THE AESTHETICS OF HAZARDOUS WASTE -

DISTINGUISHING VISUAL IMPACTS FROM PUBLICLY PERCEIVED RISK

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ABSTRACT

The need to address the aesthetic impacts of hazardous waste projects on the environment and the public stems from two sources: government regulations which specifically require assessment of aesthetic effects; and rapidly increasing public concern for perceived impacts and risks of existing or proposed hazardous waste facilities. How aesthetic issues are handled on hazardous waste projects can potentially have significant implications on the fate of those projects. These implications range from delays in the permitting process to denial of sites or costly legal judgments in damage suits. This paper will discuss strategies for evaluating the aesthetic/perceptual aspects of hazardous waste. In particular, it will focus upon ways to distinguish visual concerns from other influences on public perceptions such as perceived health and safety risks.

INTRODUCTION

The subject of aesthetics in relation to hazardous waste is not yet a widely recognized issue, but is one which will inevitably have to be faced on many major hazardous waste projects due to regulatory requirements and political realities. This may pose some new problems for the hazardous waste industry and regulators alike, but may also provide opportunities for clarifying issues and improving public relations. Aesthetic issues can influence the fate of hazardous waste projects, and strategies need to be developed for ensuring the credibility of aesthetic studies in controversial or emotional situations. This paper addresses the integration of public perceptions with aesthetic evaluations, and in particular, the need to separate aesthetic reactions from the more general public responses to perceived risks.

In this paper, the scope of aesthetics and public perceptions will be considered to include all issues related to how a site or project is perceived through the senses of sight, sound and smell, with an emphasis on the visual quality of the environment and the visual information obtained by people.

THE NEED FOR AESTHETIC STUDIES OF HAZARDOUS WASTE PROJECTS

A significant amount of federal government legislation which can apply to hazardous waste projects specifically or in effect calls for incorporation of aesthetic considerations into analysis and/or design. Some of the principal regulations in this category include:

- Nuclear Waste Policy Act (1982);
- 10 CFR Part 960 General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories;
- DOE Environmental Compliance Guide (DOE Order 5440.1B);
- U.S. Nuclear Regulatory Commission NUREG-0555;
- U.S. Nuclear Regulatory Commission Regulatory Guide 4.2;
- EPA Guidance on Feasibility Studies under Comprehensive Environmental Response, Compensation, & Liability Act of 1980 (CERCLA);
- National Environmental Policy Act (1969);
- Council for Environmental Quality Regulations;
- National Forest Management Act (1976);
- Federal Land Policy Management Act (1976);
- U.S. Army Corps of Engineers Permit Program Regulations (1984); and
- Clean Air Act as amended.

The general environmental regulations for proposed projects usually require a discrete and thorough visual assessment of the existing conditions, potential impacts on aesthetics, and mitigation measures. For example, legislation for nuclear powerplants, which is likely to be applied as a precedent for nuclear waste sites, specifically requires identification of "visually sensitive areas or viewsheds that would be affected by plant construction." (NUREG-0555, Section 2.2.1). The NRC Regulatory Guide 4.2 requires "an assessment of the visual effects of the project on nearby valued cultural, scenic, historic, park and recreation areas, together with an estimate of the total number of visually undesirable features which can be seen."

In addition, state environmental protection acts may have similar or even more stringent requirements for environmental studies (e.g., California Environmental Quality Act, 1970). Various states are bringing actions under CERCLA against hazardous waste sites on grounds of environmental damage, which include aesthetic damage.

At the same time, public awareness of and hostility toward radioactive and other hazardous waste has grown to such a pitch that public concerns for facility siting, storage, management, disposal, clean-up, and transportation of wastes have become a major factor. Although the aesthetics of waste facilities may not be the primary public issue, the appearance of these projects can provide a tangible focus for public opinion, since so little of the other environmental, health, safety, and economic factors can be readily grasped by lay people and local communities. The appearance of existing waste facilities can strongly influence public opinion and even psychological states, according to some recent research (see below). Environmental studies which address aesthetics are, then, not only required by some federal policies, but

are often an inevitable consequence of public sensitivity toward hazardous waste.

