Beyond Waste Issue Paper

Management According to Risk

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Getting "Beyond Waste"

The Department of Ecology (Ecology) has embarked on a project to update the statewide solid and hazardous waste management plans. The aim of the Beyond Waste Project is to guide Washington in a new direction away from simply managing wastes and toward preventing wastes from being generated in the first place. The vision statement for Ecology's Beyond Waste Project is, ***"We can transition to a society that views waste as an inefficient use of resources and believes that many wastes can be eliminated. Eliminating wastes will contribute to social, economic, and environmental vitality."***

This is one of eight issue papers prepared by Ecology staff to help in the development of strategic plans to move Washington in a new direction, a direction that will take us beyond waste.

Scope

The scope of this issue paper is to address the following questions:

- How have we used risk to determine and evaluate program activities?
- Is our view of risk different now than 15 years ago?
- How do we view risk now?
- What should we do differently in the future?

Introduction

The Hazardous Waste and Toxics Reduction (HWTR) Program regulates wastes that are known to be inherently risk laden in that they have the capacity to cause harm to human health or the environment. The *Dangerous Waste Regulations* were developed in the early 1980's to provide a system for identifying wastes that require special handling requirements to ensure that human health and the environment are not compromised by exposure to such wastes. The "cradle to grave" system ensures that wastes that have been identified as hazardous are identified and managed until their final disposition. There have been ongoing debates about whether or not the correct wastes are regulated as dangerous waste, and whether regulating wastes without also looking at products provides sufficient safeguards.

The waste continuum includes inert waste, solid waste, dangerous waste, extremely hazardous waste, and acutely hazardous waste. There are some other categories including infectious waste, medical waste, special incinerator ash, biosolids, corrective action/cleanup debris, and mixed (radioactive and chemically hazardous) waste.

The early focus of waste management was on identifying and containing wastes for zero release. Risk factors that were used to identify wastes were quantity, hazard characteristics such as reactivity and corrosivity, toxicity, concentration of persistent compounds, and concentration of carcinogenic compounds. Wastes with the greatest hazards were regulated at lower quantities than wastes with lesser hazards, which could be regulated at higher quantities. Generators are encouraged to reduce the quantity and toxicity/hazard of their waste to save waste management money. For example, wastes that are considered to be solid wastes only, and not hazardous, are less expensive to manage since they can be managed as solid waste. Pollution prevention activities and planning look upstream to reduce wastes and toxicity, but some waste problems may be inherent in manufacturing or process design. Currently, pollution prevention activities take place too late to impact opportunities that exist in early facility or process design.

How does this issue paper link to Ecology's Beyond Waste Vision?

In looking at the way regulation according to risk is approached, this paper encourages looking beyond the creation of wastes themselves by looking upstream to whole production processes and the materials used in those processes, as well as the products that may be equally as toxic as dangerous wastes. It is only in looking at whole processes that we will be able have a serious impact on the types of wastes that are created. Regulation of wastes according to risk, upstream processes, and how risk is defined in the future will impact potential changes to the fee structure and to future pollution prevention activities.

While there are many things that are going well within the traditional "cradle to grave" system for managing hazardous wastes, this paper offers some insights into alternative ways to explore managing and reducing risks.

Increased use of wastes to produce products (recycling or "upcycling") is one way to work toward the vision of eliminating waste. However, risks posed by the wastes or the hazardous constituents in the wastes can be barriers to using those wastes to make products. Finding ways to reduce the risks posed by wastes will reduce barriers to reusing wastes.

What is meant by the term "risk"?

Background on Risk Assessment

Risk is often evaluated within a risk assessment framework. Risk assessment is an evolving methodology used to estimate the severity and likelihood of harm to humans and ecological receptors from exposure to hazardous substances. It is one input to environmental management decisions. Other inputs include stakeholder concerns, availability of technical solutions, cost/benefit analysis, legal mandates, and political issues. Risk assessment is a systematic and tiered approach to analyzing scientific knowledge and information for potentially hazardous substances or activities. Applications are numerous, including determining health and environmental problems associated with a variety of risk agents.

