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Interstate Comparison of Soil Remediation Standards among Six Mid-Atlantic States, USA

Robert P. Blauvelt, Mathew Sweet

GEI Consultants, Montclair, New Jersey, USA
Email: rblauvelt@geiconsultants.com

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Abstract

To address and help mitigate potential public health and ecological impacts associated with contaminated soil, most state environmental agencies have promulgated cleanup standards or action level criteria that are based broadly on US Environmental Protection Agency risk assessment methodologies. These standards or criteria often are assembled into easy-to-use look-up tables that allow responsible parties (RPs) to determine quickly the extent of remediation that could be required simply by comparing site investigation data to the listed cleanup goal or standard. This paper compares and contrasts soil remediation standards and criteria for 20 common soil pollutants taken from state environmental agency look-up tables for five Middle Atlantic States: New York, Connecticut, New Jersey, Delaware, Pennsylvania, and Maryland. We examine the differences between numeric remedial goals for these pollutants and propose a relative rank for each state based on the overall degree of soil cleanup standard or criterion stringency. In order to identify and rank the stringency of the residential cleanup goals or standards published by the six Mid-Atlantic States, a three-step process was used that included compiling in one data set, the numerical (mg/kg), residential or unrestricted use look-up values published by state for each of the 20 contaminants; organizing and grouping those values in numerical sequence into one of three categories ranging from lowest (Most Restrictive) to highest (Least Restrictive); and then ranking each state by the number of first place finishes in each stringency category: Most Restrictive, Moderately Restrictive, and Least Restrictive. The socioeconomic consequences of these ranks were examined relative to their effects on gross state product, unemployment, and health.

Keywords

Regulatory Standards, Soil Remediation, Look-Up Tables, Ranking, Socioeconomic Consequences

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1. Introduction

The remediation of soil polluted with the residues of industrial and commercial processes is part of a $60 billion waste management industry that employs over 300,000 people [1]. To address and help mitigate potential public health and ecological impacts associated with contaminated soil, most state environmental agencies have promulgated cleanup standards or action level criteria that are based broadly on US Environmental Protection Agency risk assessment methodologies. These standards or criteria often are assembled into easy-to-use look-up tables that allow responsible parties (RPs) to determine quickly the extent of remediation that could be required simply by comparing site investigation data to the listed cleanup goal or standard. While many states also offer RPs the opportunity to calculate cleanup values based on site specific data such as a soil's organic content or the depth to ground water, it is the look-up tables that most RPs and environmental professionals use as their initial remedial action screening tool.

This paper compares and contrasts soil remediation standards and criteria for 20 common soil pollutants taken from state environmental agency look-up tables for six Middle Atlantic States: New York, Connecticut, New Jersey, Delaware, Pennsylvania, and Maryland. We examine the differences between numeric remedial goals for these pollutants and propose a relative rank for each state based on the overall degree of soil cleanup standard or criterion stringency. Finally, the implications of a high or low ranking are assessed in terms of each state's socioeconomic standing.

2. Why the Mid-Atlantic States?

The Middle Atlantic States (Connecticut, New York, Pennsylvania, New Jersey, Delaware, and Maryland) have a long and robust history of industrial and commercial development. It is within this region that the United States first began to extract and utilize its natural (geologic) resources and where the entrepreneurial spirit of the nation initially sought to express itself. For more than two centuries these same states continued to embrace and support an unparalleled expansion of manufacturing and commercial activities. However, such an important place in the American economy came with a hefty price—an enduring legacy of environmental problems that include soil and ground water contaminated with industrial pollutants. The six selected states host almost 30 percent of the Superfund sites listed by US Environmental Protection Agency (EPA). In response, each state's environmental protection agency have developed vigorous and flexible regulatory programs focused on the cleanup of these and other types of contaminated properties.

The Mid-Atlantic States also offer some of the most diverse geographic and socioeconomic settings in the United States. They encompass two EPA regions and are home to highly variable geologic and hydrogeologic regimes ranging from Holocene coastal plains to Mesozoic sedimentary basins to Paleozoic metamorphic rocks. Three have been ranked by Gallop [2] as politically liberal (Delaware, New York, and Connecticut), two as moderate (New Jersey and Maryland) and one as conservative (Pennsylvania). One has a population of under one million (Delaware), three have populations between three and nine million (Connecticut, Maryland, and New Jersey), and two have populations greater than 12 million (Pennsylvania and New York).

