Voluntary Cleanups and Redevelopment Potential: Lessons from Baltimore, Maryland

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Summary

Policy has increasingly shifted towards economic incentives and liability attenuation for promoting cleanup and redevelopment of contaminated sites, but little is known about the effectiveness of such policies. An example of such legislation is State Voluntary Cleanup Programs (VCPs), which were established in the US in the 1990s and to date have been implemented in almost every state. We examine Baltimore properties that participated in the Maryland VCP from its inception in 1997 to the end of 2006. Specifically, we examine what type of properties tend to participate in these programs, how these properties compare to other eligible but non-participating sites, and what is the redevelopment potential of VCP properties and implications towards open space conversion. We find that most applicants (66%) actually requested a "No Further Action Determination" directly, rather than proposing cleanup. VCP properties tend to be industrial, located in industrial areas, and away from residential neighborhoods. In more recent years larger industrial properties have increasingly enrolled in the program. The majority of sites are reused as industrial or commercial. In contrast to Alberini (2007), this suggests that pressure for residential development does not drive VCP participation. 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.

Keywords: Brownfields, Contaminated Sites, Voluntary Cleanup Programs, Incentives

JEL Classification: R14, Q58, K32

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VOLUNTARY CLEANUPS AND REDEVELOPMENT POTENTIAL: LESSONS FROM BALTIMORE, MARYLAND

By Dennis Guignet and Anna Alberini

1. Introduction and Motivation

Many observers believe that the liability regime imposed by federal and state hazardous waste programs in the US is at least partially responsible for discouraging the purchase and reuse of contaminated or potentially contaminated sites, which have remained idle or underutilized.[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" (US EPA, 2007), to the point that public intervention may be needed (Alker et al., 2000)—cover thousands of acres in many urban and rural areas of the country (US General Accounting Office, 1995).

A number of state programs and federal legislation have recently been established in an attempt to reverse these disincentives and stimulate cleanup and productive reuse of brownfields. For example, in the 1990s, several States established Voluntary Cleanup Programs (VCPs) offering liability relief, other economic inducements 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).

[1] The Superfund program was established by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), passed in 1980 and amended and re-authorized in 1986. It is probably the best known among the public programs addressing hazardous waste sites in the US. Under the Superfund program the US 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 transporters of the wastes. Liability has in some cases been construed to apply to property owners and lenders that foreclose on contaminated properties (Fogleman, 1992).

Under the Federal Brownfield Tax Incentive, since 1997 environmental cleanup costs for properties that meet specified requirements have been fully deductible in the year in which they are incurred, as long as the property is for use in a trade or business or for the production of income. Likewise, state brownfields programs grant tax credits or other benefits for cleanup and investment at potentially contaminated properties in blighted areas.

Finally, the federal Small Business Liability Relief and Brownfield Revitalization Act of 2002 provides conditional relief from environmental liability for property owners and purchasers of land. This law also establishes the EPA Brownfield Program, which provides assessment and cleanup grants to state and local governments and communities, as well as grants which 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 have been raised about whether these programs effectively provide public funding to redevelopment projects that would have occurred anyway (Alberini, 2007), and concerns exist about dedicated public funding that is left unspent (Schoenbaum, 2002). Common assertions that the majority of brownfield properties are former industrial lands, that they are usually found in central cities, and that their redevelopment is riskier and less profitable than equivalent projects on pristine lands and suburban areas have been recently challenged (Page and Berger, 2006; DeSousa, 2000). Deason et al. (2001) analyze urban redevelopment projects and compute the size of equivalent projects in open and suburban areas, showing that the latter often take up considerable more land than infill redevelopment, thus contributing to sprawl and erosion of open space.

For these reasons, it is important to understand what types of properties tend to participate in programs that offer incentives and assistance for brownfield cleanup and redevelopment. In this paper, we examine the Voluntary Cleanup Program (VCP) of the state of Maryland. We ask three related questions: First, what types of properties tend to participate in the Maryland VCP? Second, how do these properties compare with other eligible but nonparticipating industrial and commercial properties? Third, what is the redevelopment potential of VCP parcels, and can redevelopment of VCP sites help prevent conversion of agricultural land and open space in suburban and rural areas of the State?

To answer these questions, we examine 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 participating properties in Baltimore City.[2] We supplement this set of parcels with a sample of comparable size drawn at random from the universe of industrial and commercial properties in Baltimore City, which we use as a "control" group. The newly formed sample—enlisted properties plus "controls"—allows us to establish whether the VCP tends to attract parcels that are systematically different from the rest of the supply of industrial and commercial properties in Baltimore.

Simple univariate analyses suggest that VCP enlistees are generally larger and less capital intensive than the bulk of industrial and commercial properties in Baltimore, and have a higher prior probability of contamination than non-participating parcels. Probit regressions confirm that participation is more likely among industrial sites located in industrial areas, and less likely where buildings are present and 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, smaller

[2] By "Baltimore City" we mean Baltimore City County, i.e., the independent-city county with FIPS code 24510.

properties tended to be attracted into the program. Most recently, however, participation has been more likely among larger properties, and the prevalence of industrial sites among the participants has become even stronger.