Beyond the necessity to consider aesthetics for regulatory and public interest reasons, on many hazardous waste projects there may be other strong practical reasons for doing so, from the standpoint of clarifying or resolving perceived issues and demonstrating sensitivity to local concerns. This can be true for all parties concerned with project decision-making, not least the hazardous waste industry itself. The implications of aesthetics for hazardous waste projects are discussed next.

THE SIGNIFICANCE OF AESTHETIC STUDIES TO HAZARDOUS WASTE PROJECTS

A selective review of relevant project studies and research provides a range of actual and theoretical situations in which the fate of hazardous waste projects may be affected by aesthetic issues.

Proposed Projects

Probably the most prominent example to date of the influence of aesthetics on proposed projects is the high level nuclear waste salt repository program being conducted by the Office of Nuclear Waste Isolation (ONWI) for the Department of Energy (DOE). Draft Environmental Assessments (EAs) have been prepared for alternative sites in Utah, Texas, Louisiana, and Mississippi [1]. Primarily because of proximity to Canyonlands National Park, the proposed Utah sites at Davis Canyon and Lavender Canyon brought aesthetic issues to the forefront[2]. It was shown that the project would fall within the viewshed of certain vista points and travel routes for Park users, and that night time sky-glow from the facility's security lighting could impact recreation visitors seeking solitude and remoteness. Environmental interest groups from across the nation joined certain local factions in aggressively opposing these sites. Significantly, the DOE visual studies themselves were challenged on grounds of inadequacy by expert testimony on behalf of the Utah State Government[3]. The consequences of this situation have been that the EA process was substantially delayed while aesthetics studies were redone, and that further aesthetic studies (among others) for the selected site(s) will require a very high level of sophistication at a cost considerably higher than is normal for visual analysis of less controversial projects. The aesthetic conflicts of the Davis Canyon site may yet prove to be a significant factor contributing to selection of a preferred salt-repository site.

There are many other examples of industrial, energy, and waste projects where aesthetic issues have influenced the siting, licensing, or design of proposed facilities. Examples include the Sundesert Nuclear Plant Transmission System[4]; the Alton Coal Field near Bryce Canyon National Park[5]; and the Greene County Nuclear Powerplant[6], which was denied a license by NRC in part because of unacceptable aesthetic impacts on history views.

Transmission lines, which may not evoke quite as much public concern as hazardous waste, nonetheless have a history of public controversy from which lessons may be learned. A review of visual studies on proposed transmission line projects (Ref. 7) documents several instances in which aesthetic issues on one project altered the regulations and public expectations for subsequent project operations, expansions, or new projects. Also, the way in which visual studies are managed and conducted can affect not only the speed and cost of the permitting process, but also the agency requirements for future projects. It is likely that similar consequences will occur with hazardous waste sites and, thus, that experiences on the salt repository project may not be altogether unique.

Existing Hazardous Waste Projects

The aesthetic aspects of existing hazardous waste sites can also raise significant issues. The visible portions of waste facilities can provide prominent symbols which may be strongly linked in the public's view to perceived hazards. For example, ongoing studies on the Eagle Mine (a potential Superfund site) near Vail, Colorado, under the State Environmental Damages Legislation, seem to have been triggered in part by visible discoloration of the streambed and shoreline of the Eagle River near the mine tailings piles [8]. Although the reddish color can be attributed largely to iron staining, it seems to be associated in many people's minds with alleged health risks even though there is no evidence of health effects. The aesthetic aspects of the river and mine facilities, by influencing people's enjoyment of the recreation resource, have been cited by the State as contributing to the substantial economic damages being claimed as a result of mining [9]. Regardless of the outcome of the lawsuit, it seems likely that aesthetics will continue to influence the project: certain alternative remedial actions may be more visually intrusive than the existing conditions, and may be politically difficult to accept in so scenic an area. Also, the long-term success of clean-up operations in restoring public confidence may be limited unless restoration also improves the appearance of mine wastes and river conditions.