From a risk assessment perspective, risk is typically characterized by both toxicity and exposure. Both of these components are needed to generate risk. In turn, toxicity depends on dose to the target site, while exposure depends on pathway to the target (as well as contaminant fate/transport properties, spatial/temporal patterns of contaminants/receptors, etc.).

Human health risk assessment

The paradigm for human health risk assessment was initially conceived by the National Research Council (NRC, 1983)[1]. The four major steps include hazard identification, toxicity assessment, exposure assessment, and risk characterization. Hazard identification characterizes the source term (that is, amount and concentration of contaminants). The toxicity assessment describes the relationship between contaminant dose and adverse biological effects (for example, non-cancer reference dose, and cancer slope factor). The exposure assessment describes contaminant pathways to potential receptors and exposure scenarios. Finally, risk characterization integrates toxicity and exposure assessments, along with attendant uncertainties.

Ecological risk assessment

The model for ecological risk assessment was first detailed by EPA (1992)[2]. This model primarily parallels the human health risk assessment paradigm. Three major steps include problem formulation, exposure and effects analyses, and risk characterization. Problem formulation identifies source, pathways, and receptors. The analysis phase characterizes contaminant exposure (for example, temporal and spatial patterns and exposure point concentrations) and biological effects (for example, no observed adverse effect level (NOAEL)). Finally, risk characterization integrates exposure and effect analyses to estimate risk (for example, hazard quotient (HQ)=exposure/effects). This final step typically includes an uncertainty analysis, as well.

Regulation and Risk

The *Dangerous Waste Regulations* regulate wastes based on toxicity, both the federal characteristic of toxicity and the state's separate toxicity criteria. In addition to regulating wastes based on toxicity, risk from other sources has historically been regulated by the Hazardous Waste and Toxics Reduction Program. Other risks include those from corrosivity (high and low pH), reactivity (explosions), ignitability (spontaneously bursts into flames), carcinogenicity (causes cancer), mutagenicity (causes mutations), and persistence (compounds that remain in the environment for a long time).

The term risk is also used to mean those factors that can increase the chance of undesirable consequences from waste generation and management. Spills, releases, human and wildlife exposure, soil and water contamination, air pollution, abandoned waste, improper disposal are examples of some of the consequences. The *Dangerous Waste Regulations* are designed to prevent exposure such as releases by spills or waste containment failures or by waste mismanagement (for example, waste managed as solid waste instead more securely managed as hazardous waste). One important activity in reducing risk is to independently verify that hazardous waste is being managed correctly. Since resources do not exist to inspect all waste generators on a regular basis, risk factors such as quantity and type of waste generated are used to identify the highest priority facilities to inspect.

Regulatory Design

The earliest focus of the hazardous waste program, in the late 1970's, was to identify wastes that were primarily being disposed of on the land in dumps and surface impoundments, but which posed risks to human health and the environment. Risks resulted from the land disposal of certain wastes that were not being adequately managed by the rules that governed them at the time. The goal was to reduce the risk to human health and the environment by precluding an exposure pathway, in other words, achieving 100% containment of these wastes from the time they were generated until they were destroyed or while in their final disposal location.

The authors of Washington's hazardous waste disposal law in 1976 were thinking far ahead of the times by defining the characteristics of hazardous waste to include waste which "will persist in a hazardous form for several years or more…may be concentrated by living organisms through a food chain…may affect the genetic make-up of man or wildlife." The defining characteristics also include toxic, carcinogenic, mutagenic, or teratogenic properties as well as corrosive, explosive, flammable or reactive hazards.

In the regulations that implement the law, surrogates for the characteristics of hazardous waste were devised with the intent that they would be easy to implement and could be objectively measured and would achieve the intent of the law. The original surrogates were acute toxicity as a measure of toxicity and the presence of two

families of persistent chemical compounds - polycyclic aromatic hydrocarbons and halogenated hydrocarbons - as an indicator of persistence. A reference list of human positive or suspected cancer compounds was used to identify carcinogenic waste. A study of this system in 1994 resulted in the removal of the carcinogenicity criteria since most wastes that designated because of this criterion were already regulated under another category.