This type of diversity provides important context in understanding the drivers behind methodologies used to develop and enforce soil remediation standards or criteria. Like all other public policies, soil cleanup goals are not promulgated in a governmental vacuum. A state environmental agency is subject to the same political and economic pressures and concerns as those operating in public housing, health care, and education. Research has long indicated that state environmental programs are reflective and directly influenced by, among other factors, a state's income and educational level, strength and effectiveness of indigenous non-governmental organizations, and the perceived level of danger/risk posed by local environmental quality [3]-[5].

3. Parameter Selection

Table 1 lists those parameters selected for interstate standards comparison. The 20 constituents were chosen so as to be inclusive of most commonly encountered contaminants such as petroleum (BTEX and naphthalene) and chlorinated (PCE and TCE) hydrocarbons. Polycyclic aromatic hydrocarbons (PAHs) that are possible or probable human carcinogens are on the list because of their ubiquitous environmental nature and due to the fact that they serve as major drivers in the remediation of former manufactured gas plant sites. PCBs earned their place because of its commonality as an industrial pollutant as well as long-standing concerns about ecological bioaccumulation and biomagnification.

Table 1. List of common soil pollutants.

Petroleum Hydrocarbons	Chlorinated Hydrocarbons
Benzene	Tetrachloroethene (PCE)
Toluene	Trichloroethene (TCE)
Ethylbenzene	
Xylenes (Total)	**Metals**
Naphthalene	Arsenic
	Barium
Polycyclic Aromatic Hydrocarbons	Cadmium
Benzo(a)anthracene	Lead
Benzo(a)pyrene	Mercury
Benzo(b)fluoranthene	Nickel
Benzo(k)fluoranthene	Zinc
Chrysene	**Polychlorinated Biphenyls (PCBs)**

The list of comparison parameters is rounded out by seven metals (As, Ba, Cd, Hg, Ni, Pb, and Zn) many of which are found in soil at a wide variety of industrial and commercial sites. Most of these metals also occur naturally, bound up in the lattices of common rock and soil forming minerals, and their presence, absent an anthropogenic source, often cause responsible parties great expense and consternation while background levels are being established. We elected not to include chromium because of the difficulty in making comparisons between speciated and non-speciated standards.

4. Remedial Standards or Criteria Development

Table 2 summarizes the approach used by each state environmental agency evaluated in this study to develop published soil remedial action standards or goals. State methodologies for look-up table values rely heavily (and appropriately) on USEPA risk assessment protocols and default inhalation, ingestion and dermal contact exposure values. There was a wider spread in methodologies by the Mid-Atlantic State environmental agencies in developing soil to ground water (contaminant) transfer values.

While there is some variability in the basis for how look up table values were calculated, fundamentally these six Mid-Atlantic States have relied on USEPA default exposure values and related cancer and non-cancer health assessments to estimate acceptable residential and non-residential contaminant levels.

5. Ranking of Residential Standards

Even though the six Mid-Atlantic States basically have used the same methodologies to develop look up table contaminant goals or standards, there are wide variations in the allowable limits for individual parameters. **Table 3** is a list of three common pollutants that show an order of magnitude difference among these states.

In addition to risk based methodological differences, the reasons for these dissimilarities may go to current and historical attitudes regarding industrial and economic development, population densities, political leanings, site-specific catastrophes, and other factors [6]-[9]. On the basis of the compounds listed in **Table 3**, Delaware and Maryland might seem to have more stringent soil remediation standards than Connecticut or Pennsylvania. But is an examination of only three contaminants a reliable indicator of look-up value stringency? A fairer analysis would be to consider a larger universe of contaminants, such as those listed on **Table 1**. However, it would be too unwieldy to list, compare, and then evaluate the differences among 20 individual contaminant goals or standards for these six Mid-Atlantic States in the manner shown on **Table 3**.

In order to more conveniently identify and then rank the stringency of the residential cleanup goals or stan-

Table 2. Basis for soil remediation standards and criteria.