Some research supports the contention that visual impacts of a facility may be linked to psychological effects on people. It is reported in one study conducted by hospital psychologists in Bethesda, Maryland, that residents of Middletown, Pennsylvania, who live within sight of Three Mile Island showed considerably more stress symptoms than similar residents of another town 20 miles away from a nuclear power plant [10]. A study in Ontario suggests that adverse psychological effects can be traced to visual impacts and perceived risks of overhead transmission lines[11].

Influence of Aesthetics on Hazardous Waste Projects

At this point, it is useful to summarize the possible implications of aesthetics for hazardous waste planning. Aesthetic issues related to the site of a facility or to the facility itself can potentially result in:

- adverse public relations for existing or proposed projects;
- delaying the project permitting process and increasing uncertainty over the fate of the project;
- altering the design of the project;
- outright denial of the project at a given site; and/or
- altering the regulatory requirements and political climate for future projects.

All of these can have sizeable economic consequences. To ignore or downplay these implications can therefore be costly and dangerous. Conversely, consideration of aesthetics can potentially be advantageous at various stages of hazardous waste project planning for both existing and proposed projects, as illustrated in Table I. Experience on other types of controversial projects [7] indicates that well executed visual studies may potentially provide an avenue for

constructive public involvement, may avoid or lay to rest preconceived notions of aesthetic damage, and may generally enhance the credibility and acceptability of the studies. However, inappropriate or improper methods may result in:

- o greater aesthetic-related impacts than expected;
- o imposition of unnecessary, costly mitigation measures and legal settlements for non-existent or exaggerated aesthetic problems; and/or
- o uncertainties and delays in permitting or legal actions due to a lack of defensible studies.

Unfortunately, there are relatively few precedents and little guidance yet available for aesthetic studies of hazardous waste projects. Much has changed in the level of public awareness and in the state-of-the-art on public perceptions research since most of the existing nuclear powerplants were licensed. Most of the great strides taken so far in the field of waste management have occurred in the highly technical engineering and risk analysis disciplines; most of the engineers and planners involved in the field have had little exposure to aesthetics, public involvement, or landscape design. Costly lessons are only now beginning to be learned. Methods developed for other kinds of projects provide some useful pointers, but may not be best suited to the special needs of hazardous waste studies.

How, then, should those involved in controversial waste management issues address the problem of aesthetics and public perceptions?

TABLE I

Potential Role of Aesthetic Studies in Hazardous Waste Project Planning

PROJECT PHASE	PROPOSED NEW FACILITY	EXISTING FACILITY	AESTHETICS INPUT
1. SITING	X		• Avoidance of visually sensitive sites • Identification of siting opportunities with least aesthetic/public perception problems
2. IMPACT ASSESSMENT	X		• Accurate assessment of aesthetic effects of alternatives • Prediction of public acceptability of designs • Explanation to the public of the nature of the project (what it looks like)
3. MITIGATION/ DESIGN	X		• Reduction of aesthetics-related impacts • Community participation in mitigation planning
4. CONSTRUCTION/ OPERATIONS MONITORING	X	X	• Compliance with aesthetic requirements • Monitoring of perceived impacts
5. CLOSURE/ RESTORATION	X	X	• Design of aesthetically pleasing or enhancing site treatment
6. DAMAGE ASSESSMENT		X	• Accurate assessment of aesthetic effects of the project • Input to economic analysis of resource damage
7. REMEDIAL ACTION/ CLEAN-UP		X	• Assessment of aesthetic impacts/ feasibility of clean-up options • Design of aesthetically pleasing or enhancing site treatment

The remainder of this paper suggests some approaches to the successful use of aesthetic studies for hazardous waste projects, and discusses some of the issues and problems likely to arise in the process.