To answer the third question, we examine the restrictions imposed on the property when the State agency granted "No further action" status or issued a certificate of cleanup completion. 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 the land use at participating sites, and at any rate participating properties tend to be located primarily away from residential areas. Taken together, these facts suggest that VCP sites will likely remain in some type of industrial or commercial use. These conclusions are in sharp contrast with Alberini (2007), who finds that the Colorado VCP tends to attract sites under residential development pressure.

Finally, we use the figures presented in Deason et al. (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/suburban areas of the State. Under alternate assumptions, we estimate this total area to be between 1,238 and 6,444 acres. We conclude that the VCP holds good promise as a tool for reducing pressure on the conversion of open space and agricultural land. This finding should be interpreted with caution. Comparison of the findings of this paper with previous research (Alberini, 2007) suggests that until further research is done on this topic it will be difficult to extrapolate from one specific program and its achievements to another.

The remainder of the paper is organized as follows. Section 2 presents background information and describes the Maryland VCP. Section 3 reviews the literature. Section 4 presents our econometric model of participation in a VCP and data sources. Section 5 describes the data and section 6 the estimation results. Section 7 discusses the implications of our findings, and Section 8 concludes.

2. Background

A. Brownfields and Brownfields Programs

In the United States, there is a large supply of properties where prior industrial uses have resulted in contamination of soil, surface water and/or groundwater with pollutants that are noxious to human health and ecological systems. The US GAO (1995) estimates a nationwide total of 130,000 to 450,000 contaminated commercial and industrial sites.

It is widely felt that site contamination, or even *suspicion* of contamination, seriously hampers reuse. Many observers argue that the mere placement of a property on federal or state registries of sites needing investigation about possible contamination turns them into brownfields. Removal from such registries (the so-called "de-listing") would automatically remove any contamination "stigma" (Bartsch et al., 1996).

Starting in the 1990s, the States, realizing that their enforcement-based programs did not have sufficient funding to address the large number of contaminated sites needing attention, began developing an alternative approach based on voluntary cleanup programs (US GAO, 1997). It has recently been suggested that less financial support from the EPA and slow progression at Superfund sites, among other factors, increase the likelihood of state adoption of a VCP (Daley, 2007). By 2000, over 90% of the states had a VCP in place (Meyer, 2000).

Program offerings and requirements vary widely across states (Meyer, 2000; US EPA, 2005). Many state-level voluntary cleanup programs grant liability relief in exchange for voluntary cleanup, provided that the latter 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.[3]

Voluntary cleanup programs often spell out simplified or variable cleanup standards linked to land use, and hence to residents and workers' likely exposure to contaminants. Some states allow for engineering controls, such as caps, fences, or other physical means of preventing contact with pollution, and/or offer institutional controls, such as permanent land use restrictions or monitoring of the contamination plume, in lieu of a more permanent cleanup. The US GAO (1997) surveyed 17 states with VCPs and found that in many of them over 50% of the cleanups entailed non-permanent remedies and/or selected industrial land use standards.

In addition, the State frequently offers fast-track oversight of cleanup plans. This helps reduce the time it takes before remediation is undertaken, as well as 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 "brownfields" programs that offer subsidies in the form of tax credits or low-cost loans. State VCP managers believe that the programs have resulted in the reporting of contaminated sites that were previously unknown to the state agency, and have truly encouraged cleanups, as long as the program requirements are not too burdensome to the applicants.[4]

[3] A covenant not to sue is generally regarded as the strongest form of assurance, since 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.

[4] For example, the 1997 US 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.

B. The Maryland VCP

The Maryland VCP was established in 1997. Any property that is or perceived to be contaminated by controlled hazardous substances or oil (since October 2004) is eligible for participation, including sites on federal or state registries. Sites on the National Priorities List, sites under active enforcement by the Maryland Department of the Environment (MDE), currently operating RCRA sites, and sites contaminated after October 1, 1997 (if the applicant is a 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 agency. The applicant may request a "No Further Requirements Determination," which, if granted, implies no need to perform remedial work, or, upon approval of the response plan and of remediation, a "Certification of Completion." Both include certain liability assurances and are recorded in the Land Records.

The liability relief offered is not absolute: so-called reopeners are possible if new contamination occurs at the property, if cleanup exacerbates—rather than ameliorates—the existing contamination, if undiscovered contamination is found, or if there is an imminent and substantial threat to human health. However, at the time of this writing, MDE notes that only two reopeners have been issued since the inception of the program.[5] A Certificate of

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[5] http://www.mde.state.md.us/Programs/LandPrograms/ERRP_Brownfields/vcp_info/vcp_eligibility.asp, accessed 8 May 2008.

Completion (CoC) does not provide protection against third party suits, but does provide contribution protection against a third party suit.[6]

3. Previous Literature

We are aware of only a handful of previous studies that have examined the economic incentives at play in VCPs. Alberini (2007) focuses on the Colorado VCP, and concludes that this program has not addressed sites on federal registries, has implied actual cleanups at only one-third of the participating sites, and seems to attract properties that are very likely to be redeveloped soon. She also finds that property values tend to be lower in truly contaminated properties, but rebound almost completely after participation. Using data from the State of Ohio for 1989-1992, Sementelli and Simons (1997) find 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 non-tank commercial properties.