In addition to these characteristics of hazardous waste, two risk factors, quantity and concentration, were used to distinguish three management categories of waste: solid waste, dangerous waste (DW), and extremely hazardous waste (EHW). Wastes with the highest concentrations of toxic or persistent constituents, extremely hazardous waste, were regulated at lower quantities than dangerous waste. This "degree of risk" approach defined a continuum of waste management with the intent that the most stringent standards be applied to wastes that posed the most risk. The effect of these rules in the early 1980's was to provide more protective management and disposal for wastes defined as hazardous, both DW and EHW. But the use of quantity in determining whether a waste is hazardous or solid waste is one of the potential weaknesses in the system.

Waste is classified into one of the three categories at the "point-of-generation" by the person responsible for creating the waste. The quantity of waste generated each month determines the line between solid waste and the two categories of hazardous waste; dangerous waste or extremely hazardous waste. If less that 2.2 pounds of EHW or 220 pounds of DW are generated each month then that waste does not need to be managed in the hazardous waste system. This is known as the small quantity generator conditional exclusion. In 1985, concerns were raised that there would be enough of this waste to pose a threat in the local solid waste landfills. The hazardous waste law was amended to allow local government to determine whether they wanted to prohibit hazardous waste from small quantity generators to be disposed of in their landfills.

There are fewer local solid waste landfills in Washington State today, and the large regional landfills are designed for better containment of the waste than solid waste landfills in the past. However the small quantity issue remains for hazardous wastes that may not be sufficiently contained or treated by the solid waste system or the wastewater treatment system. Additionally, due to constraints on local government resources, oversight and technical assistance to businesses on the management of these wastes is limited in some areas.

RCRA/Dangerous Waste Strategy and Loopholes

The federal Resource, Conservation, and Recovery Act (RCRA) and state dangerous waste programs attempt to reduce exposure (and thereby reduce risk) to hazardous/dangerous waste by isolating the waste through containerization, treatment, disposal, etc. However, it is clear that some wastes (for example, excluded wastes and abandoned wastes) escape the system and enter the environment where both humans

and ecological receptors may be exposed. This is particularly concerning for persistent, bioaccumulative, and toxic (PBT) compounds that have been linked to numerous adverse effects in humans and other biota.

For example, a recent U.S. Geological Survey study on organic contaminants (e.g., pharmaceuticals, hormones, pesticides, fire retardants, and plasticizers) in U.S. streams demonstrates the wide variety of compounds that have been released to the environment (Kolpin et al, 2002)[3]. Although drinking water guidelines and aquatic life criteria were rarely exceeded, many compounds do not have such guidelines. In addition, little is known about the fate/transport characteristics (including biotransformation products) in the hydrologic/sediment system, as well as the potential interactive effects (e.g., synergistic or antagonistic toxicity) that may occur from these complex mixtures in the environment.

Exemptions and Exclusions

As the hazardous waste program developed, decisions were made at both the state and federal level to exempt or exclude certain wastes and not to count others. These decisions skew the picture of what is considered dangerous waste in the state. On the surface it may appear that more waste is regulated under the current system than actually is. The following paragraphs describe many of these types of wastes. There are approximately 36 categories of excluded wastes in the *Dangerous Waste Regulations*. One issue with excluded wastes is being able to address the question "are we sure the risks from these wastes are being adequately addressed?" Over time, things have changed significantly in our understanding, scientific knowledge, and in the environmental programs and systems that are in place to manage these excluded wastes. The largest categories of excluded wastes are those from households, industrial wastewaters, incinerator/wood ash, dredged materials, and from wastes/debris that is regulated under cleanup or corrective action authorities.

The *Dangerous Waste Regulations* no longer require the counting and reporting of certain wastes managed in on-site elementary neutralization units, wastewater treatment units, or totally enclosed treatment facilities. Since the data is no longer collected on the quantity or concentration of hazardous constituents in these wastes and wastewaters, it is not certain that the wastes are being adequately treated or if the risks posed by the hazardous constituents are being properly controlled. Anecdotal information from the Water Quality Program indicates they do not have sufficient information about the quantities, adequacy of treatment, or risks either.

