“The Use of Incentives in Siting Hazardous Waste Facilities”

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HAZARDOUS WASTE FACILITIES

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ABSTRACT

This paper addresses the use of mitigation and compensation as incentives policies to stimulate agreement between parties interested in siting a hazardous waste facility and potential host communities. We develop a model of facility siting that distinguishes between the effects of incentives policies on (a) outcome and process considerations and (b) the relation between a hazardous waste facility and the flow of services it creates over time. This model then is used to examine the effectiveness of different incentives packages with regard to the possibility of finding an acceptable location for a hazardous facility.
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The business of siting hazardous facilities has only recently become an important public concern. Not too many years ago the siting of a landfill, a pulp mill, or a chemical plant within a community probably would have generated very little controversy. Factories and jobs were synonymous with progress, accidents were something that management knew how to deal with, and emissions were considered to be an inevitable by-product of an industrial society. Laws were in place to protect citizens, and by-and-large the management of risks was not a topic of public concern.

Today, facilities that produce, use, store, or emit hazardous substances are the subject of intense public scrutiny. Communities no longer are apathetic, or even trusting, and government as well as private developers are finding that the public now demands a voice in decision-making processes that used to be entrusted to others. In some cases this has encouraged the development of participatory processes through which a new spirit of cooperation is formed between the developer and a host community. For example, in Alberta citizen involvement in the site selection process recently led to the
successful siting of a large, integrated waste treatment and disposal facility (McQuald-Cook & Simpson, 1986).

In other cases the developer and the community appear to be speaking different languages and conclude hostile negotiations by stating that no agreement is possible and thus no facility will be built. For example, despite the passage of promising new legislation, all five of the hazardous facility sitings attempted in Massachusetts between 1980 and 1986 failed due to community protests and lawsuits that caused developers to withdraw their proposals (English, 1988).

In still other cases an agreement remains elusive but a third party, often the government, steps in to force an administered solution. Generally this leaves at least one side disgruntled, as demonstrated by the recent decision to locate the nation’s first high-level nuclear waste repository in Nevada despite that state’s loud and continuing protests that the siting would turn the state into a nuclear wasteland (Carter, 1987).

Some part of the variation in these cases derives from differences in the initial conditions: the type of facility that has been proposed, the identity of the various stakeholders, and the status quo conditions. However, experience suggests that certain procedures have worked well in siting hazardous facilities whereas others practically guarantee failure. Knowing more about which policies do and do not work, with an eye toward prediction rather than ex-post interpretation (or lamenting), would provide both developers and host communities with
a better idea as to how to satisfy the agendas of each of the relevant interested parties.

In this paper we discuss the use of incentives policies to stimulate agreement between parties interested in siting a hazardous waste facility and potential host communities. These incentives include mitigation measures and compensation made available to the community in the event of facility approval. After presenting a model of facility siting we examine how an incentives package can be utilized as part of the facility siting process. Our focus is on factors that might encourage a movement between two states of the world, the status quo without a facility and the possibility of finding an acceptable location (or locations) for a facility.

A MODEL OF THE FACILITY SITING CONTEXT

Sittings of hazardous waste storage facilities are characterized by a variety of benefits and costs, whose relative importance is affected by whether one views the problem from a local or national perspective as well as a short or long time horizon (see Carnes et al., 1983; Markhofer & Keeney, 1987). We are interested in promoting decision processes that lead to socially desirable outcomes while at the same time improving the welfare of each of the individual parties affected by the facility. The multidimensionality aspect of facility siting outcomes suggests that in designing a siting procedure all parties may become winners through the appropriate redistribution of social gains. The trick, of course, is knowing how to design an acceptable decision
process, how to select a preferred alternative and estimate its gains and losses defensibly, and then how to establish and implement appropriate redistribution systems.