STRATEGIES FOR AESTHETIC EVALUATION OF HAZARDOUS WASTE PROJECTS

With a potentially controversial subject such as hazardous waste facilities, it is, above all, important that the credibility of all aspects of the study process be established. This includes the credibility of the study team itself, the rationale for the study, the results, the presentation methods employed, and the way in which the results are used in decision-making. Without such credibility, public reactions are likely to be negative and difficult to manage, and the studies may not be defensible in the face of intense scrutiny by state and other government agencies, the waste industry, and consultants in adversary roles. This is a major issue for aesthetics in view of the lack of comprehensive professional standards in visual resource analysis and the subjectivity of perceptual studies. Consultants to the State of Utah, for example, presented detailed arguments on why the visual analyses in the Draft Environmental Assessments for the Paradox Basin salt-repositories were inadequate[3]. Hence, studies need to be designed both to survive peer review (based on knowledge of aesthetics and specialized experience) and to convince the public. A peculiar mixture of sophistication and simplicity can be needed.

The credibility of aesthetic studies can be enhanced by the use of methods which:

- o are accepted by and familiar to the groups or agencies involved;
- o use scientifically rigorous techniques with demonstrated validity, reliability and sensitivity;
- o can be readily traced, checked, and verified by other groups; and
- o use public input to complement and confirm technical studies by professionals.

Studies need to meet most or all of these criteria if they are to be defensible in controversial situations.

Following the regulatory requirements for a particular project may not be sufficient, since most regulations and guidelines are not specific on techniques. Regulations also differ considerably in their requirements -- the NRC Regulatory Guide 4.2, for example, states that a qualified opinion should be used as a method for measuring aesthetically objectionable changes in the landscape, whereas the EPA guidelines for remedial action feasibility studies recommend incorporation of community values into the analysis[12].

Federal resource management agencies such as the Forest Service (FS) and Bureau of Land Management (BLM) have developed their own procedures for evaluating visual resources and visual impacts on public land[13,14]. Established methods of visual resource assessment such as these may provide valuable data and a useful study framework, and are often specifically required by agencies which are familiar with them. However, they may fail to meet the defensibility criteria for hazardous waste projects with controversial issues. For example, much of the visual

resource baseline data available for public land contains "visual sensitivity" information which is intended to express levels of public concern for aesthetic values but which has not been derived from public opinions or public involvement [15]. The reliability of the Federal agency systems has also been seriously questioned, both in research and practice on hazardous waste projects [16] [3]. The relative inability of existing systems to incorporate psychological factors influencing aesthetic values of particular projects is another potentially major drawback for hazardous waste facilities.

One of the complications which may not be obvious to those who are addressing aesthetic issues of waste projects for the first time is that the credibility of an individual's professional judgment on aesthetics has been somewhat eroded over the last few years. Despite the availability of systematic visual assessment methods and techniques for quantifying certain variables such as visibility of projects [17], there are increasing calls for aesthetic judgments by panels of experts rather than individuals [16,18] in order to increase reliability of results. Researchers, agencies, and environmental counsultants are also beginning to call for public validation of expert's aesthetic judgments [19,7,18]. Using data derived from the general public to defend study results which may be criticized by certain sectors of the community has obvious advantages.

However, despite the typically high level of public concern and participation in hazardous waste project planning, a direct link between required visual studies and the public involvement process may not automatically develop for several reasons:

- the public may not identify or articulate specifically visual concerns, although aesthetic issues are likely to be bound up in their overall attitudes towards the project; and
- engineering and environmental firms preparing the studies may not be familiar with methods of visual assessment or design which incorporate public opinions, and may not even consider the possibility of such studies.