Page and Berger (2006) examine properties that entered into the VCPs of Texas and New York, emphasizing that these are only a subset of the entire universe of brownfields in those states. They wish to empirically test four common beliefs about brownfields, namely that they are (i) the results of past industrial land use, (ii) in abundant supply in older industrial regions, (iii) primarily an urban problem, and (iv) 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 in terms of industrial development and recent population and employment trends.

[6] In other words, another responsible party who has been sued by parties other than the State or Federal Agency cannot demand reimbursement from the recipient of a Certificate of Completion.

Page and Berger distinguish between previous industrial or commercial use, and use at the time of entry into the program, finding that Texas actually has higher percentages of sites with prior and current industrial uses than New York, and that a higher share of the New York brownfields are abandoned at the time they entered the program (21% v. 8%, respectively). The majority of the Texas sites are in urban areas and in central cities (87% and 64% of the total, respectively, against 49% and 30% for New York). They conclude that industrial uses do account for the majority—but not an overwhelming majority (53%)—of the properties enrolled in the New York and Texas VCPs, and that suburban properties are surprisingly more common in the New York program.

Page and Berger also raise the issue of distribution of size of brownfield properties. They report that half of the properties enrolled in the New York VCP were one acre or less, while over three-quarters of the properties in the Texas VCP were at least one acre or larger.

Since VCPs often have explicit land revitalization goals, our 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 US (Wernstedt et al., 2006) suggest that developers can be attracted to contaminated sites by offering them subsidies, liability relief, and less stringent regulation.[7] The appeal of these incentives varies with the developer's prior experience with contaminated properties.

[7] Economic inducements have been advocated as potentially effective for stimulating cleanup and redevelopment of brownfields (Bartsch et al., 1996; DeSousa, 2004; Howland, 2000, 2004; Yount and Meyer, 1999). The effectiveness of economic development incentives remains a controversial matter even with non-contaminated properties. For example, recent 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 quasi-experimental approaches with control and treatment groups (Bartik, 2004; Greenstone and Moretti, 2003). It

De Sousa (2000) interviews 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. Landowners and developers share similar views, especially on liability attenuation, suggesting that VCPs that offer protection from liability are likely to attract primarily these parties.

Meyer and Lyons (2000) suggest 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) finds that contamination *risk*—i.e., the probability that a previously used site is contaminated, based on the previous use—does affect urban industrial redevelopment in Chicago both directly, and indirectly, via the differential in price before and after redevelopment.

Deason et al. (2001), De Sousa (2000) and Sigman (2005) have studied the potential for substitution between infill redevelopment and development of pristine or agricultural lands—the so-called greenfields. Based on zoning and land use ordinances for several cities, Deason et al. estimate that an industrial, commercial, and residential development project requires an average of 6, over two, and over 5 times more land, respectively, in greenfield areas than they do at urban brownfield properties. These differences are driven by local requirements in terms of 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

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remains difficult, however, to ascertain whether incentives were effective or business locations and/or area redevelopment would have taken place even in their absence (Peters and Fisher, 2004).

profitable at brownfields than in suburban areas (due to demand and prices of downtown residential properties).

We conclude our literature review by noting that not everyone agrees that actual or suspected contamination is a deterrent to redevelopment. Based on interviews with real estate agents, Howland (2004) suggests that incompatible land uses, inadequate infrastructure and obsolete buildings are more important barriers than contamination to the revitalization of brownfields in Baltimore. Schoenbaum (2002) finds no significant difference in assessed land values, vacancy rates, property turnover, and redevelopment rates across brownfield and non-brownfield properties in an industrial area of Baltimore over 1963-1999.

4. Model, Sample and Data Sources

A. The Model.

Consider a set of "candidate" parcels. We assume that a parcel is enrolled in the VCP if the net benefits of participation are positive,[8] 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:

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

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.

[8] 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 are the profits from the project, net of land acquisition costs, transformation costs, remediation costs, VCP fee, etc. The avoided liability and litigation costs would presumably be captured into the appreciation and proceeds from the project, respectively.

We cannot observe the net benefits of participation, but because we assume that properties are signed up (i.e., *VCP*=1) when the net benefits of participation are positive, we 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. Because a site can only participate in the program once, we specify the log likelihood function as:

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

where i denotes the site, t denotes the year of the program, and $\Im_t$ is the set "at risk" at time t (i.e., the set of candidate sites that have not participated yet in year t).[9] 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, p. 796-806).[10]

B. The Sample

Our goal is to estimate a probit equation that predicts the probability of participation in the VCP as a function of site and neighborhood characteristics. Estimating this probit equation requires a sample of both participating sites and eligible but non-participating sites.

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

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

[10] The random effects probit assumes that the unobserved heterogeneity is 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.

In this paper, attention is restricted to VCP sites in Baltimore City since the onset of the program up to 20 December 2006. By participation, we mean a direct application for either a No Further Requirements Determination (NFRD) or an actual cleanup proposal, so we lump together applications for a NFRD and a Certificate of Completion (CoC). In some cases there are multiple applicants for the same site; in a few cases a single site is comprised of multiple parcels. When multiple parties apply for the same property, we define participation to occur at the time of the earliest submittal for that property.