Consider a site where a hazardous waste facility has been proposed to serve a regional area composed of several distinct communities, each of which wants to see the facility built but none of which is eager to serve as host. The various parties with an interest in the siting constitute the relevant stakeholders. Generally, the most significant stakeholders in a siting dispute are (a) the residents of communities near to the facility or along key transportation routes, (b) the siting agents, and (c) the users of products that produce the wastes in question. Note that a single siting may involve multiple stakeholder groups and the predicted costs and benefits may be perceived quite differently by these various constituencies. For example, a community may favor siting because employment-related benefits will largely accrue to them, whereas the state as a whole may oppose siting due to a fear that it will create a stigma and discourage new businesses from locating in the region (Peele, 1987).

Assume there exist \( i = 1 \ldots n \) different stakeholder groups that could be affected by the outcome of the siting decision. For any proposed siting alternative, each stakeholder must choose between two states of the world: \( S_0 \) (the status quo) and \( S_1 \) (the proposed alternative). There can be many proposed alternatives, each of which would require a choice between \( S_0 \) and \( S_1 \). Let \( u \) represent the utility
of stakeholder $i$ in state $j$, where $j = 0$ refers to the status quo and $j = 1$ refers to the proposed alternative. This choice between the two states is affected by a set of factors that can be expressed for each stakeholder $i$ in the following form:

$$U_{ij} = U_i (W_{ij}, B_{ij}, C_{ij}, R_{ij}, E_{ij}), \text{ for } j = 0, 1 \text{ where}$$

$W_{ij}$ - the wealth of stakeholder $i$ given state $j$. $W_{ij}$ is thus a stock concept, analogous to the balance sheet of a firm at a point in time.

$B_{ij}$ - the flow of benefits over time associated with living in the community. Benefits include both monetary benefits such as income and nonmonetary benefits related to the quality of life.

$C_{ij}$ - the costs over time associated with living in the community. $C_{ij}$ is also a flow concept. These costs could be represented by two different vectors, one addressing monetary measures of cost (e.g., visits to a doctor) and a second addressing anxiety or other factors that affect the community's quality of life over time (e.g., worries about adverse changes in the image of a community). The benefits and costs are analogous to the income and expenditure statements of a firm, representing a change in the status of a stakeholder over time.

$E_{ij}$ - the predicted (statistical) risks faced by stakeholder group $i$, calculated as the product of emission probability and predicted consequences. In the status quo, communities face two types of statistical risk. First, there exist risks related to having poorly stored wastes at a number of locations near to or within the community. The direct purpose of a repository is to reduce these status quo risks
over time. Second, there exist background risks, not related to storage but associated with living in the community. These would include, for example, risks related to flooding, fire, traffic accidents, and environmental pollution.

\( R_{ij} \) - the perceived risk of stakeholder \( i \) given state \( j \). Like \( E_{ij} \), \( R_{ij} \) needs to account for both waste and nonwaste factors. However, \( R_{ij} \) may differ from \( E_{ij} \) because it also is affected by many other factors such as the familiarity of the risks, their discussion in the media, the amount of control people have over exposure levels, the perceived potential for catastrophic accidents, and the level of dread associated with the technology (Slovic, 1987).

Should a facility be constructed, several new factors must be considered as part of each stakeholder's utility function. First, \( E_{ii} \) and \( R_{ii} \) must include not only components for hazardous waste and background risks but a third component, related to the risks from the newly sited facility. Second, some stakeholder groups may receive certain benefits as incentives for agreeing to site the facility. Accordingly, \( B_{ii} \) - the additional benefits accruing to stakeholder \( i \) in state \( i \) associated with acceptance of the facility. These benefits could be provided either as a one-time payment (to change the existing stock) or as a (discounted) stream of compensation accruing over a number of years (to change the flow, e.g. as proposed by DOE to the

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state of Nevada for agreeing to utilize Yucca Mountain as the nation’s sole repository for high-level nuclear wastes).

The interpretation and relative significance of these variables can change dramatically as a result of the context within which facility siting occurs. Three aspects of the siting context are particularly important in determining the acceptability of a specific proposal.