The integration of public involvement with aesthetic studies is a key strategic component of successful studies, both in helping to explain the aesthetic study process and obtaining information with which to validate the results. The final section of this paper addresses this crucial interaction.

PUBLIC INVOLVEMENT AND AESTHETICS

A range of techniques are available to obtain data on aesthetics from the public. Combinations of techniques would be required to obtain data which can be verified and validated through multiple response channels [20]. Response-gathering techniques include the following general categories:

- Unstructured interviews;
- Surveys using structured questionnaires, generally distributed through the mail or on-site;
- Informal surveys using open-ended questionnaires or response sheets;
- Workshops with various groups, using a variety of possible formats;
- Delphi procedures and similar survey- or workshop-related techniques such as Public Values Assessment [21]; and
- Interactive video displays permitting simultaneous communication and collection of responses.

In most of these techniques, visual material would be presented as a stimulus or reference for public reactions. These techniques, together with the more common public information meetings, can also be used to disseminate information on the project or study findings.

A number of criteria can be applied for the selection of appropriate techniques for public participation, including:

1. Ability of the technique(s) to reach a comprehensive and representative cross-section of the public.
2. Ability of the technique(s) to foster a constructive public input process.
3. Validity, reliability, and sensitivity of the technique(s), i.e., does the technique obtain data which truly represent aesthetic perceptions, could be replicated in further similar studies, and discriminate adequately between different kinds of response?
4. Ability to gather appropriate aesthetics data; for example, in obtaining data on key viewpoints, the technique may need to permit participants to record their comments on a map of the area.
5. Appropriateness to audience type. Some techniques will be more appealing to a specific audience and, thus, more likely to deliver useful results.
6. Ability to integrate the design and the timing of the techniques with a larger public involvement program, and with other schedule, staffing and budget constraints.

However, probably the most important criterion for public input techniques is the ability to separate perceptions about aesthetics from the influence of perceptions about risk and other nuclear or toxic waste issues.

This is the major problem in assuring the validity of public input on aesthetics: how do we know whether the responses we are measuring are determined by aesthetic conditions or by other factors, such perceived risks? Unless steps are taken to limit and/or isolate non-aesthetic influences on responses there is the likelihood that unduly negative results will occur in the aesthetic study and that these could be unfairly used to bolster other arguments against waste disposal strategies or sites.

There are a number of ways to design public/visual studies in order to identify non-aesthetic bias. They include selection of participants and selection of materials used in eliciting responses.

In selecting participants, it can be important to know what types of bias to expect. Studies have shown that different groups of people can hold different aesthetic perceptions of a site or project, due, for example, to age of respondents [22], occupation [23,24], socio-cultural background [25,26], and personality [27]. Attitudes toward a project may conceptually vary according to the following factors:

A) Primarily non-aesthetic influences:

- Specific opposition to hazardous waste sites in the vicinity of an affected public (e.g., residents, recreation users, workers, etc.). This can incorporate fears of hazards, general environmental damage of an accident, inappropriate use of an area, etc.
- General opposition or uncertainty about waste facilities regardless of their location. This might characterize the reactions of people not in the vicinity of a proposed nuclear facility.
- Opposition, uncertainty, or support for a nuclear facility based on economic effects (e.g., on growth, employment, land values, etc.).

B) Primarily aesthetic influences:

- Opposition to or support for a project because of its visual character and effect on the setting [29].
- Opposition to a project because of its proximity or visibility to an affected public (e.g., residents, recreation users). In the I-220 Cross Lake Highway Study in Louisiana[30] for example different resident groups behaved similarly in rating visual alternatives in all views of a specific group; in these instances, the affected group consistently displayed a marked negative bias attributable to proximity or location.

Control groups provide one means of testing bias among public participants. The use of a control group from outside the area in which a hazardous waste facility is proposed would allow the study team to obtain aesthetic responses from people who do not perceive themselves to be directly at risk from a hazardous waste facility in their area (See Ref. 31 for application of this technique). The assumption is that responses would therefore be less biased by perceived risks, disadvantages or benefits of a waste facility.

