approaches with control and treatment groups (Bartik, 2004; Greenstone and Moretti, 2003). It remains difficult, however, to ascertain whether incentives were effective or if business locations and/or area redevelopment would have taken place even in their absence (Peters and Fisher, 2004).

driven by local requirements for setbacks, height of buildings, parking facilities, and percentage of the property that can be covered by buildings. De Sousa (2000) reports that, contrary to claims sometimes made by developers, in downtown Toronto, residential projects are actually more profitable at brownfields than in suburban areas (due to demand and prices of downtown residential properties).

Not everyone agrees that actual or suspected contamination is a deterrent to redevelopment. Basing her analysis on interviews with real estate agents, Howland (2004) suggested that incompatible land uses, inadequate infrastructure, and obsolete buildings are more important barriers than contamination is to the revitalization of brownfields in Baltimore. Schoenbaum (2002) found no significant difference in assessed land values, vacancy rates, property turnover, and redevelopment rates across brownfield and nonbrownfield properties in an industrial area of Baltimore from 1963 through 1999.

Model, Sample, and Data Sources

This section presents the econometric model of VCP participation (or enrollment). Estimation of this model requires both participating and nonparticipating sites. It also addresses the collection of this sample of sites and the variables that may influence VCP participation.

The Model

Consider a set of "candidate" parcels. This analysis assumes that a candidate parcel is enrolled in the VCP if the net benefits of participation are positive,[11] and that these benefits depend on characteristics of the property and surrounding neighborhood. Let VCP^* denote the net benefits of parcel i's participation in the program in year t, and assume that

$$VCP_{it}^{*} = \mathbf{x}_{it}\beta + \eta_{it}, \tag{1}$$

where x is a vector of parcel and neighborhood characteristics, β is a vector of unknown coefficients, and η is an i.i.d. standard normal error term.

We cannot observe the net benefits of participation, but we assume that properties are signed up (that is, VCP = 1) when the net benefits of participation are positive and obtain a probit equation:

$$E(VCP_{it} = 1) = \Pr(VCP_{it}^{*} \geq 0) = \Phi(\mathbf{x}_{it}\beta), \tag{2}$$

where $\Phi(\bullet)$ is the standard normal cdf. Since a site can participate in the program only once, we specify the log likelihood function as:

$$\log L = \sum_{t=1997}^{2006} \sum_{i \in \Im_t} \left[VCP_{it} \cdot \log \Phi(\mathbf{x}_{it}\beta) + (1 - VCP_{it}) \cdot \log\left(1 - \Phi(\mathbf{x}_{it}\beta)\right) \right], \tag{3}$$

[11] For an owner, the net benefits would be the appreciation in the value of the property minus the cost of remediation, the participation fee, and any other associated costs. For a developer, the net benefits would be the profits from the project, net of land acquisition costs, transformation costs, remediation costs, VCP fee, and so forth. The avoided liability and litigation costs would presumably be captured into the appreciation and proceeds from the project, respectively.

where i denotes the site, t denotes the year of the program, and $\Im_t$ is the set "at risk" at time t (that is, the set of candidate sites that have not participated as of year t).[12] Equation 3 is, effectively, a discrete-time duration model and can be easily amended to incorporate site-specific random effects, which capture unobserved parcel characteristics that may influence participation (see Greene, 2008).[13] This model is a reduced-form model.[14]

We do not have reliable information about whether a particular parcel is or was on the market at any given time, and, likewise, have no comprehensive databases documenting (re)development permits. For these reasons, we are forced to (1) omit potential or actual transactions or other projects from Equation 1 and its log likelihood counterpart Equation 3, (2) restrict attention to parcel and neighborhood characteristics as the possible determinants of participation in the VCP, and (3) gather only partial information about sales and proxies for redevelopment, which we describe, but do not explicitly model, in the Sales and Redevelopment section.

The Sample

A goal of this study is to estimate a probit equation that predicts the probability of enrollment in the VCP as a function of site and neighborhood characteristics. Estimating this probit equation requires a sample of both participating (or enrolled) sites and eligible but nonparticipating sites.

We obtained data about the VCP applications and sites from the MDE. As of December 20, 2006, more than 400 applications had been submitted to the Maryland VCP.

In this article, attention is restricted to VCP sites in the city of Baltimore since the onset of the program up to December 20, 2006. Participation (or enrollment) is defined as a direct application for either an NFRD or an actual cleanup proposal, so we lump together applications for a NFRD and a CoC. In some cases, multiple applications are submitted for the same site; in a few cases, a single site comprises multiple parcels. When multiple parties apply for the same property, enrollment is defined as occurring the time of the earliest submittal for that property.

Using these criteria, we obtained 116 enrolled sites in Baltimore. Of these 116 sites, 37 (32 percent) were signed up with the goal of obtaining a CoC, which requires submitting and executing a remedial plan; 77 (66 percent) applied directly for an NFRD; and no information was available for the two remaining sites.

[12] For example, if a site is enrolled in the program in 1999, it is dropped from the sample for all subsequent years.

[13] A required assumption in the random effects probit model is that the unobserved parcel characteristics be uncorrelated with the regressors x. It is not possible to estimate a fixed effects model, because estimation would have to rely on parcels dropping in and out of the participation status, a situation that is not possible here.

[14] We do not include among the regressors events such as actual or anticipated sales (that is, the property is on the market), other transactions, or redevelopment project status, because these events are clearly endogenous with participation. The only econometrically acceptable way to include such events in the right-hand side of equation (1) is to instrument for them. Unfortunately, in earlier analyses of commercial and industrial property prices in Baltimore (Longo and Alberini, 2006), we found that exogenous parcel or neighborhood characteristics have very little predictive power for sales events. In addition, instrumental-variable estimation procedures in this context suffer from an identification problem because we are unable to determine characteristics of properties or legislative events that are determinants of sales but not of participation in the program. This identification problem prevents us from imposing plausible exclusion restrictions.

After compiling the full list of enrolled properties, we then examined how to define the eligible but nonenrolled properties. Since any property contaminated or perceived to be contaminated by controlled hazardous substances or oil is eligible for participation, and Noonan and Vidich (1992) show that properties used for most industrial and commercial purposes have a moderate to high probability of contamination, it is reasonable to assume that any parcel designated for industrial or commercial use in Baltimore is a credible candidate for inclusion in the sample (see Page and Berger, 2006; Sigman, 2005).

The first step in constructing our sample was to draw a random sample of N = 131 industrial and commercial parcels out of the universe of all such sites in Baltimore. To make these randomly selected parcels proper counterparts for the enrolled properties, we formed predictions for the likelihood of contamination (PROBCON) based on current land use at the site and on the estimated probabilities reported by Noonan and Vidich (1992) and included these probabilities as a control in our probit regressions. (We also included a companion missing-value dummy when the records from SDAT did not contain specific land use information.)

For each of the 10 years of the study period (1997 through 2006), the sample we used for the probit model consisted of the enrolled parcels that had not signed up yet, plus all of the 131 above-mentioned nonenrolled sites. This resulted in a total of 247 properties and 2,097 observations.