1. **What is the relation between the facility and the flow of services it yields?**

The facility siting model presents the welfare of community residents as consisting of two components. One component relates to their wealth and is based on the stock of capital goods that is available at any point in time. A second component relates to the flow of goods and services received over time, such as the expected monetary and nonmonetary changes in risks, costs, and benefits that derive from this stock. A waste facility is like other capital assets in that it produces economic services over time, such as electricity or waste storage. However, a waste facility is unlike many other assets in that it also produces psychological services, many of which (e.g., perceived risk or dread) are negatively correlated with well-being.

In the usual case, flows of services are converted into stocks through the process of capitalization, which calculates the present value of the expected income stream. In the case of a hazardous waste site, however, the relation between flows and stocks is problematic. Fear and worry, for example, are flow concepts associated with the operation of a site over time that may or may not be captured as part
of a stock concept such as property values (Payne, Olshansky, & Segel, 1987; Zeiss, 1989). Several studies have shown that property values may decrease despite the existence of steps taken to prevent adverse changes in statistical and perceived risks or in costs (Furby, Gregory, Slovic and Fischhoff, 1988). In some cases the discounting of a future impact stream may even run counter to perceptions of a facility's risk. For example, because of the public's fear of latent illnesses and fatalities a flow concept such as the dread of a catastrophic accident may increase rather than diminish to the extent that health effects are delayed (Slovic, 1987).

2. Do community concerns focus on questions of outcome or questions of process?

Our view of the facility siting context builds on the distinction, first proposed by Herbert Simon, between substantive and procedural rationality (Simon, 1978). Substantive rationality refers to the outcomes of a decision process, which in the context of a hazardous facility siting include all the ways in which the quality of life within a community or region is expected to be affected by changes in jobs, income, local control, fear or anxiety, and other monetary or nonmonetary factors. Procedural rationality refers to the processes by which a siting outcome is determined and takes into account the effectiveness of actions in light of prior conditions and human cognitive limitations.

Both concepts of rationality are important to facility siting
evaluations but their influence is likely to vary substantially depending on the nature of a particular siting problem. In cases where a prior history of poor relations between a firm and a community has established an aura of mistrust, emphasis should be placed on procedural rationality. Changes in the risk-management decision process (such as allowing community representatives access to background reports, or veto power over key decisions) may be necessary before anticipated facility outcomes will even be discussed. In other cases, mitigation of the expected project-related risks (i.e., a focus on substantive rationality) may be needed before meaningful dialogue between a developer and a potential host community can occur.

3. What is most likely to happen if a facility is not sited?

We believe that a key to successful siting lies in delineating the default option—what will happen if a siting agreement is not reached. This may mean either that no new facility is built or that a facility is constructed at some other location. Hazardous facilities that serve more than just a local area generally have the unusual feature that they result in net regional gains but create net local losses. This leads to the widely recognized NIMBY phenomenon (Popper, 1983): either don’t build a facility at all (i.e., maintain the status quo) or build it elsewhere (i.e., in some other backyard).

What often is not clearly stated is that opposing a siting may entail significant costs, stemming (for example) from unsafe levels of exposure to hazardous materials and/or from rapidly escalating fees for waste disposal. Yet both as individuals and as members of social
groups, people tend to be wary of options that require a change from present circumstances and to cling to the status quo (Samuelson & Zeckhauser, 1988).

An unacceptable default option is hypothesized to be a necessary precondition for motivating facility acceptance on voluntary grounds. Unless the present situation creates a high level of concern there is little incentive for any public official to recommend change. If people do recognize that the risks of the present situation are serious and becoming worse and if they are convinced that a new facility will help, then they are more likely to be open to new ideas.