Using these criteria, we obtain a total of 116 participating sites in Baltimore City as of December 20, 2006. Of these 116 sites, 37 (32%) were signed up with the goal of obtaining a CoC, which requires submitting and executing a remedial plan, 77 (66%) applied directly for a NFRD, and no information is available for the two remaining sites.

We now have the full list of participating properties, but how exactly does one go about defining the eligible but non-participating 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 slated for industrial or commercial use in Baltimore is a credible candidate for inclusion in the sample (see Sigman, 2005, and Page and Berger, 2006).

The first step in constructing our sample is thus 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 "controls" for the participating properties, we form 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). This variable is included in our probit regressions, along with a companion missing-value dummy when the records from the Maryland Department of Taxation do not contain specific land use information.

In sum, by drawing a random sample of nonparticipating properties of roughly the same size as that of the participating properties, and controlling for an obvious determinant of their interest in the VCP, we are effectively constructing a “control” group (see Shadish, Cook and Campbell, 2002) that can be compared with VCP participants.

For each of the 10 years of our study period (1997-2006), the sample we use for the probit model is comprised of the participating parcels that have not signed up yet, plus all of the 131 abovementioned non-participating sites. This results in a total of 247 properties and 2097 observations.

C. Other Independent Variables

We proxy the net profits of participation with parcel and neighborhood characteristics. These 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 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 (e.g., 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 our probit regressions.

A parcel's value should also be influenced by its distance to the central business district (CBDDIST) and to major roads (MJRRDDIST),[11] whether it is for industrial use (MINDUSTRIAL), surrounding land use, and distance to the nearest residential zone (RESZNEDIST). We include the latter variable because Howland (2003, 2004) discusses 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 use 1996 land use data from the Maryland Department of Planning to form 500- and 1500-meter buffers around each property and compute 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 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. It should be noted that 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.

It is of interest to check whether VCP sites tend to be clustered, reflecting either some effect on surrounding properties (i.e., participating sites induce further participation) or simply the spatial concentration of the existing supply of contaminated sites. We control for this tendency with the number of sites previously enrolled in the VCP within a 1500 meter

[11] Data from the Maryland State Highway Administration.

buffer of each property (LNEARVCPS). Our last set of independent variables is comprised of median house values (MDVALHS) and socioeconomic characteristics of the residents in the neighborhood measured at the 2000 Census tract level.

5. The Data

A. Description of Properties

For 92 of the 116 sites participating in the VCP, we were able to identify the corresponding parcel(s) in the Maryland Department of Taxation database, and to append information about the parcel, its exact location (latitude and longitude), structures, assessed value, and recent sales (if any). The 116 participating sites are actually comprised of 172 properties, since in 21 cases one VCP application consists of multiple adjacent parcels.[12] The same type of parcel information is also available for the 131 "control" properties.

Descriptive statistics of the sample are displayed in table 1. The average parcel in our sample covers about 5 acres, and is located a little over 2 miles from the CBD. Almost all parcels (79%) have a building or other improvement, which account on average for 77% of the total property area (variable CAPITAL). Due to the criteria we used for constructing our sample, industrial properties account for over 40% of all parcels.

Table 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 our sample are located in a state Enterprise Zone and 23% are in a federal Empowerment Zone. On average industrial uses account for about 25% of the 500-meter buffer and almost

[12] Specifically, out of the 116 VCP sites, 95 consist of a single parcel, 12 of two parcels, 3 of three parcels, and 1 each of four, five, six, seven, eight and fourteen properties.

20% of the 1500-meter buffer around the properties. The median housing value in the surrounding census tract is on average about $73,000.

B. Comparison across VCP and Non-participating 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 Enterprise Zones and federal Empowerment Zones, are offered to firms (see map A.1 in Appendix A). Although they tend to be roughly at the same distance from the city center, participating sites tend to be farther from major roads than non-participating eligible properties (see map 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 map A.3 in Appendix A). This confirms that our probit model should control for the industrial v. another use of the parcel, for the prevalent uses in the neighborhood, and for distance to the nearest residential area, as mentioned in section 4.

We compare the means of all variables across participating and non-participating sites in our sample in table 2. This table shows that participating properties tend to be considerably larger than non-participating eligible properties, and somewhat less likely to contain buildings or other improvements.[13]

Participating properties tend to be less capital-intensive. Buildings at participating sites are likely slated for demolition during redevelopment, thus a less capital intensive site

[13] We note that 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 one parcel, 13.52 for the sites comprised of two parcels, 4.49 for the sites comprised of 3 parcels, 1.5 for one site comprised of 4 parcels, 1.21 for the one site comprised of 5 parcels, 54.34 for the one site with 6 parcels, 1.98 for the one site with 7 parcels, 6 acres for the one site with 8 parcels, and finally 1.44 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.

may be more attractive due to 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 in terms of 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 in the vicinity of participating properties than near non-participating properties. The proportion of residents living in poverty tends to be lower surrounding participating properties. In terms of race and ethnicity of the neighborhood, participating properties tend to be located in neighborhoods with less African-Americans, but there is no systematic difference regarding the proportion of persons of Hispanic heritage.