Other Independent Variables

Parcel and neighborhood characteristics act as a proxy for the net profits of participation. These characteristics include the size of the parcel (SIZE), a dummy for the presence of a building or improvement (BUILDING), an interaction between the presence of a building and the year of construction of the oldest building on the premises (BUILDINGYRBUILT), and the capital intensity (CAPITAL) of the parcel, which we define as the total square footage of the building divided by the area of the property.

These variables act as a proxy for remediation and demolition costs. Heavily built sites may differ from others in terms of demolition and cleanup costs because of toxic construction materials (for example, asbestos, heavy metals). To avoid losing observations to the analysis because of missing values, we created companion dummy variables to denote missing values, recoded the original missing values to zero, and included both the regressors of interest and the companion missing value dummies in the right-hand side of the probit regressions.

A parcel's value should also be influenced by its location and use. Therefore the following variables are also included as regressors in the probit model: distance to the central business district (CBDDIST) and to major roads (MJRDDIST),[15] whether the site is for industrial use (INDUSTRIAL), surrounding land use, and distance to the nearest residential zone (RESZNEDIST). We included the latter variable because Howland (2003, 2004) discussed how potential buyers in Baltimore are reluctant to purchase industrial property near residential areas because of incompatible activities and greater political barriers. Regarding land use, we used 1996 land use data from the Maryland Department

[15] Data from the Maryland State Highway Administration.

of Planning to form 500- and 1,500-meter buffers around each property and computed the percentage of the area of the buffer in various types of land use, such as low-, medium-, and high-density residential, industrial, and commercial.

A parcel's eligibility for state Enterprise Zone incentives (usually in the form of tax credits if a business is established on the premises) and for federal Empowerment Zone incentives (dummies ENTZNE and EMPZNE) may also influence its participation in the VCP. These incentives are associated with setting up a business or offering employees certain educational opportunities at specific locations, and are unrelated to contamination and cleanup. They may, nevertheless, increase the attractiveness of a location to a developer and to prospective buyers.

Whether VCP sites tend to be clustered is of interest because it reflects either some effect on surrounding properties (that is, enrolled sites induce further enrollment) or simply the spatial concentration of the existing supply of contaminated sites. We controlled for this tendency with the number of sites previously enrolled in the VCP within a 1,500-meter buffer of each property (LNEARVCPS). The last set of independent variables included median house values (MDVALHS) and socioeconomic characteristics of the residents in the neighborhood, measured at the 2000 Census tract level.

The Data

This section further describes the types of properties that are enrolled in the VCP. Univariate statistical comparisons are made between participating (or enrolled) sites and nonparticipating sites. The section concludes with a discussion of the changing nature of the VCP and the types of properties that tend to be enrolled and, in turn, how these changes are accounted for in the econometric model.

Description of Properties

For 92 of the 116 sites enrolled in the VCP, we identified the corresponding parcel(s) in the SDAT database, and appended information about the parcel, its exact location (latitude and longitude), structures, assessed value, and recent sales (if any). The 116 participating sites were actually composed of 172 properties, because in 21 cases one VCP application consists of multiple adjacent parcels.[16] The same type of parcel information is also available for the 131 nonenrolled properties.

Exhibit 1 displays descriptive statistics of the sample. The average parcel in the sample covers about 5 acres and is located a little more than 2 miles from the CBD. Nearly all parcels (79 percent) have a building or other improvement, which accounts on average for 77 percent of the total property area (variable CAPITAL). Because of the criteria used for constructing the sample, industrial properties account for more than 40 percent of all parcels.

Exhibit 1 also shows that we were able to impute the prior probability of contamination for 175 properties. Regarding additional neighborhood characteristics, half of the parcels in the sample are

[16] Specifically, out of the 116 VCP sites, 95 sites consist of a single parcel, 12 sites of 2 parcels, 3 sites of 3 parcels, and single sites each with 4, 5, 6, 7, 8, and 14 parcels.

Exhibit 1

Descriptive Statistics

Variable	Description	N Valid Obs	Mean	Std Deviation
SIZE	Area of parcel in acres	247	5.390	12.020
CBDDIST	Distance to CBD (Inner Harbor) in meters	246	3,764.99	2,321.17
BUILDING	Building or other improvement present (dummy)	247	0.794	0.406
YRBUILT	Year the oldest building was built	52	1,943.31	30.944
CAPITAL	Capital intensity	247	0.768	1.228
MJRDDIST	Distance to nearest major road in meters	246	466.375	481.852
PROBCON	Predicted probability of contamination	175	0.475	0.304
PROBCONMISSING	Probability of contamination undefined (dummy)	247	0.291	0.455
ENTZNE	Located in Enterprise Zone (dummy)	246	0.516	0.501
EMPZNE	Located in Empowerment Zone (dummy)	246	0.236	0.425
LNEARVCPS	Number of properties previously enrolled in VCP within 1,500 m buffer (all years)	247	2.530	4.413
INDUSTRIAL	Zoned industrial (dummy)	247	0.417	0.494
PCTIND	Percent of land in industrial use within 1,500 m buffer	246	0.196	0.212
PCTIND500M	Percent of land in industrial use within 500 m buffer	246	0.257	0.310
RESZNEDIST	Distance to nearest residential zone in meters	246	155.439	202.877
MDVALHS	Median housing value in census tract (2000 dollars)	245	73,267	36,745
PCTPOVERTY	Percent of census tract population living below poverty line	246	0.237	0.125
PCTOWNERS	Percent of residents in census tract who own home	246	0.481	0.228
PCTBLACKS	Percent of African Americans in census tract	246	0.364	0.335
PCTHISPANICS	Percent of Hispanics in census tract	246	0.024	0.027
PCTCOLLEGE	Percent of people with college degree in census tract	246	0.175	0.150

CBD = central business district. Obs = observations. VCP = voluntary cleanup program.

Note: Full sample (N = 247).

located in a state Enterprise Zone and 23 percent are in a federal Empowerment Zone. On average, industrial uses account for about 25 percent of the land use within a 500-meter radius around the properties and nearly 20 percent within 1,500 meters. The median housing value in the surrounding census tract is on average about $73,000.

Comparison Across VCP and Nonparticipating Sites

Maps of the VCP sites suggest that participating properties are more likely to be in areas where economic inducements, such as those associated with state Enterprise Zones and federal Empowerment Zones, are offered to firms (see exhibit A-1 in appendix A). Although they tend to be roughly the same distance from the central business district, participating sites tend to be farther from

major roads than nonparticipating eligible properties (see exhibit A-2 in appendix A). Participating sites are more likely to be surrounded by industrial properties and tend to be located farther away from residential zones (see exhibit A-3 in appendix A). These spatial patterns confirm that the probit model should control for industrial versus another use of the parcel, for the prevalent uses in the neighborhood, and for distance to the nearest residential area, as mentioned in Model, Sample, and Data Sources section.

We compared the means of all variables across nonparticipating and participating sites in the sample in exhibit 2. This table shows that participating properties tend to be considerably larger than nonparticipating eligible properties and tend to be somewhat less likely to contain buildings or other improvements.[17] As expected, enrolled sites have a higher predicted probability of contamination.