THE EFFECT OF INCENTIVES ON OUTCOMES

Both mitigation and compensation measures are used to provide local stakeholders with a way to affect the decision outcome and to improve the welfare of stakeholders over the status quo.³ Mitigation typically results in the redesign of a facility to decrease its perceived risks and the development of new monitoring and control procedures in order to change the psychological flow of services it produces. Compensation typically results in guarantees or payments to the community, either in dollars or in services that are designed to affect a desired redistribution of the facility’s benefits and costs. Both mitigation and compensation can address either stock or flow concerns: a key to their effective use as facility siting policy tools is the recognition that changes in the psychological flows from a
facility will, in time, affect the value of capital stocks.

Mitigation.

Two basic types of mitigation measures are used in facility siting, engineering and institutional. Engineering mitigation measures typically relate to the residual statistical risks of a proposed facility and reflect both well-defined probabilities (e.g., failure of stress member) and the past performance of related systems. Many types of engineering mitigation measures are commonly used in large-scale public projects. In the context of a hazardous waste site, for example, engineering measures typically involve placing materials in secured underground storage tanks, designing long-term electronic monitoring of a site, or installing double liners and clay membranes around waste pools.

Public trust in engineering mitigation is to some extent a function of the familiarity of the risk under consideration and its potential consequences. Risk sources that are unfamiliar or which exhibit substantial uncertainty about the magnitude of an accident's consequences are viewed with more dread than more familiar risks whose consequences are known (Slovic, 1987). For unfamiliar risks, the announcement of mitigation plans may even serve to fuel public opposition and discontent. For example, when the U.S. Army revealed plans to stockpile safety and emergency evacuation equipment near the site of a planned chemical weapons incinerator in Kentucky (one of eight proposed incineration facilities), local opposition to the project was reported to be heightened rather than calmed (Washington
Institutional mitigation, on the other hand, seeks either to regulate the operation of a facility or to directly empower the local citizenry. Institutional mitigation at a hazardous waste site might involve imposing fines for accidental releases, establishing local representation on a facility's governing board, or developing training programs for local health officials.

Mitigation measures are designed to affect $R_{ij}$ and $E_{ij}$ directly and thereby maintain the value of current stock. Siting a waste storage facility in a community where none previously existed clearly will add a new source of risks to the region. But siting does not occur in a vacuum, and (in theory) the proper focus of concern is not the risks from any single site but total individual exposure: it is the magnitude of the risks from all sources that should be of concern to risk managers and the public (Keeney, 1988).

If the local community considers the risks of a proposed site to be relatively small (e.g., no catastrophic potential) and if the technology involved is familiar, then mitigation may be able to reduce $R_{i1}$ to a level below or equal to that of $R_{i0}$ (current conditions). A key factor here is understanding that the risks of the default option are both non-zero and (in the typical case) increasing over time. This is why a waste facility would be desired in the first place. If risks of the proposed site are large, however, or if the technology is considered to be unfamiliar, then mitigative measures may have very
little impact on $R_{11}$ and the gap between $R_{10}$ and $R_{11}$ could appear large.

Large-scale, centralized facilities are likely to fail to reduce $R_{10}$, particularly when the default risk is considered small and the facility risk is perceived by the affected public to be significant. One way to beat this situation, of course, may be to switch from a single large facility to several smaller, decentralized ones (e.g., Ratick and White, forthcoming). In many cases, however, the introduction of an unfamiliar risk source may unavoidably serve to highlight the existence of similar risks in the community and lead to the desire that these other, previously ignored sources of risk also be mitigated. A case in point is the Hanford Reservation in southeastern Washington state, where selection of the site as a candidate for construction of a high-level nuclear waste repository increased the concern of the local community about storage procedures for existing radioactive wastes (Washington State, 1988).

Compensation.

