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Improving Waste & Materials Tracking
in Washington

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Executive Summary

The Washington State Department of Ecology is charged with protecting, preserving and enhancing Washington's environment; and promoting the wise management of air, land and water for the benefit of current and future generations. To support this mission, Ecology's Solid Waste and Financial Assistance Program (SWFA) and the Hazardous Waste and Toxics Reduction Program (HWTR) have together launched the Beyond Waste Project. This project will guide Washington in a new direction, from containing and managing wastes toward creating systems where waste does not exist – systems that prevent waste in the first place, view materials as valuable resources, and eliminate toxics.

Ecology's Beyond Waste vision:

"We can transition to a society that views wastes as inefficient uses of resources and believes that most wastes can be eliminated. Eliminating wastes will contribute to social, economic, and environmental vitality."

In transitioning to Beyond Waste, it will be important to monitor progress toward the vision by tracking how much waste is generated in Washington. Currently, Ecology's SWFA and HWTR programs track many types of waste, including solid waste disposed in landfills, moderate risk waste collected for treatment, and hazardous waste generated by many types of businesses, industries, and institutions. Still, many waste and material flows are currently not tracked. Because Ecology's Beyond Waste vision requires a broad understand of the types and quantities of waste generated in Washington, the consultant team was asked to prepare a methodology to more comprehensively track future waste generation.

This report addresses waste and materials tracking in Washington in two fundamental ways:

- By examining current waste tracking systems to assess gaps in understanding, and evaluating the significance of those gaps in measuring progress toward the Beyond Waste vision; and
- By developing and evaluating possible tracking approaches to improve the understanding of waste and material flows in Washington State.

Based on these assessments, the consultants make the following recommendations to improve waste and materials tracking in Washington.

RECOMMENDATION 1: ADOPT MATERIAL FLOW FRAMEWORK

In moving forward with the Beyond Waste vision, it will be important to consider not only the quantities and types of waste but also the input of materials into the economy and the processes that transform them into the products and structures used in our daily lives. Such a focus will help Ecology to anticipate and prevent future waste. Accordingly, the consultants recommend adoption of a new conceptual model that helps organize and describe what materials and wastes are used and generated. This model could be patterned after the *material flow framework* described in Consultant Team Issue Paper #1 -- Waste and Material Flows in Washington.

RECOMMENDATION 2: ASSESS UNTRACKED FLOWS

Current tracking systems do not completely monitor many of the waste and material flows in Washington. Examples of these untracked flows include overburden and waste ore from mining operations; many industrial wastes disposed or stored on-site; forestry slash; spent pharmaceuticals that make their way into water bodies, carbon dioxide and other greenhouse

gas emissions, and agricultural wastes, among others. In moving forward with the Beyond Waste planning process, Ecology will need to conduct assessments of these untracked flows to characterize them and determine their relevance and importance to the Beyond Waste vision.

RECOMMENDATION 3: DETERMINE AND RANK SIGNIFICANCE OF MATERIAL AND WASTE FLOWS

Given the multitude of material flows and wastes – tracked and untracked – Ecology needs a rigorous methodology to establish priorities for which materials and wastes to manage and address and in which order. The consultants recommend that such a methodology consider both the magnitude of each flow as well as a measure of toxicity or inherent hazard grounded in a rigorous scientific assessment.

RECOMMENDATION 4: ADOPT INDICATOR APPROACH

The consultants recommend that Ecology develop indicators to track generation, use, disposal, and recovery of the priority wastes and materials determined above. In the indicator approach, specific indicators are strategically selected to measure key, significant waste or material flows, as well as other factors that measure progress toward the Beyond Waste vision such as behavior change, value created, etc. Indicators have the potential to provide useful and meaningful information to a broad audience while reducing data tracking and management responsibilities. Additional indicators and performance measures will likely be needed to track effectiveness of specific programs, to set priorities, and to meet other state or federal reporting requirements.

RECOMMENDATION 5: ADDRESS SIGNIFICANT GAPS

Once the exact set of indicators has been finalized, Ecology will need to focus on filling any major information gaps in existing tracking system to support those indicators, as well as those gaps that must be filled in order to meet additional performance measures or reporting requirements. Examples of gaps that should be addressed include the lack of information on the composition of known solid and hazardous wastes and the lack of information on the sources, quantities, and composition of unreported hazardous wastes.