State	Basis for look-up table values	Can site specific standards be calculated?	Residential and non-residential standards available?	Do potential soil impacts to ground water need to be considered?	Do soil standards address potential vapor intrusion?	Other
Connecticut	State-specific calculations. Cancer risk level of 1E−6 or an HQ of 1	Yes	Yes	Yes	Yes	No reference to EPA methods
Delaware	EPA Region III risk based methods. Cancer risk level of 1E−6 or an HQ of 1	Yes	Yes	Yes	No	Look-up table values are guidance, not promulgated regulations
Maryland	EPA Region III risk based methods Cancer risk level of 1E−6 or an HQ of 0.1	Yes	Yes	Yes	No	HQ is set at 0.1 to account for potential additive effects
New Jersey	EPA 1996 and 2002 soil screening guidance for superfund sites	Yes	Yes	Yes	No	Look-up table values are developed based on individual pathway calculations
New York	2006 Technical Support Document to 6 NYCRR Part 375-6 Cancer risk level of 1E−6 or an HQ of 0.1	Yes	Yes	Yes	Yes	Very detailed and extensive description of how standards were developed
Pennsylvania	Subchapter C Statewide Health Standards Section 250.305	Yes	Yes	Yes	Yes	Also includes contaminant limits based of soil saturation capacity

Table 3. Comparison of residential cleanup standards or goals (values shown are in mg/kg).

Contaminant	Connecticut	Delaware	Maryland	New Jersey	New York	Pennsylvania
Trichloroethene	56	0.5	1.6	7	0.47	260
Benzo(a)pyrene	1	0.09	0.022	0.2	1	0.57
Arsenic	10	0.4	0.43	19	13	12

dards published by the six Mid-Atlantic States a three step process was used that included:

- Compiling in one data set the numerical (mg/kg), residential or unrestricted use look-up values published by each state for the 20 contaminants listed on **Table 1**;
- Organizing and grouping those values in numerical sequence into one of three categories ranging from lowest (Most Restrictive) to highest (Least Restrictive); then
- Ranking each state by the number of first place finishes in each stringency category: Most Restrictive, Moderately Restrictive, and Least Restrictive.

For example, New Jersey had four look up values that were among the lowest numerically (Most Restrictive) for residential use: Naphthalene @ 6 mg/kg; PCBs @ 0.2 mg/kg; Benzo(a)anthracene @ 0.6 mg/kg; and Benzo(b)fluoranthene @ 0.6 mg/kg. This resulted in New Jersey being scored a four in the Most Restrictive column on **Table 4**. Alternatively, none of Pennsylvania's look up values are the lowest (Most Restrictive) for residential use within the Mid-Atlantic States. Pennsylvania thus scored a zero in the Most Restrictive column. When carried through each contaminant for the Mid-Atlantic States, the scores shown on **Table 4** were generated.

Viewed graphically, the data summarized on **Table 4** show those Mid-Atlantic States with the least (overall) restrictive soil remediation standards or goals, as per published look-up tables.

6. Discussion

Figure 1 ranks the six Mid-Atlantic States by the degree of stringency in look-up table values for residential property re-use. But what real-world impact, if any, does the degree of residential, look-up table stringency for

Table 4. Summary of residential standards stringency ranking.

State	Least Restrictive	Moderately Restrictive	Most Restrictive
Pennsylvania	18	2	0
Connecticut	10	10	0
New Jersey	8	8	4
New York	2	4	14
Delaware	1	8	11
Maryland	1	8	11

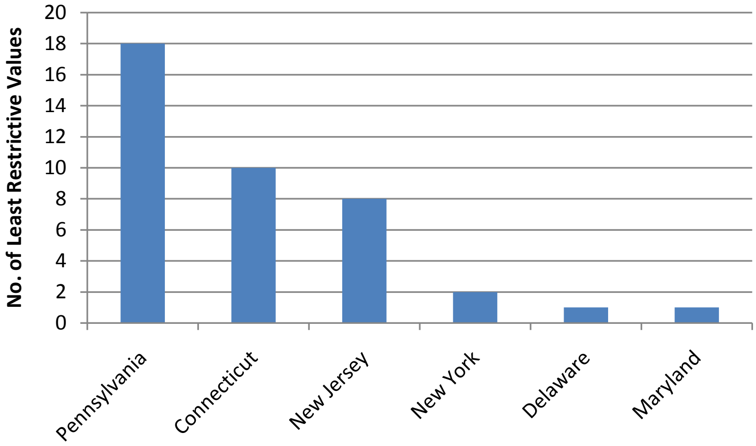

Figure 1. Comparison of least restrictive soil standards among the Mid-Atlantic States.

soil have on a state's economic or development status? We examined this question by comparing the following three data sets compiled between 2000 and 2009 for each state: gross state product related to mining and manufacturing; unemployment rate; and health ranking.