Compensation measures, emphasizing cost-sharing and the redistribution of gains, generally focus on payments or guarantees that address concerns of equity and fairness. For example, compensation measures may be proposed so that $U_{11} > U_{10}$ by offsetting those risks of a facility that are viewed as difficult or impossible to mitigate. In such cases, compensation might be proposed to protect utility levels by offsetting residual damages that cannot be "made whole" through other means.
Six basic forms of compensation are available in facility sitings, as summarized in Table 1. **Direct monetary payments** are viewed at one level as particularly appropriate, because they give the community freedom to exchange dollars for specific desired commodities. However, individuals may refuse an offer of money because payments are viewed as a bribe or as a poor substitute for the "priceless" goods (e.g., health, peace-of-mind) that are at risk (Calabresi and Bobbitt, 1978). Thus, monetary payments may be controversial because they are viewed as unethical or as failing to address the multi-dimensional features of the siting problem. **In-kind awards**, a second form of compensation, generally are more acceptable because they directly replace resources expected to be affected, such as building fish hatcheries to replace lost stocks. They can also directly reduce the flow of health risks facing individuals over time by being used for such purposes as improving hospital facilities. **Contingency funds** set aside sums of money and thereby provide assurance of a facility's ability to meet its future obligations should there be an accident. **Property value guarantees**, a category of compensation that directly affects stocks, attempt to protect against falling property values by tying future price changes in the vicinity of a facility to those of the region or state as a whole. For example, Kodak developed a plan which guarantees the property values of two hundred homes near its industrial complex in Rochester over the next ten years (New York Times, June 5, 1988). **Benefit assurances**, which guarantee direct or indirect employment for
community members as a result of the proposed project, may be a particularly attractive compensation mechanism in areas where job opportunities are low. Finally, generalized economic goodwill incentives, which include non-project-specific expenditures (e.g., charitable contributions), also may be important in those cases where local resistance to a project is high. In particular, goodwill incentives may be perceived as appropriate compensation when other forms carry the stigma of a bribe.

Compensation is designed to affect $B_{ij}$ and $C_{ij}$ directly but also $R_{ij}$ and $W_{ij}$ indirectly, because it functions as a signal to the local community of the intentions and expectations of a potential developer. For example, a developer unwilling to provide strong property value guarantees signals his fear that a facility could result in adverse economic consequences whereas a decision to guarantee property values relieves the flow of anxiety and thereby may boost the value of housing stocks. Similarly, a developer willing to close a new plant if emissions ever exceed a stated "safe" level signals her trust in the designated technology and her responsiveness to community perceptions of risk.

Compensation also is used to address concerns regarding increased nonmonetary costs to the host community; that is, whether $C_{11}$ is larger than $C_{10}$. In the usual case, the nonmonetary components of $C_{ij}$ would be expected to increase following the introduction of a new site. For example, if local residents perceive a new facility in negative terms, then they may worry more about the possibility of an accident or fear
future adverse changes in the community's image (O'Hare, Bacow, and Sanderson, 1983). Issues related to community image may become particularly sensitive in cases where the prior location of one noxious facility is given as a reason for selecting a community to host a second facility. In Massachusetts, for example, the Water Resources Authority used the existence of a prior treatment plant at Deer Island as one reason for that community's selection as the site of a new regional sewage treatment facility (Boston Globe, July 7, 1988).

Community reaction to a compensation package is likely to be particularly sensitive to changes in the presentation of a facility's expected risks and benefits. This is suggested by the results of experiments, for example by Keller and Sarin (1988), which show a strong relation between \( B_{11} \) and \( R_{11} \): as the anticipated benefits of an action increase, the associated risks decline. Thus an attractive compensation package addresses not only equity considerations but also may make it seem that a facility's level of risk is lower than the level of risk for an otherwise identical site which offers fewer benefits.

Compensation also has a temporal dimension: it can be provided at the time a facility is sited (i.e., ex-ante), while the facility is operating smoothly (i.e., interim), or after some negative event occurs (i.e., ex-post). The purpose of ex-ante compensation is to spread the benefits of a policy decision when a facility is sited, so that those who gain actually do compensate those who lose. Ex-ante compensation
therefore may add to current stocks (e.g., by lowering property taxes, or by adding to hospital facilities in the community) or increase the flow of services (e.g., by augmenting discretionary income, or by decreasing health risks as a result of the hospital expansion). In either case, one common purpose of ex-ante compensation is to ensure that the process of siting a facility is considered to be fair (Raynor and Cantor, 1987).