RECOMMENDATION 6: ADOPT ALTERNATIVE DATA COLLECTION METHODS AND MAXIMIZE DATA USE

Given Ecology's resource constraints, a major thrust of Beyond Waste planning should be to find ways for the agency to maximize the utility of information and data that staff already collect during regular visits with the regulated community as well as to employ survey and extrapolation techniques (and data collected by other agencies) in place of reporting, where possible.

RECOMMENDATION 7: CONDUCT PERIODIC EVALUATION AND REVIEW

On a regular basis – as well as when specific needs emerge – managers should reexamine the existing tracking system to determine if it continues to cover the key issues of interest or needs modification. Such an approach will allow the indicators tracking system to be adaptive and flexible – and updated periodically – so that it is not static and ossified.

This package of recommendations is designed to facilitate Ecology's efforts to advance and measure progress towards the Beyond Waste vision. Transitioning to a new system of waste and materials tracking will involve many challenges, some of which are described in this report,

and will require careful coordination between the SWFA and HWTR programs. Nevertheless, moving to a new tracking system can allow Ecology to view the broader system in which wastes are generated, take a proactive approach to reducing and preventing waste, track and communicate its progress toward Beyond Waste more effectively, and potentially, over time, streamline data tracking and management responsibilities.

1. Introduction

This issue paper presents the consultant's research, findings and recommendations on how to develop a methodology to more comprehensively track waste and material flows in Washington State. The findings and recommendations presented in this report rely on the following work completed by the consultant, all part of the Beyond Waste project:

- Assembling and characterizing existing information about material and waste flows in Washington, including developing order of magnitude quantity estimates of wastes. This information was presented in the consultant's first issue paper *Waste and Material Flows in Washington.*
- Researching and documenting trends concerning hazardous and non-hazardous wastes. This information was presented in the consultant's second issue paper, *Achieving the Beyond Waste Vision: A Framework for Moving Forward.*
- Detailed research into specific actions the State and its partners can take to achieve the Beyond Waste vision. These actions are presented in Consultant Team Issue Papers #3 - #6, which focus on organic materials, pollution prevention, and the industrial and construction sectors.
- Conducting an information gap analysis to examine and describe the flows and wastes that are not tracked and characterize the significance of those omissions;
- Preparing and evaluating alternative conceptual approaches for reporting and tracking these wastes and flows; and
- Formulating recommendations for a preferred approach to tracking wastes and flows in the future that ultimately will support implementation of the Beyond Waste vision.

This report presents the results of the above activities, including an assessment of the gaps in Ecology's systems of tracking these flows, three possible conceptual approaches to improving waste tracking, and ultimately a recommended methodology and approach to more comprehensively track waste generation in Washington.

This report is organized into four chapters, with this introduction as Chapter 1.

- Chapter 2 presents an assessment of gaps in Ecology's current tracking systems.
- Chapter 3 describes alternative conceptual approaches to address those gaps; and finally,
- Chapter 4 presents the consultant team recommendations for establishing a new tracking system or systems consistent with the Beyond Waste vision.

Please note that the hazardous and non-hazardous components of the work have been deliberately combined into one integrated report, and section headings are designed to delineate those parts of the report that specifically and separately address the hazardous and non-hazardous waste streams.

KEY QUESTIONS, TRACKING SYSTEMS, AND THE BEYOND WASTE VISION

In late 2001, Ecology formally adopted an overarching vision to guide the formulation of 1) an updated strategic plan for hazardous wastes to be prepared by the Hazardous Wastes and Toxics Reduction Program (HWTR) and 2) an updated plan for solid and non-hazardous wastes to be prepared by the Solid Waste and Financial Assistance Program (SWFA). This shared "Beyond Waste" vision commits Ecology to implementing policies and programs to reduce wastes and the use of toxic substances in Washington to the greatest extent possible:

> *We can transition to a society that views waste as inefficient uses of resources and believes that most wastes can be eliminated. Eliminating wastes will contribute to social, economic, and environmental vitality.*

The initial work of the consultant team focused on understanding material and waste flows and then formulating a viable methodology to "track what matters" in support of this broad vision. In assessing the current tracking systems and developing alternative approaches, the consultant worked closely with Ecology staff to define a series of "key questions" that the ideal tracking system must answer. Through a collaborative approach, eight such questions were formulated. These are presented below with a brief discussion of their meaning and significance.