Recycling exemptions or recycled wastes: There are alternative management and reduced requirements for certain *secondary materials* that are "accumulated speculatively," or are held prior to "reclamation." Certain recycling processes result in exemption from the definition of solid waste (exempt from *Dangerous Waste Regulations*) if used/reused as ingredients, effective substitutes, or returned to original processes.

There are also administrative *variance* procedures whereby solid wastes that are dangerous may be evaluated and deemed exempt when recycled in various ways.

Various exemptions or reduced requirements exist for wastes recycled, reclaimed or recovered. These include scrap metals and certain fuels/oils managed in accordance with the specified requirements. The *Dangerous Waste Regulations* provide reduced requirements or conditional exemption for recycled or reclaimed spent CFC or HCFC (chlorofluorocarbons) refrigerants, spent lead acid batteries, precious metal recyclable materials, spent antifreeze, and "universal wastes" (batteries, mercury thermostats, and fluorescent light tubes). There is also a conditional exemption for waste military munitions. Alternative management or conditional exemption is also available for certain wastes managed under other authorities or permits, pursuant to Permit by Rule.

In addition to exemptions and exclusions, an area that is not covered by similar regulation is use of hazardous substances and products. The existing program focuses on managing wastes. The same precautions and safeguards are not in place for products and substances. Releases during the use of hazardous substances (earlier in a process than when wastes are created) may naturally occur (some releases are permitted). Also, releases from the use of products either prior to processing/manufacturing or post-manufacturing should be better controlled in order to meet the Beyond Waste vision.

As mentioned above, the recent U.S. Geological Survey study on organic contaminants (e.g., pharmaceuticals, hormones, pesticides, fire retardants, and plasticizers) in streams demonstrates the wide variety of compounds that have been released to the environment. It is unknown whether the compounds found in streams are from wastes or from product use by businesses or individuals. It has long been recognized by those working on hazardous waste issues that it does not make sense to regulate wastes so carefully from cradle to grave, but have no similar management requirements for products.

How have we used risk to determine and evaluate program activities?

The following activities, factors, and approaches have been used to address risks associated with the creation and management of dangerous wastes. By creating a thoughtful, targeted approach, generators can be educated to think about reducing or substituting the products they use that result in the generation of dangerous waste. Spills and other incidents that increase risk exposure can be limited by more effectively managing processes and wastes.

Wastes are regulated because they exhibit risk in some form to human health or the environment. The *Dangerous Waste Regulations* are considered to be self-implementing regulations in that it is the responsibility of the generator of waste to determine what their requirements are under the law. There are many more generators of dangerous

waste in the state than those that are visited on an individual basis by Hazardous Waste and Toxics Reduction Program staff. Depending on program resources, various factors and approaches have been used over the years to determine which waste streams and types of generators should be targeted in order to obtain the best results from the resources available.

Targeting Inspections
Activities have often been targeted based on generator status categories. There are several categories of dangerous waste generators in Washington State. Dependent on the amount of waste generated, generators are classified as small (conditionally exempt) quantity generators (SQG's), medium (MQG's), and large quantity generators (LQG's). Moderate risk waste (MRW) generators consist of either or both SQG's and households. (Household hazardous waste is categorically exempt from dangerous waste regulation.)

Inspections based on the size of the generator are meant to address risk in terms of waste quantities. Larger quantities of waste may translate into greater risks due to potentially large quantities of abandoned waste, increased environmental contamination if those wastes are not properly and safely managed, or increased worker exposure. Other methods of targeting inspections or site visits are based on waste type and industry type, or complaints about specific businesses or the past history of that specific business. Inspections or site visits have also been targeted based on information that shows that small quantity generators benefit from increased contact with Ecology staff, resulting in a higher level of knowledge and compliance by a larger number of generators who individually generate small amounts of waste.