Gross state product (GSP), sometimes called gross regional product (GRP), is a measure of the non-governmental economic output of a state. It is the sum of all goods and services produced by industrial and commercial activity within the state and serves as a counterpart to the more commonly cited US (*i.e.*, nationwide) gross domestic product or GDP. Mining and manufacturing are sectors that are reported separately by each state and were chosen here because they tend to be more pollutant intensive than other types of economic activity [9]. **Figure 2** plots mining and manufacturing GSP for the six Mid-Atlantic States as reported to the US Census Bureau (http://www.census.gov/compendia/statab).

This figure indicates that, in spite of having the most stringent residential soil cleanup standards of the Mid-Atlantic States, the value of Delaware's and Maryland's mining and manufacturing GSP has remained relatively constant. Pennsylvania, the state with the least restrictive residential cleanup standards is struggling with declining outputs from its mining and manufacturing sectors. New York and New Jersey, states with moderately restrictive residential cleanup standards, have not fared much better than Pennsylvania, with clear declines in mining and manufacturing GSP apparent. Connecticut's mining and manufacturing GSP values have risen slightly over the past decade with the Nutmeg State having the second least restrictive set of residential soil cleanup standards.

In economics, a person who is able and willing to work yet is unable to find a paying job is considered unemployed. The unemployment rate is the number of unemployed workers divided by the total civilian labor force, which includes both the unemployed and those with jobs (all those willing and able to work for pay). The unemployment rate often is used as an important metric to gauge the economic vitality of a state and as an indirect measure of the effect of market-restrictive forces (such as environmental regulations) on job creation. **Figure 3**

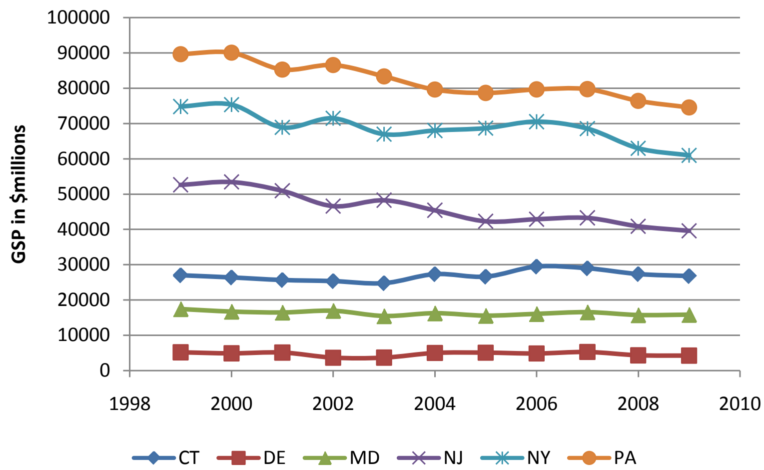

Figure 2. Mid-Atlantic States gross state product between 2000 and 2009. (CT: Connecticut; DE: Delaware; MD: Maryland; NJ: New Jersey; NY: New York; PA: Pennsylvania).