Exhibit 2

Comparison of Means of Variables for Nonparticipating (VCP = 0) and Participating (VCP = 1) Parcels

Variable	VCP = 0			VCP = 1			T Statistic
	N Valid Obs	Mean	Standard Deviation	N Valid Obs	Mean	Standard Deviation	
SIZE	131	1.188	5.940	116	10.134	15.046	– 6.003**
CBDDIST	131	3,834.800	2,579.010	115	3,685.470	1,995.580	0.511
BUILDING	131	0.901	0.300	116	0.672	0.471	4.476**
YRBUILT	5	1,917.000	26.833	47	1,946.110	30.261	– 2.277**
CAPITAL	131	1.141	1.305	116	0.347	0.982	5.435**
MJRDDIST	131	322.770	421.112	115	629.959	496.055	– 5.197**
PROBCON	100	0.278	0.183	75	0.736	0.225	– 14.419**
PROBCONMISSING	131	0.237	0.427	116	0.353	0.480	– 2.010*
ENTZNE	131	0.427	0.497	115	0.617	0.488	– 3.020**
EMPZNE	131	0.168	0.375	115	0.313	0.466	– 2.667**
LNEARVCPS	131	2.416	4.569	116	2.722	4.132	– 0.553
INDUSTRIAL	131	0.145	0.353	116	0.724	0.449	– 11.164**
PCTIND	131	0.080	0.130	115	0.327	0.211	– 10.864**
PCTIND500M	131	0.084	0.187	115	0.454	0.305	– 11.277**
RESZNEDIST	131	103.986	164.188	115	214.051	226.290	– 4.314**
MDVALHS	130	75,297.69	45,078.93	115	70,972.17	24,094.09	0.951
PCTPOVERTY	131	0.260	0.137	115	0.211	0.104	3.183**
PCTOWNERS	131	0.409	0.235	115	0.563	0.190	– 5.648**
PCTBLACKS	131	0.474	0.339	115	0.239	0.285	5.903**
PCTHISPANICS	131	0.023	0.028	115	0.025	0.027	– 0.635
PCTCOLLEGE	131	0.177	0.144	115	0.172	0.158	0.250

Obs = observations. VCP = voluntary cleanup program.

** = significant at the 5-percent level. ** = significant at the 1-percent level.*

Note: Statistical comparison of the means is done using t-tests of the null hypothesis that the difference in the means is zero.

[17] Sometimes multiple parcels were combined into the same application to the VCP (and into the same redevelopment project). The average size of a VCP site is 9.82 acres for the sites consisting of 1 parcel, 13.52 acres for the sites consisting of 2 parcels, 4.49 acres for the sites consisting of 3 parcels, 1.5 acres for the one site consisting of 4 parcels, 1.21 acres for the one site consisting of 5 parcels, 54.34 acres for the one site with 6 parcels, 1.98 acres for the one site with 7 parcels, 6 acres for the one site with 8 parcels, and 1.44 acres for the one site with 14 parcels. This suggests that in some cases it was necessary for developers to combine several very small parcels together to get a site of acceptable size for redevelopment.

Enrolled properties tend to be less capital intensive. Buildings at enrolled sites are likely slated for demolition during redevelopment, thus a less capital-intensive site may be more attractive because of lower demolition costs. Howland (2004) interviewed Baltimore real estate agents and industrial property owners and found that the expense of removing obsolete structures is one barrier to redevelopment.

There are no systematic differences across the two groups of properties for housing values and share of residents with a college degree. The proportion of residents who own their homes—as opposed to renting them—is higher near enrolled properties than near nonparticipating properties. The proportion of residents living in poverty tends to be lower surrounding enrolled properties. Regarding race and ethnicity of the neighborhood, enrolled properties tend to be located in neighborhoods with fewer African Americans, but no systematic difference exists regarding the proportion of people of Hispanic heritage.

Features of Participating Sites

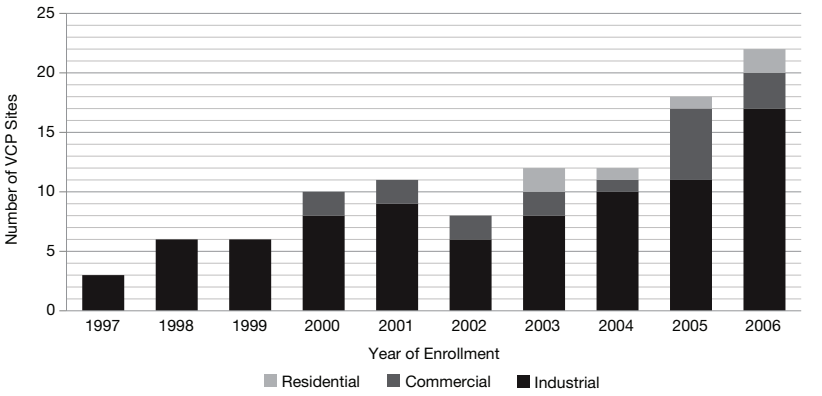
We checked for possible overlapping between VCP participation status and the other programs described in the Background section (Other Programs and Factors Potentially Affecting VCP Participation) but found that only one VCP property received a grant from the EPA under the Brownfields Program established by the Small Business Liability Relief and Brownfields Revitalization Act of 2001. None of the nonparticipating properties received funding under this program. Only five properties that received assessment grants under the earlier EPA Brownfield Assessment Demonstration Pilot Program subsequently entered the VCP program.

Among the VCP properties, we found no obvious differences between those that applied for an NFRD and those for which a cleanup plan was submitted, except that the predicted probability of contamination is greater for the latter. Among enrolled properties, those in industrial use tend to be larger than commercial properties.

Exhibit 3 displays the distribution of land use at Baltimore City participating sites by the year of enrollment, showing that (1) participation has picked up steam since the inception of the program,

Exhibit 3

Land Use at VCP Sites by Year of Enrollment



VCP = voluntary cleanup program.

with the largest enrollment (22 sites) in 2006, and (2) industrial properties make up most of the enlisted sites. Commercial properties started being enrolled in the program starting in 2000, but they still account for a small fraction of all sites. Residential properties are even less common.

Perusal of exhibit 3 suggests that, all else the same, participation rates and hence the likelihood of participation have changed over time. This change may have occurred because of changes in the eligibility criteria, the establishment of concurrent programs that target similar properties (see the Background section [Other Programs and Factors Potentially Affecting VCP Participation]), changes in the economic climate of the city, and changes in the real estate market. To account for these changes, we grouped the 10 years from the inception of the program to 2006 into four discrete periods: 1997 through 2000, 2001, 2002 through 2003, and 2004 through 2006. We then interacted key regressors with dummies for those periods.