Increased Generator Contact
Increased Generator Contact (IGC) visits allow Ecology staff to visit a large number of generators/facilities in a relatively short amount of time. These generators are not necessarily those who generate the most waste. Often, these are visits to a large number of small quantity generators. Such visits have been used to cover an entire industry or a geographic area of small and medium quantity generators.

Sector Approaches and Single Industry Campaigns
Ecology has conducted a number of campaigns that reach a large number of generators in a certain "sector" or industry. These campaigns identify a segment of business or industry where Ecology can provide information to a large number of generators in a targeted approach. Both compliance and pollution prevention information is communicated to the generators during visits by Ecology staff. These efforts are based on identification of risk using methodology that ranges from identifying a large number of generators in a specific area to knowledge that the waste they produce is one that can be significantly reduced with minimal effort. Such targeted approaches include:

- Shop Sweeps – automotive
- Snap Shots – printing and photo processing
- School Sweeps – community colleges

- Integrated Pest Management – schools
- Shipshape – marinas
- Wood treaters
- Plating industry
- Transporters

Is our view of risk different now than 15 years ago?

The focus in the early years was on the creation and development of a system in which dangerous wastes would be appropriately managed. Now that the program has been in place for approximately 20 years, areas of risk that should be considered include looking at opportunities within processes that will result in less waste and less toxic waste being created in the first place and other types of compounds and situations that the early regulations did not address. The early law was quite proactive in seeing the need to regulate wastes based on such things as risk of developmental toxicity. However, risks that were either not apparent, or that are new continue to come to light. These new risks must be explored to see if the HWTR Program should be modified to address them. Newer risks include those from products, PBT's, endocrine disruptors, pharmaceuticals that are showing up in the environment such as antibiotics and new compounds from genetically modified organisms. An example of relative risk from household goods and products was discovered during work on Ecology's Mercury Action Plan. It has been estimated that the mercury in consumer products is a higher source of mercury released to the environment than mercury from mining operations and coal-fired combustion combined, the two largest previously identified sources. Another approach may be to look at risk from many small sources as opposed to risk from fewer large sources.

How do we view risk now?

As the HWTR Program has "matured," the regulation of wastes has changed. The *Dangerous Waste Regulations* have been modified in many different ways. One example is that fewer wastes are now regulated as EHW than in earlier years. Waste management technologies have changed and the perception of hazard has been tempered with the development of disposal technologies and experience with how wastes are managed.

We have learned over the years that it is important to acknowledge the risk of small amounts of waste produced by large numbers of generators. Cumulatively, these add up to sizeable amounts, plus there are fewer regulatory requirements for these generators to follow, so there may be more risk from their waste. In 1995, the HWTR Program increased the amount of waste that may be accumulated by small quantity generators (those with the least number of requirements to comply with) before they are more fully regulated. As a result, larger amounts of wastes can be accumulated with

less oversight and less stringent disposal requirements. This could also pose a greater risk.

We are also becoming increasingly aware of the risks associated with whole processes and acknowledging that more than just the risks associated with wastes should be looked at. Program activities have been looking at whole processes in more recent years largely through pollution prevention efforts, but it would be valuable to work with facilities before they even begin building so that all potential waste and hazardous/toxic inputs could be considered prior to construction.

An area in which the HWTR Program does not currently have regulatory authority is the management of products that have the same properties as wastes that are considered "hazardous." Consideration should be given to regulating "hazardous" products because they are, in essence, just as toxic (sometimes less, sometimes more) than wastes that are subject to requirements that are protective of human health and the environment. Reaching the Beyond Waste vision will require a more comprehensive approach, including addressing process inputs and product use, and not focusing exclusively on risks posed by wastes.

Likewise, new areas have become apparent, such as PBT wastes. This has brought into question such things as how to identify an appropriate level for regulating these wastes.

What happens if we make no changes in how we manage wastes according to risk?

While it is impossible to predict the future, it is at least certain that if we make no changes to how we currently focus on regulation of wastes without looking more at the processes that create these wastes (and products) and at new information emerging about risks for other types of compounds, we will be missing many opportunities to affect the nature and character of wastes that are created in the future. We may also someday appear to have been negligent with respect to having missed regulating newly emerging categories of wastes, such as those from genetic engineering or new persistent compounds.