Table 1. Descriptive statistics. Full sample (N=247).

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	3764.99	2321.17
BUILDING	building or other improvement present (dummy)	247	0.794	0.406
YRBUILT	year the oldest building was built	52	1943.31	30.944
CAPITAL	capital intensity	247	0.768	1.228
MJRDDIST	distance to nearest major road in meters	246	466.375	481.852
PROBCON	a priori 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 1500m buffer (all years)	247	2.530	4.413
MINDUSTRIAL	zoned industrial (dummy)	247	0.417	0.494
PCTIND	percent of land slated for industrial within 1500m buffer	246	0.196	0.212
PCTIND500M	percent of land slated for industrial within 500m 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	73267	36745
PCTPOVERTY	percent of census tract population living below poverty line	246	0.237	0.125
PCTOWNERS	percent residents in census tract who own home	246	0.481	0.228
PCTBLACKS	percent blacks in census tract	246	0.364	0.335
PCTHISPANICS	percent Hispanics in census tract	246	0.024	0.027
PCTCOLLEGE	percent persons with college degree in census tract	246	0.175	0.150

Table 2. Comparison of means of variables for participating (VCP=1) and non-participating (VCP=0) parcels. T test of the null hypothesis that the difference in the means is zero.

Variable	VCP=0			VCP=1			t statistic
	N valid obs	Mean	Std deviation	N valid obs	Mean	Std deviation	
SIZE	131	1.188	5.940	116	10.134	15.046	-6.003**
CBDDIST	131	3834.800	2579.010	115	3685.470	1995.580	0.511
BUILDING	131	0.901	0.300	116	0.672	0.471	4.476**
YRBUILT	5	1917.000	26.833	47	1946.110	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
MINDUSTRIAL	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	75297.690	45078.930	115	70972.170	24094.090	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

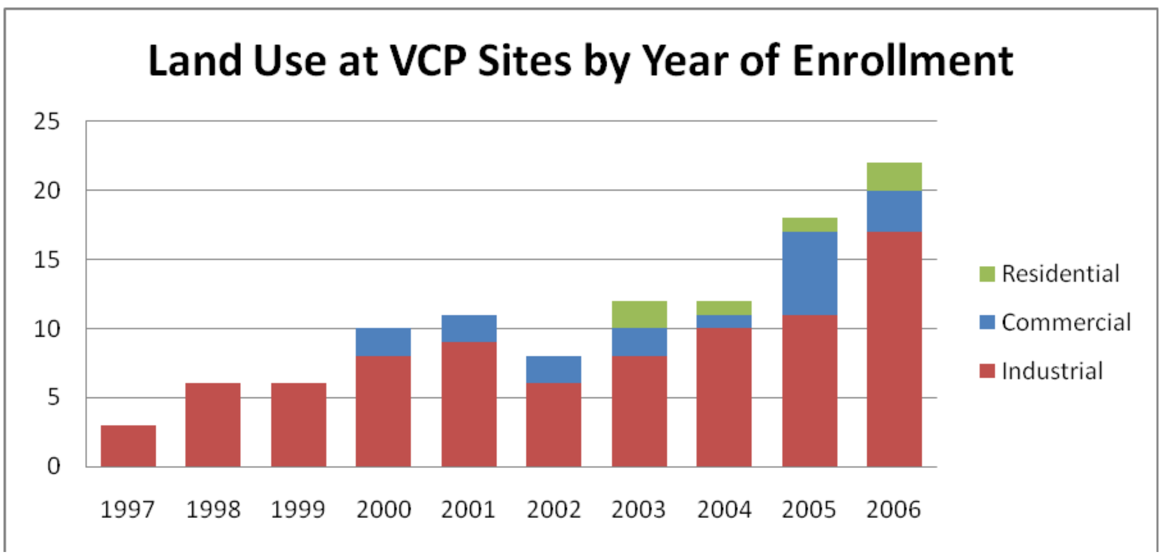
^ = significant at the 10% level; * = significant at the 5% level; ** = significant at the 1% level.

C. Features of Participating Sites

Among the VCP properties, we found no obvious differences between those that applied for a NFRD and those for which a cleanup plan was submitted, other than in the prior probability of contamination, which is larger for the latter group. Among participating properties, those slated for industrial use tend to be larger than commercial properties.

Figure 1 displays the distribution of land use at Baltimore City participating sites by the year of enrollment, showing that (i) participation has picked up steam since the inception of the program, with the largest enrollment (22) in 2006, and (ii) industrial properties make up the majority of the enlisted sites. Commercial properties started being signed up for the program starting in 2000, but still account for a small fraction of all sites. Residential properties are even less common.

Figure 1.



Perusal of figure 1 suggests that, all else the same, participation rates and hence the likelihood of participation have changed over time. This may have occurred because of changes in the eligibility criteria, changes in the economic climate of the city, and changes in the real estate market. For this reason, we group the ten years from the inception of the program to 2006 into three discrete periods (1997-1999, 2000-2003, and 2004-2006), and interact key regressors with dummies for these periods.