The first period (1997 through 2000) captures the early years of the VCP, the most restrictive version of the federal Brownfields Tax Incentive and one city administration.[18] The second period, consists of a single year (2001) to allow for the disruption to business associated with the events of September 11, 2001, and because of subsequent policies and programs affecting contaminated sites that had not yet taken effect. With the third period (2002 and 2003), we hoped to capture the incentives associated with the Small Business Liability Relief and Brownfields Revitalization Act, which implied changes in funding for assessment and cleanup of contaminated sites and substantial limitation of Superfund liability for prospective purchasers and owners. In 2002, Baltimore voters passed the Economic Development Loan Bond Issue, which included $2 million for brownfield redevelopment (BDC, 2005). A change in political climate also occurred, starting with the beginning of 2003, when Robert Ehrlich, a Republican, took over as Governor of Maryland from Parris Glendening, a Democrat. It is possible that this shift in state government may have changed priorities for state agencies.

Finally, in 2004, the VCP was changed so that it began to admit oil pollution sites. These sites are likely to differ in size and use relative to sites contaminated by other hazardous wastes. For example, gas stations are comparatively small and are considered a commercial use.[19]

Basing our analysis on these considerations, we entered in the model the variable SIZE, a likely determinant of participation; SIZE2, the interaction term between SIZE and the dummy denoting the second period of the study (2001); SIZE3, the interaction term between SIZE and the third period of the study (2002 through 2003); and SIZE4, the interaction term between SIZE and the fourth period (2004 through 2006). This inclusion allows for the effect of property size on the probability of participation to vary over time.

[18] In December 1999, a change occurred in Baltimore's government when Mayor Martin O'Malley took over from Kurt Schmoke, who had been mayor since 1987. This change in city government may have resulted in changes of several aspects of city law, taxation, redevelopment efforts, and so forth. It seems reasonable, however, to include the first year of his administration within our first period because, during his first term as a mayor, O'Malley emphasized safety and crime reductions. This emphasis and any other regime changes were unlikely to have had an immediate effect on redevelopment and investment opportunities.

[19] The program was also amended to accept application packages that included Phase I and Phase II environmental assessment studies funded through grants from the EPA Brownfields Program. As discussed at the beginning of this section, however, only one property appears to have availed itself of this opportunity.

Estimation Results

Exhibit 4 reports the results for the random effects probit model of participation.[20] We present three specifications. Specification (A) is the base specification, which includes size of the property and interactions between size and time period, in addition to the regressors listed in the Model, Sample, and Data Sources section (Other Independent Variables). Specifications (B) and (C) include census tract characteristics (as of 2000) to capture socioeconomic differences in neighborhood character and blighted areas.

Exhibit 2 had suggested that the VCP tends to attract larger sites. This tendency would appear to be a recent phenomenon, because the results of all the probit specifications in exhibit 4 suggest that, in the early years, the program actually attracted smaller properties, but that trend was subsequently reversed, as implied by the signs and significance levels of the coefficients on SIZE, SIZE2, SIZE3, and SIZE4.

Exhibit 4

Results of Random Effects Probit Regression of VCP Participation

Variable	(A)		(B)		(C)	
	Coefficient	T Stat	Coefficient	T Stat	Coefficient	T Stat
INTERCEPT	– 1.6806	– 4.93**	– 1.2733	– 2.81**	– 1.9840	– 4.62**
SIZE	– 0.0124	– 1.81^	– 0.0128	– 1.87^	– 0.0127	– 1.84^
SIZE2	– 0.0020	– 0.13	– 0.0022	– 0.14	– 0.0021	– 0.13
SIZE3	0.0090	0.98	0.0087	0.94	0.0089	0.95
SIZE4	0.0301	3.72**	0.0304	3.73**	0.0312	3.78**
CBDDIST	0.0000	0.02	– 0.0000	– 0.35	– 0.0000	– 0.11
BUILDING	– 0.2201	– 1.34	– 0.2271	– 1.36	– 0.2319	– 1.4
BUILDINGYRBUILT	– 0.0001	– 0.64	– 0.0001	– 0.8	– 0.0001	– 0.77
YRBUILTMISSING	– 0.6347	– 3.18**	– 0.6919	– 3.35**	– 0.6947	– 3.34**
CAPITAL	– 0.1881	– 2.67**	– 0.1946	– 2.72**	– 0.1898	– 2.65**
MJRDDIST	– 0.0001	– 1.42	– 0.0001	– 0.92	– 0.0001	– 0.96
PROBCON	0.4593	1.73^	0.4418	1.65^	0.4182	1.55
PROBCONMISSING	0.1414	0.73	0.1428	0.73	0.1296	0.66
ENTZNE	– 0.0143	– 0.09	– 0.0656	– 0.37	– 0.0097	– 0.06
EMPZNE	0.0645	0.4	0.0110	0.06	0.0562	0.35
LNEARVCPS	0.0592	5.13**	0.0620	5.22**	0.0601	5.07**
INDUSTRIAL	0.4536	3.27**	0.4273	3.04**	0.4320	3.07**
PCTIND	0.5401	1.36	0.5251	1.32	0.1941	0.39
RESZNEDIST	0.0007	2.37*	0.0007	2.36*	0.0007	2.42*
MDVALHS			– 0.0000	– 1.29		
PCTCOLLEGE			0.2803	0.44		
PCTPOVERTY					1.3077	1.45
PCTOWNERS					0.4786	0.89
PCTBLACKS					– 0.2992	– 0.93
Log Likelihood	– 351.86906		– 350.71099		– 350.78477	

VCP = voluntary cleanup program.

*^ = significant at the 10-percent level. * = significant at the 5-percent level. ** = significant at the 1-percent level.*

Note: Dependent variable: participation in year T of the program.

[20] The correlation between any two error terms within the same site is generally small (about 0.03) and significant only at the 10-percent level. Nevertheless, random effects were incorporated to obtain the correct standard errors.

It is possible that, in the later years, developers became familiar with the workings of the program and saw opportunities for economies of scale in assessment, development, and cleanup; moreover, larger sites cater to large projects and can be subdivided. This result may also have been a consequence of the Small Business Liability Relief and Brownfields Revitalization Act. Before this law, holding the probability of contamination per acre the same, a developer or owner would be more likely to face exposure to liability (or be more heavily exposed) with larger properties. With the law in effect, which limits or eliminates liability for certain parties under specific conditions, larger sites become comparatively more attractive.

This finding also suggests that the VCP did not prove to be particularly attractive to (closed) gas stations, which are generally small properties, after the VCP eligibility rules were amended in 2004 to include petroleum-contaminated sites. Conversations with MDE staff suggested that very few leaking underground storage tank (LUST) sites were signed up with the VCP, probably because the VCP has relatively more stringent environmental assessment and cleanup requirements. Gas station owners and operators would have found the Maryland LUST program more attractive because, until the middle of 2005, this program would have reimbursed them for the cost of remediation.[21]

The probit model confirms that participation is also more likely to occur among sites without buildings (an effect that is not significant at the conventional levels, however) and among properties with lower capital intensity, suggesting a preference for sites with lower demolition and remediation costs. Distance to the central business district or to major roads does not seem to be an important driver of participation. This finding should be interpreted with caution, because it may be due to collinearity and to the use of imperfect proxies for site access. Distance to the central business district is correlated with several other spatial characteristics, and distance to major roads may not fully capture how easy or difficult it is to access a particular property in an urban setting.