Interim compensation protects the residents of the host community from any tangible losses associated with operation of the facility, such as decreases in their wealth (e.g., via changes in property values). Ex-post compensation, on the other hand, helps defray the losses from an unintended accident or error. Each of these mechanisms may affect either stock or flow concerns. For example, a guarantee to replace homes lost in an accident has a direct impact on stakeholders' wealth while at the same time indirectly alleviating stakeholders' fear or anxiety over time.

Ensuring that $B_{i1}$ exceeds $E_{i1}$ may be a necessary condition for dialogue between a host community and a developer, because if the predicted risks from a proposed site exceed the anticipated benefits then the facility is clearly a source of welfare loss for local residents. The large number of compensation alternatives and the richness of people's concerns, however, make it important that (a) the type of compensation follow the suggestions of those likely to bear the costs and (b) compensation offers be designed to match commodities similar in nature and use.
If the perceived risks from a facility are sufficiently severe, however, any form of compensation may be considered to be an unacceptable incentive mechanism. Participants in Nevada surveys, for example, were asked whether they would vote for a repository, should it be sited within 50 or 100 miles of Yucca Mountain (in the Nevada survey) or their home (in the national survey), if they were given a $1000, $3000, or $5000 savings on their Federal income taxes for the next 20 years (Kunreuther, Desvouges, and Slovic, 1988). The responses to this question revealed that few people who felt the repository posed serious risks were willing to vote for its siting whether the amount of compensation offered to them was small or large. In cases such as this, mitigation measures appear to be required to first reduce the perceived risks of a hazardous facility to an acceptably low level.

THE EFFECT OF INCENTIVES ON PROCESS

The proposed siting framework views incentives as a link between substantive and procedural concerns. Two procedural siting criteria—trust and equity—are hypothesized to form a set of threshold conditions, necessary for the establishment of a dialogue about siting but not sufficient to ensure its success.

The Trust Criterion.

Trust is a key element of siting disputes, difficult to define and often an issue whenever it is absent from the decision process.
Incentives play an important role in defining trust because they function as a signal to the community regarding the intentions of a proposed developer and demonstrate the developer's concern with minimizing the risks of a facility.

Trust connotes a sharing of power between experts and laypersons and a level of comfort within a community about its own role in the risk-management decision process (Sandman, 1986). In the minds of the public, therefore, trust is not something suddenly created as the result of a particular incentive strategy. Trust is instead something that develops, over time and within a social and historical context.

If trust does not already exist, empowerment of the local community via direct participation in siting commissions or other decision-making bodies will be necessary for achieving siting success. In California, for example, hazardous waste siting laws require that a developer work closely with a broad-based citizen's advisory board. In New York, current law states that the commission overseeing the siting of state-owned hazardous facilities must include at least three private citizens from the proposed host county. In Alberta, extensive participation by community representatives in the siting evaluation program is credited with having three communities compete with each other to host a large waste-treatment facility (McGlennon, 1983).

One way to create trust is by designing mitigation measures so that the probability of an accident in any designated time period is perceived to be less than some threshold p*. This probability level p* can be defined in terms of maximum permissible levels of exposure or
maximum tolerances in a technological process. There is empirical evidence to support a concern with setting $p^*$ in designing new facilities. The U.S. Nuclear Regulatory Commission (NRC), for example, had as a stated goal that the "risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed 0.1% of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed" (Nuclear Regulatory Commission, 1982).

A second component of trust requires that safety levels be maintained throughout a facility's operating life. This can be accomplished through the design of monitoring and detection procedures acknowledged by all stakeholders to be effective in maintaining exposure levels below $p^*$. Monitoring is more likely to be successful to the extent that it is (a) established with the participation of local representatives and (b) conducted with the assurance that all incidents will be reported openly: a company that shows it can deal successfully with minor incidents may be viewed as far more capable of handling a serious accident than a firm with a reputation for maintaining secrecy about even the most trivial incident.