1. **Total Waste: How much waste are we producing?** This question goes to the heart of the Beyond Waste vision, and calls for a tracking system that effectively measures the bottom line of total waste generated and disposed.
2. **Inputs & Efficiency: Are we reducing the use of materials over time?** This question compels Ecology to look "beyond waste" and consider the inputs to Washington's economy and the efficiency with which materials are transformed into goods and services. Ecology is already working in this arena. For example, current pollution prevention and waste reduction initiatives are focused on these issues.
3. **Return Flows & Eco-Effectiveness: How much and what is the value of "waste" output returned and reused as material inputs?** This question requires measuring how much "waste" material is returned to the economy to be reused and what value is associated with that reuse. The question addresses the "waste = food" concept, the definition of "beneficial use," and requires a consideration of "downcycling," or reduction in value of materials that are recovered for recycling after their initial use in the economy.
4. **Risk & Inherent Hazard: Are we reducing risk from toxic materials and wastes?** A fundamental aspect of achieving the Beyond Waste vision is to reduce risk to the environment and human health from toxic materials to the greatest extent possible. In fact goals associated with this vision call for eliminating the use of toxics as well as most hazardous wastes. An effective tracking system therefore would measure the change in both the amount of toxic materials in the economy as well as hazardous waste outputs.

5. **Contribution to Vitality: Does eliminating wastes contribute to economic, environmental, and social vitality?** The Beyond Waste vision anticipates that significant benefits will be associated with eliminating wastes. Accordingly, it will be essential that the tracking system identify and measure these benefits.
6. **Behavior Change: Are residents, businesses, and institutions taking actions to achieve the Beyond Waste vision?** This question seeks to understand how the behavior of those who produce and consume materials and generate waste is changing in relation to the goal of eliminating waste. Tracking behavior change involves monitoring attitudes and practices that over time may lead to a reduction (or increase) in waste outputs.
7. **Beyond Waste Strategy Effectiveness: Are Ecology's strategies achieving their intended goals?** Beyond Waste Consultant Team Issue Papers #3-#6 identified and analyzed Beyond Waste strategies designed to achieve the vision – specifically focusing on organic wastes, wastes in the industrial and building sectors, and pollution prevention. Accordingly, the performance of these strategies will need to be monitored to determine whether they are achieving their goals in an efficient and cost effective manner.
8. **Capacity & Safety: Do we have adequate, safe facilities to handle remaining wastes?** This final question, while not directly related to the Beyond Waste vision, is tied to the core mission and regulatory responsibility of Ecology. Until such time as no materials enter waste handling or disposal facilities, Ecology is charged with ensuring that there is adequate capacity to safely handle wastes. Accordingly, a viable tracking system must include a monitoring mechanism for capacity and safety of waste handling facilities.

Of these questions, the first five are most directly related to determining if Washington State is indeed moving over time towards achieving the Beyond Waste vision. Questions 6 and 7 are also related to the Beyond Waste vision but in a slightly less direct way. And question 8 addresses the problems of managing wastes independent of the vision.

This initial discussion of key questions and Beyond Waste vision has been provided to provide the context and starting point for this report. The following chapters evaluate the gaps in Ecology's waste tracking systems and identify and recommend alternative approaches for Ecology to consider to better answer the key questions – ultimately providing the methodology essential to tracking progress towards the Beyond Waste vision.