As expected, participation is positively and significantly associated with the prior probability of contamination—in other words, the program is attracting sites that one would truly expect to be contaminated. That does not mean, of course, that the property is necessarily cleaned up, and indeed about two-thirds of the VCP applications, as discussed in the Model, Sample, and Data Sources section, requested an NFRD.

There is no evidence of an independent effect of Enterprise and Empowerment Zone designations. However, these designations are correlated with land use, location, and size of the site. Once again, it is thus difficult to say whether this result is genuine or an artifact of collinearity. Most likely, VCP properties—brownfields, for all practical purposes—are typically in abundant supply in blighted areas that are also addressed by state and federal economic development programs.

The results suggest that participation is more likely among sites zoned for industrial use and grows with distance from residential areas and with the percentage of the surrounding land designated

[21] The fact that the VCP attracted larger sites in more recent years is in sharp contrast to general nonresidential development and building trends. Data from the Baltimore Metropolitan Council indicate that in Baltimore City the average size of such development projects followed an inverted-U trend over the study period and had reached its lowest levels (about 12,000 sq. ft.) by 2004 through 2006. The square footage of the average project has been declining steadily over the study period in the entire Baltimore metropolitan area (about 9,000 sq. ft. in 2004 through 2006).

as industrial (the latter is statistically insignificant at all the conventional levels).[22] The coefficient on LNEARVCPS suggests that the number of nearby properties previously enrolled in the VCP is positively associated with the probability of enrollment. It is possible that successful participation encourages enrollment of other nearby sites. Alternatively, this finding may also be due to the spatial clustering of brownfields or to other unobserved amenities.

Specification (B) adds the median housing value and the education level of the residents in the census tract around each property, although neither variable has an independent effect on the likelihood of enrollment. These variables were intended to act as a proxy for up-and-coming versus blighted neighborhoods, but their effect (if any) is probably already captured in other site and neighborhood characteristics. Specification (C) includes other characteristics of the residents, namely the percentage of people who live in poverty, own their homes, and are African American. In both (B) and (C), likelihood ratio tests indicate that the newly added census-tract variables are jointly insignificant.

To get a sense of the magnitude of the probit coefficients, using specification (A) we computed the annual probability of participation (or enrollment) for a hypothetical industrial-use parcel of average size, distance to the CBD, capital intensity, and in an Enterprise Zone. We assumed that this site had the average prior probability of contamination, was surrounded by the average extent of industrial land, and was at the average distance from residential areas. For a parcel with these characteristics during the first period of the program (1997 through 2000), the probability of enrollment in any given year was 9.36 percent. Increasing the size of this average parcel by a standard deviation (that is, by 12.02 acres above the original 5.43 acres) slightly decreased the probability of enrollment from 9.36 to 7.12 percent.

The story changes in more recent years (2004 through 2006). A parcel that was average in all respects and was zoned for industrial use would have had a greater annual probability of participation (12.39 percent), which increases to 17.31 percent if the parcel's size is increased by a standard deviation above the average. If this larger parcel during the most recent years of the program was located an additional 0.25 miles from the nearest residential zone (about a two standard-deviation increase), then the probability of participation would increase from 17.31 to 25.10 percent.

Sales and Redevelopment

A natural issue to address is whether properties that signed up for the VCP did so because they had just been or were about to be purchased or sold. We did not include sales events in the right-hand side of the probit equation because we were unable to find good instruments for them and for related econometric difficulties, but we checked whether participating sites were bought or sold around the time of enrollment in the program.

Of the 247 properties in the sample, 100 had no records of sales in recent years (after 1990). These 100 parcels with no recent sales were evenly split between VCP participants and nonparticipants

[22] The probit regressions reported in exhibit 4 used the 1,500-meter buffer when computing the percentage of surrounding land dedicated to industrial uses, but we obtained the same result when we used smaller buffer sizes (for example, 500 meters) to capture closer neighbors of each property in the sample.

(51 and 49 parcels, respectively). Of these 100 parcels, we were unable to identify 22 in the SDAT records. The remaining 78 were mostly commercial and industrial parcels (49 and 22 parcels, respectively) and were properly documented in the Maryland taxation data. Of these 78 well-identified parcels, 29 (37.18 percent) were VCP participants.

The remaining properties had been bought and sold during the 1990-through-2006 period for a total of 224 sales. When we restricted our attention to the 185 sales that occurred during or after 1997 (that is, since the beginning of the VCP), we found that 92 of these sales were among 67 non-VCP properties and the remaining 93 sales were of 55 VCP properties. Between 1997 and 2006, about 66 percent of the sold non-VCP sites were sold once, 27 percent were sold twice, 7 percent were sold three times, and none were sold four times. In contrast, 53 percent of the sold VCP sites were sold once, 34.55 percent were sold twice, 9.09 percent were sold three times, and 3.64 percent were sold four times.

Of the 93 sales of VCP sites, 72 occurred at properties that received application approval as of December 20, 2006. Of these sales, 39 occurred before the VCP application was approved, and 33 occurred after approval. Of these sales, 11 took place within 3 months of the approval of the VCP application, but the lion's share (52 sales) took place 6 months after application approval or later. Of these 52 sales, 20 were properties that had a proposed cleanup plan. Taken together, these facts suggest that the properties enrolled in the VCP come from a pool of properties that are sold or bought no less than the nonparticipating sites.

The next logical issue to follow this discussion of transaction activity of VCP properties is whether parcels enrolled in the Maryland VCP are likely to be redeveloped soon. Possibly, but we believe that redevelopment is unlikely to bring significant land use changes. Of the 58 properties that had received an NFRD letter or a CoC within the study period, residential use was explicitly prohibited at 44 sites (75.80 percent). At 12 sites (20.69 percent), only limited residential development was allowed. These restrictions are meant to protect the public from possible exposures to contaminants, while at the same time trying to encourage some form of reuse.

We obtained the specific land use before and after VCP completion for 40 of the 58 properties that completed the program. Only 8 properties changed uses after completion: most were converted from parking lots (n = 3), warehouses (n = 2), and manufacturing facilities (n = 1) to offices. Only 2 properties were converted to residential use (the first was initially a warehouse and the other a manufacturing facility).

Taken together with the likelihood that enrollment is greater at industrial properties in industrial areas and increases with distance from residential neighborhoods, the above evidence suggests that the vast majority of redevelopment would either keep the existing land use or convert the parcel to nonresidential uses.

Infill redevelopment is touted as helping to meet smart growth goals and as avoiding conversion of open space, so it is natural to ask how well the VCP is doing in this respect. As of December 2006, a total of 1,175 acres were enrolled in the VCP in the city of Baltimore alone.

Deason, Sherk, and Carroll (2001) considered eight brownfield properties in the city of Baltimore and assumed redevelopment as office buildings, commercial facilities, or homes (see exhibit B-1 in

appendix B). They calculated the land area that would be necessary if such redevelopment projects took place in surrounding suburban areas (Baltimore, Kent, and Frederick Counties). They consistently found that, based on local zoning, such redevelopment projects would require larger land areas in these latter three counties than in the city of Baltimore.