Empirical evidence on experimental responses to alternative risk management options supports this point. For example, Elliott (1984) found that simulated communities participating in siting a hypothetical waste treatment facility strongly preferred an emphasis on the early
detection and responsive management of risks over improvements in technological capabilities to predict or prevent risks. The use of careful planning to achieve zero risk was viewed as an unrealistic possibility; coping with risk, and knowing how to minimize exposure and damages after the inevitable accident occurred, was viewed as a far more important factor influencing the acceptability of a facility.

Thus, trust reflects a safety-first constraint that is based on societal norms about acceptable risk levels. An increased level of trust suggests that the host community has a greater confidence in the ability of mitigation measures to reduce and maintain facility risks to levels below p*. Discussions about compensation then may be possible; that is, after exposure levels are perceived to be securely below p* and after an acceptable level of participation in decision-making has been assured. Until a threshold level of trust is established, however, compensation is likely to be viewed as a bribe and negotiations regarding the level of compensation are likely to be perceived as irrelevant, premature, or insulting (Peele, 1987).

The Equity Criterion.

The facility siting process must be viewed as equitable or fair by each of the different affected stakeholders. Keeney (1980), among others, has shown how difficult the achievement of outcome equity may be because of the conflict between intuitively appealing objectives such as the avoidance of catastrophes, the minimization of the expected number of fatalities, and an equitable ex-post distribution of risk. We believe that procedural equity, in general, will be achieved only
when all key parties in facility siting negotiations are willing to accept the decision-making process (ex-ante) without regard to its outcome (ex-post). Thus, the existence of procedural equity should ensure that an ex-ante siting agreement between communities will remain intact even after the selection of a candidate site and realization of its associated impacts. In such cases there exists a Rawlsian ("veil of ignorance") agreement as to procedure because the outcome is uncertain and all parties have an equal ex-ante opportunity to gain or to lose. Compensation may be paid to the winner but it is not necessary; instead, the operative incentive may be to avoid the health and economic risks associated with a continued stalemate and failure to site a facility. The Southeast Compact, in which eight states have joined to site a low-level radioactive waste repository based on the group's weighting of 10 technical criteria, represents an extremely interesting, and ongoing, experiment in the use of this type of procedural mechanism (Wolle and Visocki, 1988).

A key aspect of a procedural equity criterion involves the demonstration of both the need for a facility (Colglazier, 1988) and the recognition that the default option, associated with not selecting a particular site, is unattractive. This will occur whenever construction of a well-designed and closely monitored waste site could reduce the risks of an accident to a community relative to status quo waste storage conditions or result in lower prices for waste removal or for some other commodity (such as electricity) than those now in place.
In Montgomery County, Maryland, for example, discussions concerning the construction of a waste incinerator emphasized that the current system (an overused landfill) cannot continue to be used and that developing a new facility could result in lower health risks while saving local families a significant amount of money in waste pickup and disposal fees over the long term (Washington Post, September 4, 1988).

Similarly, communities in France within 50 kilometers of a nuclear power plant were until recently given ten percent reductions in their electricity rates (Carle, 1981).

Equity, like trust, is honored in the abstract but in real-world siting disputes it is often treated inconsistently. For example, agricultural communities in eastern Washington state were worried that the establishment of a nuclear-waste repository site at Hanford would result in the geographic stigmatization of the local area and its products, including wines and fruits. This would lead to a sharp decline in export sales and would condemn the area (over the long-run) to economic stagnation (Washington State, 1988). Industrial and real-estate interests in Oak Ridge, Tennessee also worried about environmental stigma, based on their concern that images of a nuclear dump would discourage future economic development in their area (Sigmon, 1987). Because economic stigma in Washington state was considered an uncertain future phenomenon based on the fear of contamination, rather than its occurrence, DOE failed to consider the impact in its own analysis and ruled that potential stigmatization was insufficient grounds for compensation. In contrast, stigma associated
with operation of the Oak Ridge MRS was freely acknowledged by the DOE, which worked closely with the local community to develop a mutually-satisfactory plan that would counteract any adverse economic impacts (Sigmon, 1987).