The late 1990s period captures the early years of the program. In 1999 there was a change in Baltimore City's government when Mayor Martin O'Malley took over for 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, etc. In 2004, the VCP program was changed, in that it began to admit oil pollution sites. These are likely to differ in size and/or use relative to sites contaminated by other hazardous wastes. For example, gas stations are comparatively small and are considered a commercial use. A change in political climate also occurred after 2003, when Robert Ehrlich, a Republican, took over as Governor of Maryland for Democrat Parris Glendening. It is possible that this shift in State Government may have changed priorities for state agencies.

Based on these considerations, we enter in the model the variable SIZE—a likely determinant of participation—plus SIZE2, the interaction term between SIZE and the dummy denoting the second period of the study (2000-2003), and SIZE3, the interaction term between SIZE and the third period of the study (2004-2006). This inclusion allows for the effect of property size on the probability of participation to vary over time.

6. Estimation Results

Table 3 reports the results for the random effects probit model of participation.[14] We present four specifications. Specification (A) is our base specification, which includes size of the property and interactions between size and time period, in addition to the regressors listed in Section 4.C. Specification (B) adds an interaction between the industrial-use dummy and the last time period of the study (MINDUSTRIAL3). Specifications (C) and (D) include census tract characteristics (as of 2000) to capture socioeconomic differences in neighborhood character.

Table 2 had suggested that the VCP tends to attract larger sites. This would appear to be a recent phenomenon because the results of all the probit specifications in table 3 suggest that in the early years the program actually attracted *smaller* properties, but that trend was subsequently reversed. These are the implications of the signs and significance levels of the coefficient on SIZE, SIZE2, and SIZE3. 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.

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

Table 3. Random Effects probit regression results. Dependent variable: participation in year t of the program.

	(A)		(B)		(C)		(D)	
Variable	coefficient	tstat	coefficient	tstat	coefficient	tstat	coefficient	tstat
INTERCEPT	-1.678010	-4.94**	-1.449801	-4.21**	-1.164552	-2.53*	-1.667947	-3.85**
SIZE	-0.018765	-2.01*	-0.013602	-1.54	-0.013987	-1.58	-0.013935	-1.57
SIZE2 = size*(2000-03 dummy)	0.013557	1.40	0.013386	1.46	0.013249	1.44	0.013344	1.44
SIZE3 = size*(2004-06 dummy)	0.036325	3.62**	0.021049	2.02*	0.021564	2.06*	0.022257	2.11*
CBDDIST	0.000001	0.03	-0.000024	-0.65	-0.000035	-0.89	-0.000026	-0.63
BUILDING	-0.226463	-1.37	-0.260919	-1.57	-0.258604	-1.54	-0.268075	-1.60
BUILDINGYRBUILT	-0.000078	-0.68	-0.000092	-0.79	-0.000106	-0.91	-0.000103	-0.88
YRBUILTMISSING	-0.640592	-3.21**	-0.719794	-3.58**	-0.757513	-3.66**	-0.760784	-3.65**
CAPITAL	-0.187718	-2.66**	-0.196322	-2.73**	-0.201543	-2.77**	-0.197466	-2.72**
MJRDDIST	-0.000180	-1.41	-0.000183	-1.42	-0.000143	-1.05	-0.000151	-1.08
PROBCON	0.475813	1.79^	0.475370	1.77^	0.464092	1.72^	0.445313	1.64
PROBCONMISSING	0.137286	0.70	0.119255	0.61	0.125401	0.64	0.111832	0.57
ENTZNE	-0.014003	-0.08	-0.017537	-0.11	-0.064305	-0.36	-0.012449	-0.07
EMPZNE	0.068361	0.42	0.142767	0.88	0.113200	0.64	0.135206	0.82
LNEARVCPS	0.058682	5.08**	0.042576	3.42**	0.044719	3.49**	0.043546	3.42**
MINDUSTRIAL	0.454171	3.27**	0.238738	1.58	0.220864	1.44	0.231807	1.52
PCTIND	0.557989	1.41	0.589488	1.47	0.588896	1.46	0.332140	0.66
RESZNEDIST	0.000684	2.41*	0.000688	2.41*	0.000682	2.41*	0.000730	2.37*
MINDUSTRIAL3			0.734217	3.79**	0.716439	3.67**	0.711673	3.65**
MDVALHS					-0.000003	-0.82		
PCTCOLLEGE					0.104482	0.16		
PCTPOVERTY							0.976555	1.08
PCTOWNERS							0.331421	0.62
PCTBLACKS							-0.241601	-0.75
Log Likelihood	-351.31053		-344.22415		-343.50624		-343.62496	

^ = significant at the 10% level; * = significant at the 5% level; ** = significant at the 1% level.

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 city center 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 city center 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 must necessarily be cleaned up, and indeed about two-thirds of the VCP applications, as discussed in section 4.C, request a 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 also addressed by state and federal economic development programs.