Assuming that all of the participating 1,175 acres are redeveloped and remain in their use at the time of enrollment, we used the land area "ratios" derived by Deason, Sherk, and Carroll (2001) to estimate the amount of open space that the VCP may have deterred from being developed (see exhibit B-2 in appendix B). We considered greenfields in Baltimore County as likely substitutes for infill development because this rural or suburban area surrounds the city of Baltimore and is part of the overall metropolitan area. For purposes of this illustrative calculation, we assumed that VCP properties can accommodate similar projects as any other properties.

Basing our analysis on these assumptions, if the urban redevelopment projects on VCP properties were built on greenfields instead of brownfields, they would require as many as 6,444 acres in suburban Baltimore County under generous assumptions about the conversion "ratio" between city and suburban projects and 1,238 acres under more conservative assumptions. This illustration suggests that if VCP properties are indeed all redeveloped, if redevelopment can be attributed solely to the VCP, and if greenfields and brownfields are truly substitutable, then the VCP is potentially an effective tool to deter open space conversion.

Conclusions

To understand the promise and potential of voluntary cleanup programs (VCPs) in promoting remediation and reuse of brownfields, this study focused on enrollment and participation in the Maryland VCP, which began in 1997. To ensure a homogeneous legal and tax environment, we restricted attention to the 116 sites in the city of Baltimore that had participated as of the end of 2006.

Participation in the Maryland VCP has led to the identification and environmental assessment of 1,175 acres of contaminated land in the city of Baltimore alone. The vast majority of applications (66 percent) requested a No Further Requirements Determination (NFRD) on the part of the state agency, suggesting that actual cleanup is not undertaken at most of the sites. We believe that participation in the program is often motivated by developers' or business owners' desire to protect themselves from future environmental liability. A clean bill of health may, of course, also increase the value of property (and of any redevelopment project on site). In that sense, the evidence from Baltimore confirms the findings for the Colorado VCP reported in Alberini (2007).

One major issue to tackle when studying the determinants of voluntary cleanup is the identification of "counterfactuals," namely properties that are potentially eligible for the program but are not enrolled. Given Noonan and Vidich's 1992 estimates of the a priori probability of contamination for commercial and industrial properties, we believe that it is reasonable to consider virtually all commercial and industrial parcels in Baltimore as potential candidates for the VCP (see Page and Berger, 2006; Sigman, 2005). We therefore compared the VCP properties with a sample of similar size properties selected at random from the universe of industrial and commercial properties in Baltimore. Probit regressions confirm that participation is more likely among industrial sites

located in industrial areas and less likely in the presence of improvements and heavy building capitalization. They also suggest that the distances to the central business district and major roads, respectively, are not very important. Even more important, the probit regressions point to the changing nature of the program—or of the sites that tend to be attracted to the program. In the first few years of the program, smaller properties tended to be attracted into the VCP. Most recently, however, participation has been more likely among larger properties.

Given the surrounding land use and the restrictions imposed on the use of the property by the VCP approval, it is likely that such industrial properties will be kept in industrial or perhaps commercial use but will not be turned into residential projects. This likelihood is supported by recent home construction trends. Records from SDAT show that, from 1996 to 2007, of the 371 single-family homes built in the city of Baltimore, only 1 was built in an industrial use area and 4 were built in a commercial use area (see exhibit A-4 in appendix A). In fact, only 21.8 percent of these homes are within 1 mile of an industrial area, and most (77.1 percent) are more than 0.5 miles from a VCP site. This finding is in sharp contrast with the findings in Alberini (2007), who concludes that properties enrolled in the Colorado VCP were most likely under residential development pressure.

Assuming that all of the participating 1,175 acres are redeveloped and remain in their use at the time of enrollment, and using the land area "ratios" derived by Deason, Sherk, and Carroll (2001), we estimate that if the urban redevelopment projects on VCP properties were instead built on greenfields, they may require between 1,238 and 6,444 acres in suburban Baltimore County. Because most of the enrolled sites tend to remain in nonresidential uses, it appears that VCPs, at least in the case of Baltimore, may encourage commercial and industrial activities to take place on already contaminated brownfields, thus leaving pristine land available as open space or for residential uses.

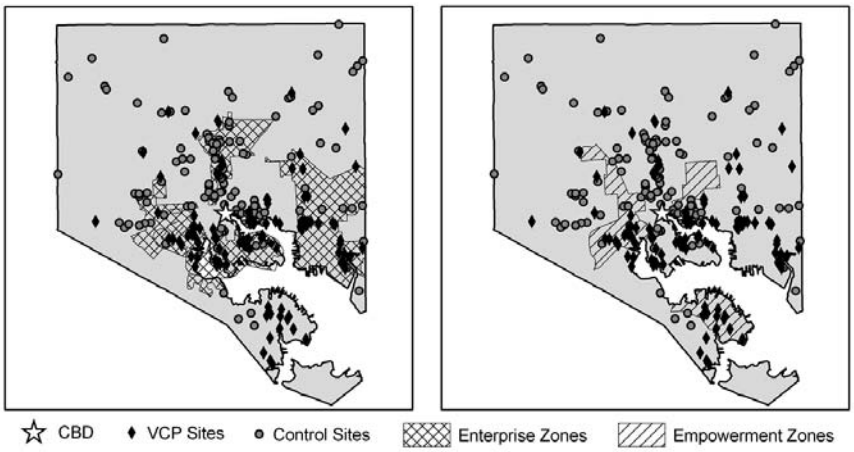
The findings should, as always, be interpreted with caution. This study is specific to the city of Baltimore, and, given the limited body of research about VCPs and their context-specific results, it would be necessary to conduct more research at a variety of locations before attempting to extrapolate from this study's locale to another. Future research endeavors might compare the VCP in a city like Baltimore with VCPs of other cities that have experienced similar declines in population and manufacturing and blue-collar jobs.

Another limitation of the study is that, given the many concurrent local and federal programs in place at the same time as the VCP, it is impossible to isolate the effect of any single policy in promoting brownfield cleanup and redevelopment. Thus, in conducting future research, it would be important to control carefully for previous brownfields pilot status and for the generosity of assistance and incentives to environmental assessment and redevelopment.

Appendix A. Maps of Sample Sites in Baltimore, Maryland

Exhibit A-1

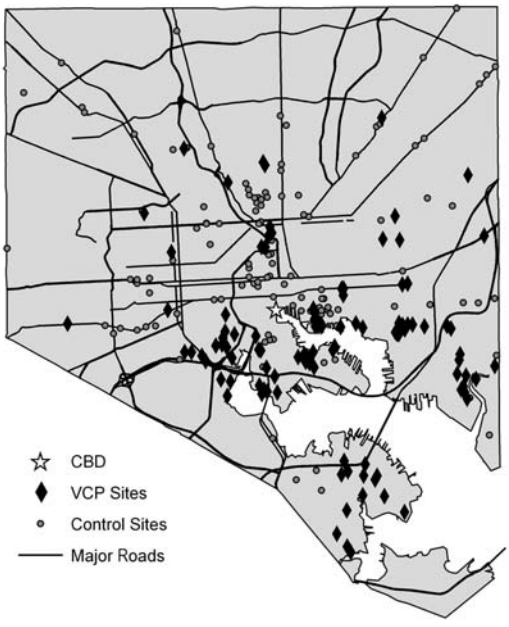
Enterprise and Empowerment Zones



CBD = central business district. VCP = voluntary cleanup program.