2. Assessment of Gaps in Waste Tracking

OVERVIEW

Environmental agencies like the Washington Department of Ecology require accurate, timely, and relevant data to make informed programmatic and regulatory decisions. However, data collection, management, and analysis consume large amounts of resources while competing with other program activities (e.g., technical assistance, enforcement, and regulatory development) for support. This tension leaves many agencies' data resources incomplete. Like most programs, Ecology's Solid Waste and Financial Assistance (SWFA) and Hazardous Waste and Toxics Reduction (HWTR) programs continually wrestle to find the right "balance point" between data management and implementation activities and to address key data gaps. Effective implementation of the Beyond Waste vision requires the SWFA and HWTR programs to re-examine their information holdings, gaps, and priorities so that they can address changing data needs.

Historically, Ecology has tracked specific waste flows to air, land, and water while monitoring for specific contaminants in the environment. As a result, the agency's historical datasets present a fairly complete picture of the magnitude (volumes) of Washington State's **waste** streams, especially solid waste. Hazard information for most waste streams, however, is seldom collected. To date, Ecology has not placed great emphasis on tracking volumes or assessing the inherent hazard of hazardous/non-hazardous substance **inputs, process transformation** or the **incorporation of certain substances (especially toxics) into products**. As a result, Ecology's understanding of these important material flows is significantly less robust.

INFORMATION FLOWS: WHO COLLECTS THE DATA

Much of the data "collected" by Ecology are submitted by regulated facilities or enterprises; others are obtained directly by Ecology staff. For some flows, Ecology depends on other entities (including other state and local environmental, agriculture, or health agencies) to share pertinent information. In some cases, Ecology relies on studies conducted outside its jurisdiction. Realistically, some important flows are not tracked at all. Given perpetual resource burdens (both to facilities and to Ecology) associated with data collection, management, and analysis, these gaps are expected and reflect where Ecology has chosen to focus resources. At this juncture the challenge facing Ecology is to determine which gaps are most significant and should be plugged to enable and hasten Ecology and the State's progress towards the Beyond Waste vision.