At any rate, participation *is* more likely among sites that are slated for industrial use, and grows with distance from residential areas and—but only weakly—with the percentage of the surrounding land designated as industrial.[15] The number of nearby properties previously enrolled in the VCP is positively associated with the probability of participation. It is possible that successful participation encourages enrollment of other

[15] The probit regressions reported in table 3 all use the 1500-meter buffer when computing the percentage of surrounding land dedicated to industrial uses, but we obtain the same result when we use smaller buffer sizes (e.g. 500 meters) to capture closer neighbors of each property in the sample.

nearby sites. Alternatively, this may also be due to the spatial clustering of brownfields, or to other unobserved amenities.

Specification (B) confirms the results of specification (A), and also suggests that the prevalence of industrial properties among those enlisted in the VCP has strengthened in recent years, as shown by the positive and significant coefficient of MINDUSTRIAL3. Specification (C) adds median housing values and education level of the residents in the census tract around each property, but neither variable has an independent effect on the likelihood of participation. We had intended these variables to proxy for up-and-coming neighborhoods, but their effect (if any) is probably already captured in other site and neighborhood characteristics. Specification (D) includes other characteristics of the residents, namely the percentages of persons who live in poverty, own their homes, and are African American. In both (C) and (D), 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 (B), we compute the annual probability of participation for a hypothetical industrial-use parcel of average size, distance to the CBD and capital intensity, and in an Enterprise Zone. We assume that this site has the average prior probability of contamination, that it is surrounded by the average extent of industrial land and is at the average distance from residential areas. For a parcel with these characteristics during the first period of the program (1997-99), the probability of participation in any given year is 6.52%. Increasing the size of this average parcel by a standard deviation (i.e., by 12.02 acres above the original 5.43 acres) slightly *decreases* the probability of enrollment from 6.52% to 4.69%.

The story changes in more recent years: A parcel that is average in all respects and is zoned for industrial use would now have a much greater annual probability of participation (25.33%), which increases to 28.27% if the parcel's size is increased by a standard deviation above the average. If this parcel during the most recent years of the program was located an additional quarter mile away from the nearest residential zone (a two standard-deviation increase), then the probability of participation would increase from 25.33% to 34.91%.

7. Discussion

Now that we have established what characteristics influence whether a site is enrolled in the VCP and the magnitude of such influences, it is important to discuss what happens after enrollment. Specifically, are parcels participating in the Maryland VCP 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 a NFRD letter or a CoC within our study period, residential use was explicitly prohibited at 44 of them (75.80%). At 12 of them (20.69%), only limited residential development was allowed.

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

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

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

Deason et al. (2001) consider 8 brownfield properties in Baltimore City and assume redevelopment as office buildings, commercial facilities, or homes (see table C.1 in Appendix C). They calculate the land area that would be necessary if such redevelopment projects took place in surrounding suburban areas (Baltimore County, Kent County, and Frederick County). They consistently find that, based on local zoning, such redevelopment projects would require larger land areas in these latter three counties than in Baltimore City.

Assuming that all of the participating 1,175 acres are redeveloped and remain in their use at the time of enrollment, we use the land area "ratios" derived by Deason et al. to estimate the amount of open space that the VCP may have deterred from being developed (see table B.2 in Appendix B). We consider greenfields in Baltimore County as likely substitutes for infill development because this rural/suburban area surrounds Baltimore City and is part of the overall Metropolitan area. If the urban redevelopment projects on VCP properties were instead built on greenfields, 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 under more conservative assumptions.

This suggests that if greenfields and brownfields are truly substitutable then the VCP is potentially an effective tool to deter open space conversion.

8. Conclusions

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

The vast majority of the applications (66%) request a "No Further Requirements Determination" on the part of the agency, suggesting that much participation in the program is simply 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).

We compare the VCP properties with a sample of similar size 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 show that the distances to the city center 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, and the prevalence of industrial sites among the participants has become even stronger.

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 conclusion is in sharp contrast with the findings in Alberini (2007), who concludes that properties who signed up with the Colorado VCP were most likely under residential development pressure. Given the limited body of research about VCPs and their context-specific findings, it will be necessary to conduct more research at a variety of locations before one can attempt to extrapolate from one locale to another.

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 et al. (2001), we estimate that if the urban redevelopment projects on VCP properties were instead built on greenfields, they would require between 1,238 and 6,444 acres in suburban Baltimore County. Since the majority of participating sites tend to remain in non-residential uses it appears that VCP programs, at least in the case of Baltimore, encourage potentially contaminating activities to take place on already contaminated brownfields, thus leaving pristine land available as open space or for less environmentally damaging uses.