This case is instructive, because it demonstrates the extent to which a developers' responsiveness to concerns of the affected population (e.g., fears of economic stigma) could engage public support and overcome opposition based on equity considerations. However, the case also demonstrates the limits of a consensual dialogue: that in-depth talks were even possible at Oak Ridge probably owes much to the prior goodwill and long history existing between DOE and the community. In addition, these local successes were made irrelevant by the subsequent decision of the state's governor to veto the site for non-negotiable political reasons. Thus, if a close working relationship has not already been established prior to the start of the negotiations, then there may be no set of incentives that can overcome the perception of inequity and move the developer and community toward a siting agreement.

CONCLUSION

The approach we present in this paper depicts the hazardous waste facility siting context as a function of two types of considerations, those concerned with outcomes (substantive rationality) and those concerned with process (procedural rationality). The major policy
tools available to use as incentives, mitigation and compensation, affect both outcome and process considerations. For the risk manager, mitigation and compensation provide accessible mechanisms to influence the course of public debate about a proposed hazardous facility and to alter public perceptions of a facility's expected risks, costs, and benefits.

Incentives directly affect the relation between a hazardous waste facility within a community and the flows of services anticipated to derive from it. In particular, incentives can affect the balance between economic flows produced by a facility, most of which (e.g., jobs or waste storage) are perceived as beneficial, and the negative psychological services (e.g., dread or worry) that also are produced. Reductions of negative flows can lead to increases in the value of stocks such as housing or property.

Siting a hazardous waste facility is an inherently difficult task and attention to the concerns noted in the model we present will not lead to a guarantee of success. However, whenever the default option is unacceptable, the use of incentives can provide all stakeholders with a means to improve their welfare over that of an increasingly undesirable status quo. In the present highly-charged siting environment, doing things even a little bit better could make a very big difference.
Footnotes

1. For purposes of this discussion, the term community is defined broadly. It could mean a single town or county, as in the case of siting a local landfill. Alternatively, it could refer to a well-defined region or state, as in the case of siting a low-level radioactive waste facility as part of an interstate compact.

2. We do not explicitly address the transition between $S_0$ and $S_1$ and we ignore impacts relating to construction at the site itself. In some cases, the alternatives within state 1 could usefully be expanded to account for multiple facility sizes or locations.

3. We therefore do not distinguish between compensation and rewards, where the latter term is defined as payments designed to result in a net improvement in the host community’s level of well-being.

4. This discount recently has been removed because the French government concluded that nuclear power was as safe as any other source of electricity.
# Table 1

**Alternative compensation mechanisms**

<table>
<thead>
<tr>
<th>Form of compensation</th>
<th>Example units</th>
<th>Example sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Direct monetary payments</td>
<td>$</td>
<td>Illinois radioactive waste facility, Deer Island (Mass.) waste treatment</td>
</tr>
<tr>
<td>2. In-kind awards</td>
<td>hospitals, fish hatcheries, fire protection</td>
<td>USDOE Synthetic coal plant, West Virginia Revelstoke damsite, British Columbia</td>
</tr>
<tr>
<td>3. Contingency funds</td>
<td>$</td>
<td>Florida's Recovery &amp; Management Act (Hazardous waste trust fund)</td>
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<tr>
<td>4. Property value guarantees</td>
<td>$</td>
<td>Oak Ridge, Tennessee Monitored Retrievable Storage Facility (MRS)</td>
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<tr>
<td>5. Benefit guarantees</td>
<td>jobs, local contracts</td>
<td>Electricite de France, proposed West Virginia MRS</td>
</tr>
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<td>6. Goodwill incentives</td>
<td>contributions to charities</td>
<td>Trident West Coast submarine base, Wash.</td>
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References