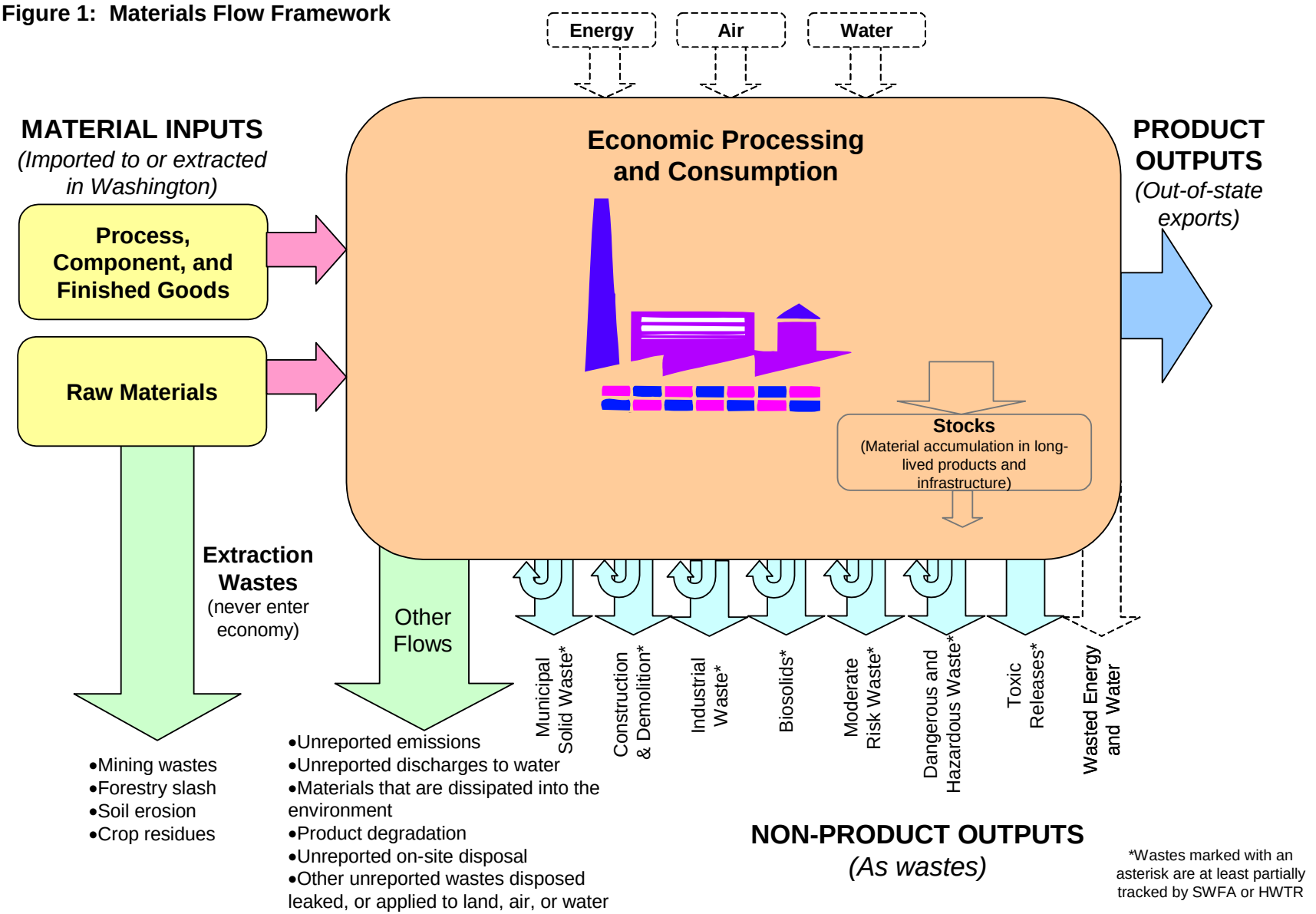
CHARACTERIZING THE INFORMATION GAPS

The data gaps found in the Department of Ecology's materials/waste systems vary in size, type, composition, and significance. Some are a function of mandated reporting requirements. For example, Toxics Release Inventory data is only obtained from certain types of industries with reporting required for certain chemicals above a specific quantity threshold. Some data gaps may be associated with underreporting. Others are the result of imperfect measurement techniques (e.g., some facilities may not be equipped

with sufficient scales or resources to measure waste stream quantity and composition). Others arise because Ecology does not request specific types of information (e.g., concentration of specific chemical releases). In addition, some material flows, such as cell phones and other electronics, may be altogether new. Other gaps are tracked elsewhere or for different purposes.

This section outlines several key gaps in Ecology's understanding of hazardous and non-hazardous materials flows in the Washington State's economy. Information gaps are listed in tables, and are organized according to the material or waste outputs depicted in the material flow framework, which is shown below. This chart was first presented in the consultant's first issue paper -- Waste and Material Flows in Washington, where it is described in more detail.

Figure 1: Materials Flow Framework



For each gap, this report will present the following information:

- **Current or Available Tracking System(s).** What tracking system (if any) currently addresses the relevant waste or material flow (and the gap in it)? If no tracking system is currently used, what other data or information might be used to help understand the flow and plug the information gap?
- **Tracking System Assessment.** How well does the current or available tracking system address the information gap?
- **Relative Significance of Gap.** How significant is the lack of understanding of the flow relative to other flows? A "high" rating means very little information is available about the flow or gap relative to others; a "low" rating means that although there is an information gap, enough information is available to reasonably understand it. The consultant team made these assessments based on the available data. Although not particularly scientific or rigorous, the ratings are meant to be indicative of the relative understanding and availability of information on each gap.
- **Relevance to Beyond Waste key questions.** How important is knowledge about this flow (and plugging the information gap) to answering the key questions posed in Chapter 1? A "high" rating means that however large or small the gap, an understanding of it is very important to answering the key questions; a "low" rating means that plugging the gap is not crucial to answering the key questions, or that enough information already exists to address the gap. An "Assessment Needed" rating means that the flow/gap must be assessed before its relevance can be judged.[1] Recommendation #2 in Chapter 4 will address possible means of assessing these flows.

Table 1 and Table 2 on the following pages list these gaps and assess them according to the above criteria.