How does what we do now detract from where we want to go based on our vision?

HWTR Program activities are currently split between regulation and management of wastes that are created, and work to assist facilities in looking at their processes to reduce wastes (pollution prevention). The work on pollution prevention is based on planning that is required by some facilities, but it is not mandatory that the plans are implemented. Having Ecology Technical Resources for Engineering Efficiency (TREE) teams work with facilities is also a voluntary process. These are positive steps that must

not be dismissed as detractions; however, in the future we will need to develop incentives so that all facilities in the state will look at their processes, eventually resulting in a significant reduction in wastes by both type and hazard. Paying more attention to what goes into the front end of production processes and to what is in products should result in smaller volumes of waste that are inherently less risky. Also, forethought should be given to processes so that "wastes" can be used as substitutes for other inputs in production processes.

What should we do differently in the future?

In the short-term, we should continue with the existing regulatory scheme, but make modifications to address risk issues as much as we are able to within the current system. The existing system has had many successes at keeping hazardous wastes well managed and in a manner that has been protective of human health and the environment. A mid-term goal will be to regulate high risk newly identified wastes that should be managed as hazardous waste, to target our efforts at inspections somewhat differently than they have been in the past, and to continue to work on waste reduction initiatives. Incentives for waste reduction and hazard reduction should be built into the regulations. In the long-term, as other Beyond Waste initiatives are implemented, the regulatory system should transform into a system that contributes to positive reinforcement for facilities and businesses that reduce their wastes and the hazards of the wastes they create, and that increase their recycling/"upcycling." Instead of a focus on waste only, the regulatory system will reward generators and facilities for producing less waste and finding ways to reuse, recycle, and "upcycle" wastes that are created. Products and substances should be subject to regulation in much the same manner as wastes. Those with higher hazards should be subject to more stringent management scenarios.

Recommendations for changes that are needed to move toward the Beyond Waste vision

- Continue working within the existing system (with appropriate modifications) for managing wastes that are created.
- Look for opportunities to blend hazardous waste regulatory requirements with new initiatives for waste reduction.
- Improve the regulations to encourage legitimate recycling and "upcycling."
- Incorporate criteria into the regulations for identifying wastes that are considered a high enough risk to warrant hazardous waste regulation.
- Target initiatives to address the many small quantity generators who produce small amounts of waste (these add up to larger, less regulated quantities of waste).

- Conduct frequent inspections and site visits (recent information shows that more frequent inspections correlates with higher levels of compliance, see the Compliance issue paper).
- Coordinate with pollution prevention efforts to work as far "upstream" in a process as possible to include new facilities in the design stage.
- Coordinate with permitting efforts to eventually see the development of a system for permitting and corrective action that transcends the current treatment, storage, and disposal model and matures into a *second generation treatment* (by reclaiming, reusing, or recovering for beneficial value), *stocking*, and *distribution* facility.
- Address risks posed by hazardous products and substances. Ecology does not have the authority over substances and products that it has over waste, but products or substances may pose greater hazards than wastes. The concentration or quantity of hazardous constituents in products being used or stored around us, and potentially released to the environment, is often higher than in wastes.
- Support work that EPA is doing which looks at new risks. In its paper on future waste and materials management (Fagan, 2001)[4], several points are made relating to risk. New risks are addressed (e.g., new chemical compounds derived from genetically modified organisms); the need to protect sensitive subpopulations (e.g., children, the elderly) is emphasized; attention is drawn to cumulative risks from multiple chemicals/multiple exposure pathways; and the need to conduct life cycle analysis for new chemicals when they are produced is highlighted. The paper proposes that the focus should be on materials management, as well as proper waste disposal, in order to reduce the amount of toxic chemicals in the environment. Finally, the paper suggests creating a comprehensive system for waste and materials management in a single unified program for all environmental media, in ways that go far beyond the scope of the current hazardous waste program. Such a program may not be in the immediate future, but we need to begin looking at processes and wastes and all media in a more comprehensive manner as soon as possible.

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