Exhibit A-2

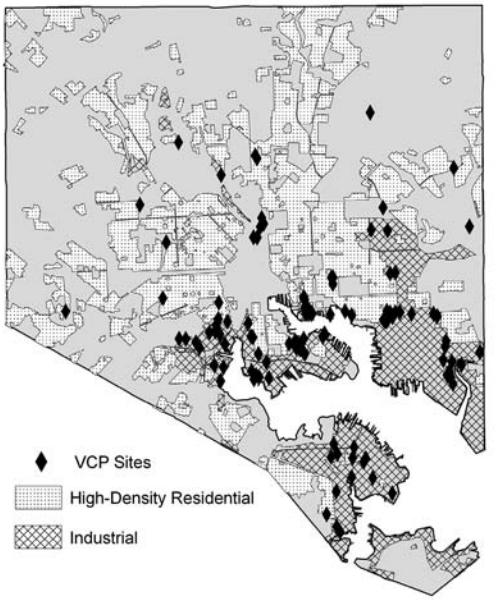
Baltimore Major Roads



CBD = central business district. VCP = voluntary cleanup program.

Exhibit A-3

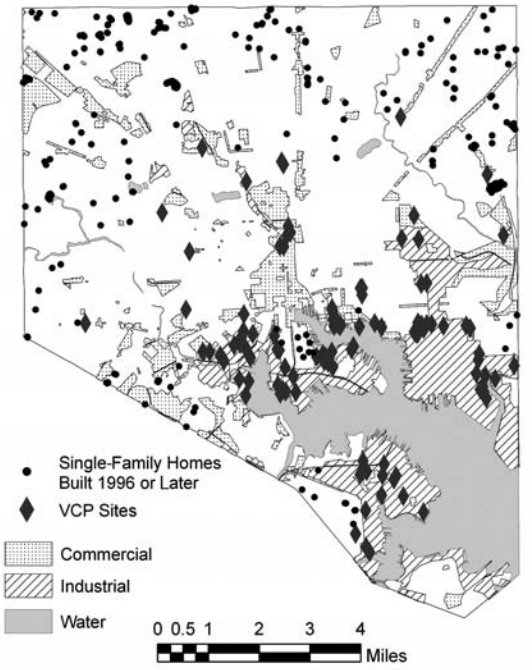
Baltimore 1996 Land Use



VCP = voluntary cleanup program.

Exhibit A-4

Land Use (1996) and New Home Construction



VCP = voluntary cleanup program.

Appendix B. Calculation of Land Area Conversion Ratios

Exhibit B-1

Property-Specific Conversion Ratios
Calculations for Brownfield Properties in the City of Baltimore

Property	Size (Acres)	Assumed Reuse	Required Area if in Baltimore County (Acres)	Ratio
1	15	Office buildings	18.37	1 : 1.22
2	4.5	Redeveloped comm. facility	9.18	1 : 2.04
3	0.7	Office buildings	4.59	1 : 6.12
4	2.75	Two office buildings	5.42	1 : 1.97
5	6	Residential multifamily complex	6.00	1 : 1
6	1.3	Residential, 26 townhomes	2.25	1 : 1.73
7	2.8	Residential	2.23	1 : 0.80
8	0.17	Two-story office building	0.67	1 : 3.94

Source: Deason, Sherk, and Carroll (2001)

Exhibit B-2

Development Conversion Rates Assumed in This Article
(See the Sales and Redevelopment section.)

Land Use	N	Total Acres	"Ratio"	Total Required for Equivalent Projects in Suburban Areas
Generous assumptions*				
Industrial	83	975.02	6.24	6,084.12
Commercial	14	62.86	3.0875	194.08
Residential	6	32.79	1.86	60.99
Other	13	104.86	1.00	104.86
Total				6,444.05
More conservative assumptions**				
Industrial	83	975.02	1.00	975.02
Commercial	14	62.86	2.00	125.72
Residential	6	32.79	1.00	32.79
Other	13	104.86	1.00	104.86
Total				1,238.39

** Means of the conversion ratios for the Baltimore projects reported in Deason, Sherk, and Carroll (2001), except for industrial use projects, where the figure in this table (6.24) is the average for industrial projects nationwide. (Deason, Sherk, and Carroll [2001] do not examine industrial projects for Baltimore.)*

*** Median conversion ratios. The same exceptions as in * apply.*

Acknowledgments

We thank the following organizations and individuals for their helpful comments and suggestions: the National Center for Smart Growth for their support and the data for this analysis; attendees of the brownfields session at the International Atlantic Economic Conference, Savannah, Georgia, October 2007; participants in "The Reuse of Contaminated Sites in Sustainable Development Strategies" Workshop, Venice, Italy, May 2008; and Edwin A. Stromberg.

Authors

Dennis Guignet is a Ph.D. candidate in the Department of Agricultural and Resource Economics at the University of Maryland.

Anna Alberini is an associate professor in the Department of Agricultural and Resource Economics at the University of Maryland.

References

Alberini, Anna. 2007. "Determinants and Effects on Property Values of Participation in Voluntary Cleanup Programs: The Case of Colorado," *Contemporary Economic Policy* 25 (3): 415–432.

Alberini, Anna, Alberto Longo, Stefania Tonin, Francesco Trombetta, and Margherita Turvani. 2005. "The Role of Liability, Regulation and Economic Incentives in Brownfield Remediation and Redevelopment: Evidence from Surveys of Developers," *Regional Science and Urban Economics* 35 (4): 327–351.

Alker, Sandra, Victoria Joy, Peter Roberts, and Nathan Smith. 2000. "The Definition of Brownfield," *Journal of Environmental Planning and Management* 43 (1): 49–69.

Baltimore Development Corporation (BDC). 2010. "Overview of the Baltimore Development Corporation." http://www.baltimoredevelopment.com/overview-baltimore-development-corporation (accessed September 20, 2010).

———. 2005 (January). "Brownfields Progress in Baltimore and Maryland—A Chronology." www.baltimoredevelopment.com/files/pdf/brownfields/chronology.pdf (accessed August 20, 2009).

Baltimore Metropolitan Council (BMC). 2010 (February). "Building Permit Annual Summaries." http://www.baltometro.org/content/view/432/292 (accessed September 20, 2010).

Bartik, Timothy J. 2004. "Evaluating the Impacts of Local Economic Development Policies on Local Economic Outcomes: What Has Been Done and What Is Doable?" In *Evaluating Local Economic and Employment Development: How To Assess What Works Among Programmes and Policies*, edited by Alistair Nolan and Ging Wong. Paris, France: Organisation for Economic Co-operation and Development: 113–141.

———. 1991. *Who Benefits From State and Local Economic Development Policies?* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Bartsch, Charles, Elizabeth Collaton, and Edith Pepper. 1996. *Coming Clean for Economic Development: A Resource Book on Environmental Cleanup and Economic Development Opportunities*. Washington, DC: Northeast-Midwest Institute.