It is also possible to obtain information on where people live and work in relation to the site, whether they feel a general hostility to nuclear facilities or see employment/economic benefits, and normal socioeconomic data on age, sex, background, etc. This would allow the study team to divide participants into subgroups based on a particular variable and compare the two sets of responses to provide information on that variable.

Recent research and experience on controversial projects suggests that the nature of response stimuli used to gather perceptions can also bias aesthetic judgments in predictable ways which reflect preconceived perceptions. Use of accurate photosimulations which show proposed projects in a realistic view of the actual site context [32] can be valuable in explaining the project, dispelling misconceptions of aesthetic impacts, and focusing responses on visual issues. However, it has been shown by several teams[33,34] that identical scenes which were described or labelled differently were rated differently in aesthetic value.

It would thus be possible to measure bias related to hazardous wastes issues by the technique of labeling scenes used for public input or response. Two groups or subsets of people could be shown scenes as follows:

A) For one group of people, a number of scenes may be shown without mentioning any nuclear projects; a range of scenes could be shown and described as industrial facilities, e.g., cement plants or gravel pits.

B) Another similar group would be shown the same scenes and hazardous waste facilities would be identified.

CONCLUSIONS

The potential for techniques like those described raises the question of which factor has the most influence on people's reactions to a project: the characteristics of project appearance (e.g., scale, recognizable shape, color contrast), or the meanings and associations intrinsic to the type of project. How much, for example, can design of a hazardous waste facility reduce people's negative associations with the project and thereby possibly reduce stress? If a facility is sited to be invisible from most vantage points, or is restored to a natural appearance, to what extent is it "out-of-sight, out-of-mind?" Other kinds of projects have been deliberately disguised in an attempt to reduce adverse aesthetic reactions: examples include the architectural treatment of powerplants, urban sub-stations concealed within building facades, and offshore oil facilities designed to look like an island of palm trees in views from Southern California beaches. Could the disguise approach work for hazardous waste sites? Conversely, it may be important for high-level radioactive sites to be designed with permanent visual markers in which case, are there precedents in history[36] or in instinctive behavior[37] which could be used to design such markers?

Answers to these kinds of questions are not yet available. The application of aesthetics and perception science to hazardous waste projects has barely begun [28]. One of the key issues yet to be investigated is as important to hazardous waste projects as it is to other types of facilities: are people's predictions of the visible effects of proposed projects as bad (or good) as their actual reactions to the project? Research on powerlines [38] indicates that, once built, projects may be accepted more readily than is anticipated during project planning, but [32] found that predictions based on visual simulations of various projects tended to err in both directions: some built projects appeared better than expected, while others appeared worse.

It is clear that we need to learn more about how people perceive hazardous waste projects, and how best to incorporate aesthetics into the planning process. Research efforts such as the May 1986 U.K.-U.S. "Joint Seminar on the Role of Environmental Perception in the Siting of Hazardous Technological Facilities," in Surrey, England, may soon begin to provide answers.

In the meantime, it is also clear that much can be done to increase awareness of the aesthetics-related issues of hazardous waste, and to reduce the chances of inappropriate use of aesthetic study findings. Aesthetic studies are required for many hazardous waste projects. They need to be conducted carefully and defensibly. This requires some sort of public input, which itself must be carefully conducted to provide valid and unbiased data and avoid conflict. Such an approach may demand specialized knowledge and sophisticated techniques (e.g., surveys and photosimulations) in order to satisfy the demands of peers, agencies, the courtroom, and the public. However, to

assume that this effort is unnecessary and that the aesthetic issues will always take care of themselves may be to lose valuable opportunities to communicate with the public, explain the project, and establish the credibility of the studies; worse, it may even mean surrendering control of the project.

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