SUMMARY OF GAPS

HAZARDOUS WASTE AND TOXIC SUBSTANCE DATA GAPS

Hazardous wastes and toxic releases are, for the most part, carefully regulated to ensure their proper management and to control their movement into the environment. Ecology's hazardous waste data systems contain extensive information on the volumes, types, disposition, and generators of hazardous wastes and toxic substances in Washington State. Notwithstanding this extensive monitoring and tracking network in place, however, significant gaps in Ecology's understanding of hazardous waste generation, movement, and disposition in Washington State do exist. The following types of data gaps are of particular concern:

- **Inherent Hazard.** Information is incomplete related to the chemical composition of hazardous wastes and toxic emissions. As a result, it is difficult to assess fully the inherent hazard of specific waste streams. An additional concern is the

[1] Although the flow may be significantly large, it may not fall within the scope of Beyond Waste planning needs. For example, Ecology may not wish to consider soil erosion as a waste. The assessments proposed in Chapter 6 would determine whether or not the gaps rated "Assessment Needed" should be filled.

possible synergistic or antagonistic effects of combining different hazardous materials. Furthermore, little information is generally reported on the concentration of hazardous substances in waste streams. This issue may be particularly important for hazardous wastewaters, which are produced in high volumes but may contain only small amounts of hazardous wastes. Without this information, it is challenging to monitor and manage for changes in hazardous chemical releases over time.

- **Sources.** Federal law exempts certain hazardous waste generators (such as small quantity generators) from reporting the volumes, type, and disposition of hazardous wastes they produce. As well, other "sources" such as residences or farming operations, may unwittingly or unknowingly introduce hazardous substances into the environment (either via misuse or improper disposal of tiny volumes of hazardous substances). Proper management of such hazardous materials can prove very challenging.
- **Quantity.** The quantities of certain hazardous wastes produced in Washington State are also incompletely understood. For example, currently there are no Ecology programs monitoring the flow of pesticides through Washington State. Consequently, it is difficult to understand changes in overall volumes as well as patterns of use over time. This gap in quantity monitoring reflects the difficult challenge of collecting information in an open and diffuse distribution/use system. Additionally, dangerous waste generators are exempted from reporting on certain waste streams. Tracking the volume of these hazardous substances entering the environment facilitates monitoring the reduction of substances that require consistent attention to limit unintended consequences. Such substances would include wastes receiving a high Vigilance Index score as described in Consultant Team Issue Paper #1 -- Waste and Material Flows in Washington, like asbestos or solvents.

Table 1 below presents and summarizes key gaps in information regarding the flows of hazardous and dangerous wastes in Washington State.

Table 1. Hazardous Waste Data Gaps

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
Toxic releases	▪ Chemicals consumed during manufacture/used as reactants are not tracked ▪ Releases from diffuse, non-industrial sources are not captured by system ▪ Chemical concentration information is currently not collected, thereby limiting ability to estimate exposure risks for specific chemicals	EPCRA System, the Toxics Release Inventory (TRI) Master and Facility Site Database, mainly (Ecology)	▪ Does a good job of capturing releases for all reporting facilities; ▪ Does not cover all industry types (mainly manufacturing and extraction); ▪ Only covers generators with >10 employees; ▪ Only covers releases from facilities that meet certain toxic substance use/manufacturing/ processing thresholds ▪ Does not characterize exposure or calculate potential adverse effects; ▪ Does not track hazardous materials incorporated into products (only releases to air, water, land); ▪ Provides chemical-specific analyses; ▪ Historical database allows for some analysis of trends (although thresholds and tracked chemicals has changed over time)	Low	Medium

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
Dangerous & Hazardous Wastes	*Sources and quantities:* ▪ Certain categories of hazardous waste and hazardous waste generators (SQGs) are exempted from reporting ▪ Amounts of hazardous wastes that are discharged into wastewaters/ stormwater and/or released to air from dispersed sources or during isolated events are not always tracked	HWIMSy (Ecology)	▪ Captures information on facility, industry type, waste type, management type to provide fair picture of traditional waste streams; does not record chemical composition (except for certain waste codes) or concentrations.	Medium	High
Dangerous & Hazardous Wastes	*Chemical composition:* Lack of information on chemical composition of a waste makes it difficult to assess inherent hazard of individual waste streams	HWIMSy (Ecology)	▪ Captures information on facility, industry type, waste type, management type to provide fair picture of traditional waste streams. ▪ HWIMSy does not record Chemical CAS (Chemical Abstracts Service) numbers; RCRA waste codes alone provide limited bases for determining chemical composition of reported wastes. ▪ HWIMSy does not track concentration of hazardous wastes/substances	High	High