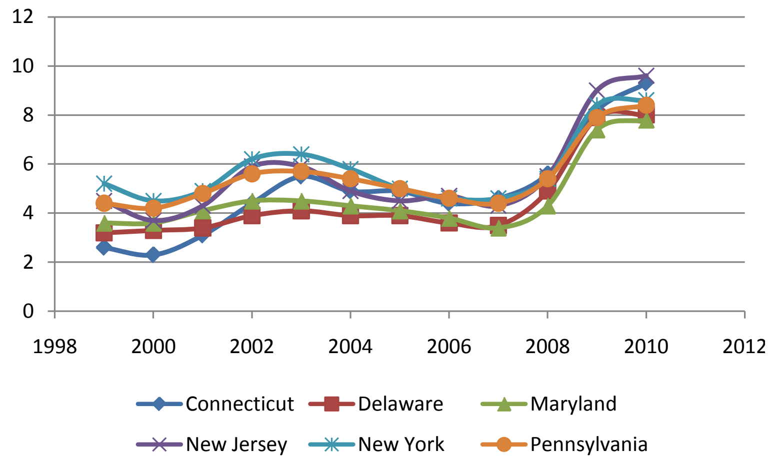

Figure 3. Mid-Atlantic States average annual unemployment rate 2000 through 2009.

plots unemployment rate for the six Mid-Atlantic States as reported to the US Bureau of Labor Statistics (http://www.bls.gov/regions).

From **Figure 3**, it appears that the degree of stringency of residential cleanup standards has had little effect on unemployment rate. There is not much separation between state unemployment rates and it is likely that more significant market forces (e.g., interest rates, consumer demand) drive unemployment rather than the stringency of environmental regulations.

The ultimate objective of establishing environmental regulations and controls is to protect the public health and enhance eco-system viability. For almost the past 25 years the non-profit United Health Foundation has gathered a comprehensive set of health, environmental, socioeconomic, and other quality of life data (http://www.americashealthrankings.org/Rankings). This information is compiled and benchmarked annually to produce a rank, on a state-by-state basis, of the nation's health. The state with the highest overall health score is ranked as No. 1 (Vermont in 2010) and the one with the worst overall health score is ranked last (Mississippi in 2010). **Figure 4** illustrates the health rankings between 1999 and 2010 for the six Mid-Atlantic States. For this chart, a downward trend is reflective of an improving health score, which is a desirable objective.

Over the past ten years, Delaware's health rank has improved by 10 places and New York's by more than 10 places. Pennsylvania, Maryland, New Jersey and Connecticut's health rankings have remained essentially the same over this same time period. There appears to be little influence on public health in the majority of Mid-

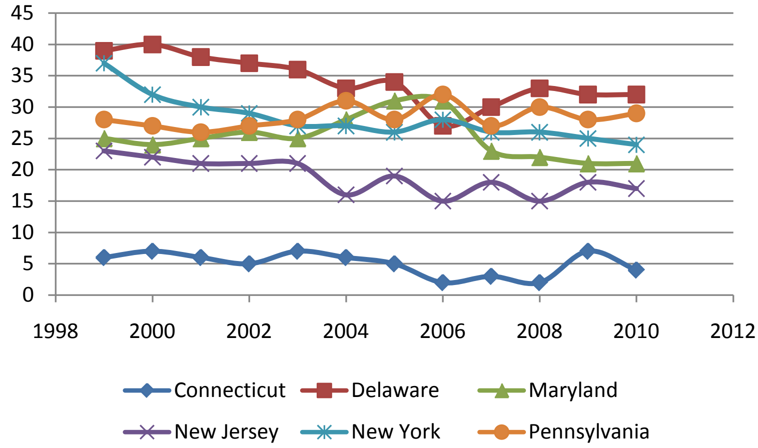

Figure 4. Mid-Atlantic State health rankings (2009 through 2010).

Atlantic States based on the stringency of soil cleanup standards and again, other, more significant public health factors such as smoking or obesity rates likely are driving those changes.

Inherent in our analysis is the assumption that residential soil cleanup standards and criteria published by state environmental agencies in look-up tables can serve as a larger surrogate for the stringency of that state's environmental regulations. These standards and guidelines are developed individually by each state using the exposure and risk factors that they feel offer the highest level of protection to their most sensitive populations. The calculations used in developing the numerical values are based on EPA methodologies and are very similar. Therefore, the choice of cancer slope factors and other indices of potential harm used to develop the numerical standards, which vary widely and often by an order of magnitude or more in the published literature, are reflective of the level of regulatory conservatism present within the state environmental agency.

It is improbable that this level of conservatism is restricted solely to soil cleanup standards. Rather, it most likely will permeate the agency as a whole, touching each of its programs to one degree or another. In other words, states with less restrictive soil cleanup standards should not be expected to have restrictive (*i.e.*, more conservative than federal maximums) water quality or air quality emission standards.