Bartsch, Charles, and Bridget Dorfman. 2000. *Brownfields 'State-of-the-State': An End-of-Session Review of Initiatives and Program Impact in the 50 States*. Washington, DC: Northeast-Midwest Institute.

Daley, Dorothy M. 2007. "Voluntary Approaches to Environmental Problems: Exploring the Rise of Nontraditional Public Policy," *The Policy Studies Journal* 35 (2): 165–180.

De Sousa, Christopher. 2004. "The Greening of Brownfields in American Cities," *Journal of Environmental Planning and Management* 47 (4): 579–600.

———. 2000. "Brownfield Redevelopment Versus Greenfield Redevelopment: A Private Sector Perspective on the Costs and Risks Associated With Brownfield Redevelopment in the Greater Toronto Area," *Journal of Environmental Planning and Management* 43 (6): 831–853.

Deason, Jonathan P., George William Sherk, and Gary A. Carroll. 2001. *Public Policies and Private Decisions Affecting the Redevelopment of Brownfields: An Analysis of Critical Factors, Relative Weights and Areal Differentials.* Report to the U.S. Environmental Protection Agency (EAP), George Washington University/EPA Brownfields Economic Redevelopment Cooperative Agreement. Available at http://www.gwu.edu/~eem/Brownfields/.

Fisher, Peter S., and Alan H. Peters. 1998. *Industrial Incentives: Competition Among American States and Cities*. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Fogleman, Valerie M. 1992. *Hazardous Waste Cleanup, Liability, and Litigation: A Comprehensive Guide to Superfund Law*. Westport, CT: Quorum.

Fox, William F., and Matthew N. Murray. 2004. "Do Economic Effects Justify the Use of Fiscal Incentives?" *Southern Economic Journal* 71 (1): 78–92.

Greenberg, Michael R., and Justin Hollander. 2006. "The Environmental Protection Agency's Brownfields Pilot Program," *American Journal of Public Finance* 96 (2): 277–281.

Greene, William H. 2008. *Econometric Analysis*, 6th ed. Upper Saddle River, NJ: Pearson-Prentice Hall.

Greenstone, Michael, and Enrico Moretti. 2003. Bidding for Industrial Plants: Does Winning a 'Million Dollar Plant' Increase Welfare? Working Paper No. 9844. Cambridge, MA: The National Bureau of Economic Research.

Howland, Marie. 2004. "The Role of Contamination in Central City Industrial Decline," *Economic Development Quarterly* 18 (3): 207–219.

———. 2003. "Private Initiative and Public Responsibility for the Redevelopment of Industrial Brownfields: Three Baltimore Case Studies," *Economic Development Quarterly* 17 (4): 367–381.

———. 2000. "The Impact of Contamination on the Canton/Southeast Baltimore Land Market," *Journal of the American Planning Association* 66 (4): 411–420.

Longo, Alberto, and Anna Alberini. 2006. "What are the Effects of Contamination Risks on Commercial and Industrial Properties? Evidence From Baltimore, Maryland," *Journal of Environmental Planning and Management* 49 (5): 713–737.

Maryland Department of the Environment (MDE). "Maryland's Voluntary Cleanup Program." http://www.mde.state.md.us/Programs/LandPrograms/ERRP_Brownfields/vcp_info/ (accessed September 8, 2008).

McGrath, Daniel T. 2000. "Urban Industrial Land Redevelopment and Contamination Risk," *Journal of Urban Economics* 47: 414–442.

Meyer, Peter B. 2000. Looking at State Voluntary Cleanup Programs in Perspective: Liability Relief, Flexible Cleanup Standards and Institutional Controls as Forms of Economic Development Subsidies. Working paper. Louisville, KY: University of Louisville, Center for Environmental Policy and Management.

Meyer, Peter B., and Thomas S. Lyons. 2000. "Lessons From Private Sector Brownfield Redevelopers: Planning Public Support for Urban Regeneration," *Journal of the American Planning Association* 66 (1): 46–57.

Meyer, Peter B., and H. Wade VanLandingham. 2000. "Reclamation and Economic Regeneration of Brownfields," *Reviews of Economic Development Literature and Practice: No. 1*. Washington, DC: U.S. Economic Development Administration.

Newman, Robert J., and Dennis Sullivan. 1988. "Econometric Analysis of Business Tax Impacts on Industrial Location: What Do We Know and How Do We Know It?" *Journal of Urban Economics* 23 (2): 215–234.

Noonan, Frank, and Charles A. Vidich. 1992. "Decision Analysis for Utilizing Hazardous Waste Site Assessment in Real Estate Acquisition," *Risk Analysis* 12 (2): 245–251.

Page, G. William, and Robert S. Berger. 2006. "Characteristics and Land Use of Contaminated Brownfield Properties in Voluntary Cleanup Agreement Programs," *Land Use Policy* 23: 551–559.

Peters, Alan, and Peter Fisher. 2004. "The Failure of Economic Development Incentives," *Journal of the American Planning Association* 70 (1): 27–37.

———. 2002. *State Enterprise Zone Programs: Have They Worked?* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Schoenbaum, Miriam. 2002. "Environmental Contamination, Brownfields Policy, and Economic Redevelopment in an Industrial Area of Baltimore, Maryland," *Land Economics* 78 (1): 60–71.

Sementelli, Arthur J., and Robert A. Simons. 1997. "Regulation of Leaking Underground Storage Tanks: Policy Enforcement and Unintended Consequences," *Economic Development Quarterly* 11 (3): 236–248.

Sigman, Hilary. 2005. Environmental Liability and Redevelopment of Old Industrial Sites. Unpublished paper.

Solitare, Laura, and Michael Greenberg. 2002. "Is the U.S. Environmental Protection Agency Brownfields Assessment Pilot Program Environmentally Just?" *Environmental Health Perspectives* 110 (2): 249–257.

U.S. Environmental Protection Agency (EPA). 2009 (September). *Brownfields and Land Revitalization*. Washington, DC: U.S. Environmental Protection Agency. http://www.epa.gov/brownfields/overview/glossary.htm (accessed September 20, 2010).

———. 2005 (February). *State Brownfields and Voluntary Response Programs: An Update from the States*. EPA–560–R–05–001. Washington, DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

U.S. General Accounting Office (GAO). 1997 (April). *Superfund: State Voluntary Programs Provide Incentives to Encourage Cleanups*. GAO/RCED–97–66. Washington, DC: U.S. General Accounting Office.

———. 1995. *Community Development: Reuse of Urban Industrial Sites*. GAO/RCED 95–172. Washington, DC: U.S. General Accounting Office.

Wasylenko, Michael. 1997. "Taxation and Economic Development: The State of the Economic Literature," *New England Economic Review* March/April: 37–52.

Wernstedt, Kris, Peter Meyer, and Anna Alberini. 2006. "Attracting Private Investment to Contaminated Properties: The Value of Public Interventions," *Journal of Policy Analysis and Management* 25 (2): 347–369.

Yount, Kristen R., and Peter B. Meyer. 1999. "Factors Affecting Investments in Small- and Large-Scale Brownfield Projects," *Urban Ecology* 3 (4): 351–365.