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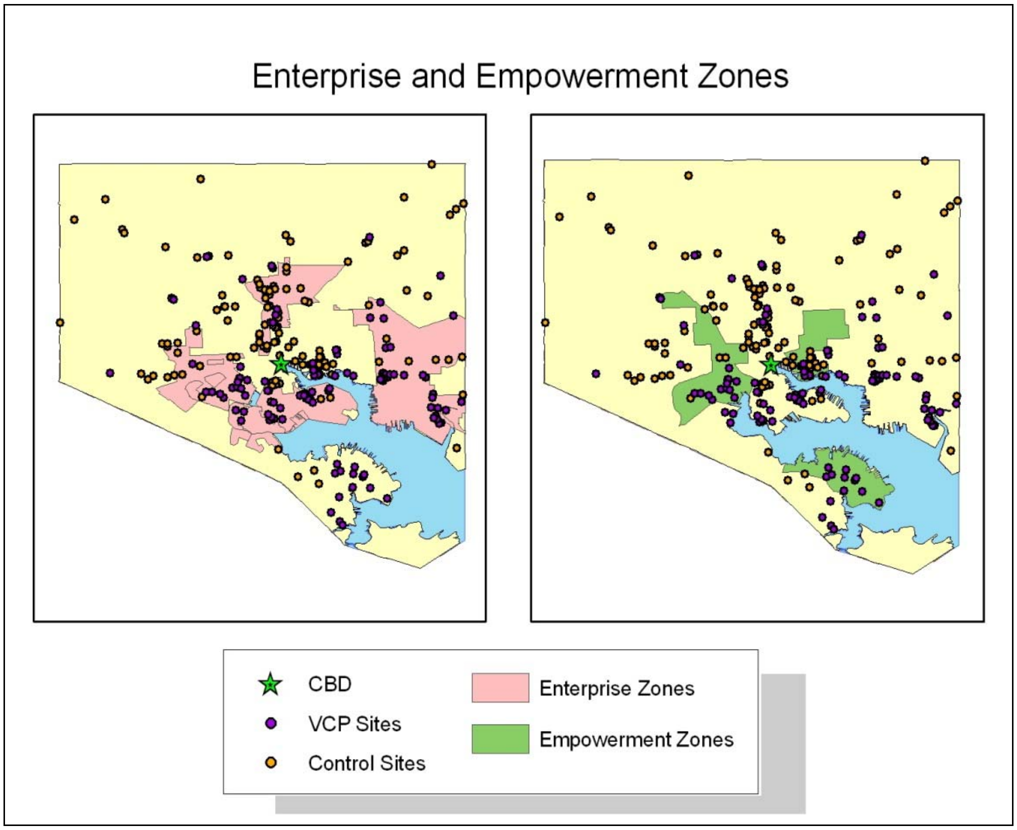
Appendix A. Maps of sample sites in Baltimore City.

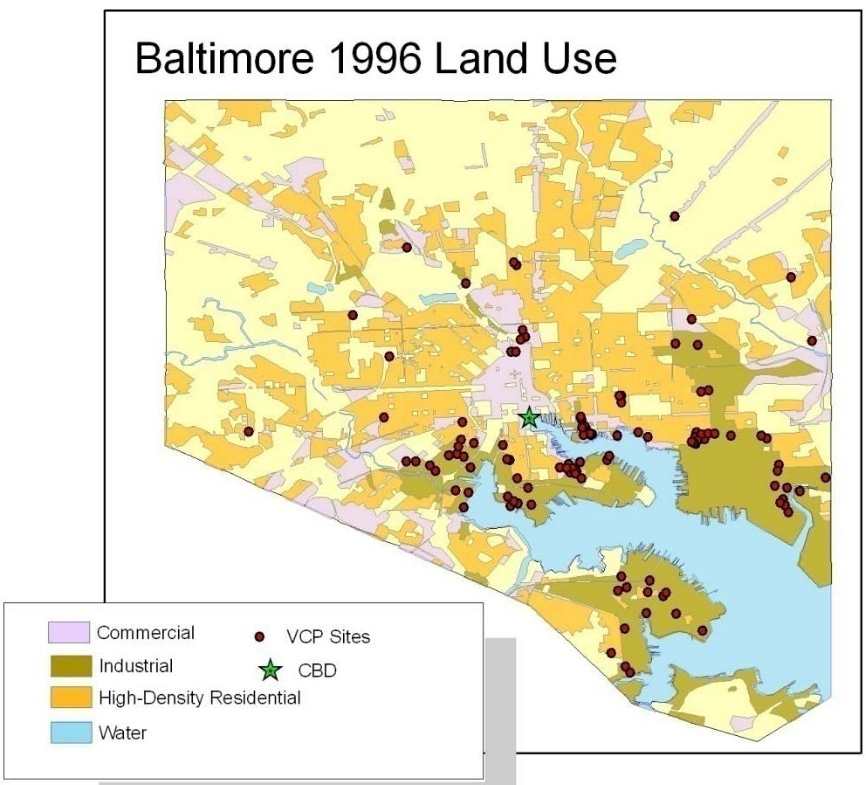
Map A.1.



Map A.2.


Baltimore Major Roads
CBD
VCP Sites
Control Sites
Major Roads

Map A.3.


Baltimore 1996 Land Use
Commercial
Industrial
High-Density Residential
Water
VCP Sites
CBD

Appendix B. Calculation of land area conversion ratios.

Table B.1. Property specific conversion ratios.

Deason et al. calculations for Baltimore City Brownfield Properties				
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 multi-family 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 et al. (2001).

Table B.2. Development conversion rates assumed in this paper (see Section 7).

land use	**N**	**total acres**	**"ratio"**	**total required for equivalent projects in suburban areas**
A. Generous assumptions*				
industrial	83	975.02	6.24	6084.12
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	6444.05
B. 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	1238.39

Note:

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

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

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