7. Conclusions

The data sets are small and, for that reason, we have not attempted any statistical or mathematical manipulations of the information. Similarly, we acknowledge that other, more significant driving forces may mask trends or correlations between state environmental stringency and socioeconomic performance. However, some patterns seem clear. Despite having the least restrictive soil cleanup standards, Pennsylvania continues to struggle to maintain its manufacturing base. Manufacturing GSP in Delaware and Maryland, two states with the most restrictive set of soil cleanup standards, has remained relatively constant, albeit at a volume only 20 percent that of Pennsylvania.

Soil cleanup standards influence on unemployment (if any) is not apparent from the data presented and this may be such a minor factor amid other more important drivers so as not to be measureable. Improvements to health, the ultimate goal of most environmental regulations, do not track directly with soil cleanup standards stringency. Delaware is the state with the highest (least desirable) health ranking score and yet has one of the most restrictive sets of soil cleanup standards. Pennsylvania moved into second place in 2006 as the state with a high (undesirable) health ranking score, followed closely by New York. Pennsylvania has the least restrictive set of soil cleanup standards with New York close to the middle of the states that were evaluated. Connecticut, the state with the second least restrictive set of soil cleanup standards has the best (lowest) overall health ranking of the Mid-Atlantic States.

Confounding our analysis is the availability within most of these states to develop alternative, site-specific, risk-based valves that provide relief from some or all of the look-up table standards. However, given the patterns described above, caution needs to be exercised by stakeholders decrying the loss of business or economic activity due to unreasonable or overly stringent environmental standards, particularly soil cleanup standards. Similarly, stakeholders insisting on more robust standards cannot point to improvements in health patterns as justification for increased conservatism in environmental regulation. Additional, more rigorous analyses are required that hopefully will eventually illustrate the trade-offs and advantages inherent in changes in remedial goals for soil.

References

[1] Muller, J. (2011) Environmental Industry Outlook for 2011. *Environmental Business Journal*, **24**, 4-12.

[2] Newport, F. (2013) State of the States: Alabama, North Dakota, Wyoming Most Conservative States. Gallup, Inc., Washington DC. http://www.gallup.com/poll

[3] Bergstrom, J.C., Boyle, K.J. and Yabe, M. (2004) Trading Taxes vs. Paying Taxes to Value and Finance Public Environmental Goods. *Environmental and Resource Economics*, **28**, 533-549. http://dx.doi.org/10.1023/B:EARE.0000036779.58923.02

[4] Blomquist, G.C., Newsome, M.A. and Stone, D.B. (2003) Measuring Principals' Values for Environmental Budget Management: An Exploratory Study. *Journal of Environmental Management*, **68**, 83-93. http://dx.doi.org/10.1016/S0301-4797(03)00005-7

[5] Hajkowicz, S. (2009) Cutting the Cake: Supporting Environmental Fund Allocation Decisions. *Journal of Environmental Management*, **90**, 2737-2745. http://dx.doi.org/10.1016/j.jenvman.2009.03.002

[6] Jennings, A.A. (2012) Analysis of Worldwide Naphthalene Surface Soil Regulatory Guidance Values. *Soil and Sediment Contamination*, **21**, 451-497. http://dx.doi.org/10.1080/15320383.2012.672492

[7] Kowalsky, E.S. and Jennings, A.A. (2012) Worldwide Regulatory Guidance Values for Chlorinated Benzene Surface Soil Contamination. *Journal of Environmental Engineering*, **138**, 1085-1105. http://dx.doi.org/10.1061/(ASCE)EE.1943-7870.0000574

[8] Tenbrunsel, A.E., Wade-Benzoni, K.A., Messick, D.M. and Bazerman, M.H. (2000) Understanding the Influence of Environmental Standards on Judgments and Choices. *Academy of Management Journal*, **43**, 854-866. http://dx.doi.org/10.2307/1556414

[9] Levinson, A. (2001) An Industry-Adjusted Index of State Environmental Compliance Costs. In: Carraro, C. and Metcalf, G.E., Eds., *Behavioral and Distributional Effects of Environmental Policy*, University of Chicago Press, Chicago. http://dx.doi.org/10.7208/chicago/9780226094809.003.0005


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