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
Hazardous wastewaters	▪ Incomplete information on quantities and concentrations of hazardous substances wastewaters discharged to Publicly Owned Treatment Works (POTW) via common conveyances constrains Ecology's ability to track changes in loading and inherent hazard over time.	▪ HWIMSy (Ecology) ▪ EPCRA System, TRI Master and Facility Site Database, mainly (Ecology)	▪ Hazardous wastewaters are inconsistently reported through HWIMSy and may be set aside during analyses because their high-volume, low hazardous waste concentrations waste streams may dwarf others and mask key trends. ▪ Chemical concentration information is not reported in HWIMSy ▪ TRI reports the total amount (pounds) of EPCRA section 313 chemical discharged to POTWs [See **Tracking System Assessment,** above, to better understand related limitations of the EPCRA reporting system	High	High
Dangerous & Hazardous Wastes/ MSW/Other	▪ Quantity and type of hazardous/toxic materials incorporated into products ▪ Quantity and type of hazardous substances bought and used ▪ Missing data on storage below thresholds	Not tracked in any single system.	None exists	High	High

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
Other Flows: Personal care products and pharmaceuticals (includes antibiotics, surfactants, phthalates)	▪ Unknown quantities and concentration and composition ▪ Potential for direct continual release into the environment ▪ Unknown synergistic/additive or antagonistic effects limit ability to assess inherent hazard ▪ Possible effects at low concentrations ▪ Of special concern for aquatic organisms due to perpetual life-cycle exposure ▪ Potential effects may include olfactory and reproductive impairment[2]	None specifically. Chemicals are seldom monitored for and/or occur at very low concentrations. The INFORM research group (www.informinc.org) has some information available.	No comprehensive system exists, but some progress is being made at a national level by INFORM.	Medium	Assessment Needed

[2] For more information, see *www.epa.gov/nerlesd1/chemistry/pharma/book-summary.htm* or Daughton, C.G. and Ternes, T.A. "Pharmaceuticals and personal care products in the environment: Agents of subtle change?" *Environ. Health Perspect.* **1999**, *107* (suppl 6), 907-938

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
Other Flows: Pesticides	▪ Volumes of pesticides placed into natural environment are not tracked; potentially large flow of untracked material ▪ Lack of understanding of how pesticides are handled, applied, and disposed (due to operation in a diffuse system that allows variability) ▪ Inherent hazard of material requires constant attention throughout product's lifecycle ▪ Limited information on "inert" ingredients	▪ Pesticide Product Registration Database at WSDA ▪ National Agricultural Statistics Service Ag Chemical Usage Database ▪ NCFAP National Pesticide Use Database 1992 and 1997 ▪ EPA Report "Pesticides Industry Sales and Usage: 1996 and 1997 Market Estimates" ▪ PICOL – Pesticide Information Center On-Line (WSU)	▪ No estimates of volume placed into environment ▪ Based exclusively on data collected from WA farmers ▪ Limited survey of specific crops and chemicals ▪ Time series data possible as crops are reselected for survey ▪ Does not track non-agricultural uses ▪ Does not track non-crop applications ▪ Data may rely on information from other states ▪ Limited time series data possible ▪ Comprehensive national level information ▪ Captures non-agricultural use estimates that other sources do not quantify ▪ Searchable information on pesticide labels registered in WA without any ranking of hazard characteristics	Medium	Medium

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
Other Flows: Fertilizers	▪ volumes of materials placed into natural environment; potentially large flow of untracked material that can affect surface water quality by contributing to nutrient overloading through runoff ▪ handling, application, and disposal due to operation in diffuse system	▪ Waste in Fertilizer Database at WSDA ▪ National Agricultural Statistics Service Ag Chemical Usage Database ▪ WSDA Fertilizer Tonnage Reporting System	▪ Contains metals concentrations for which WA has developed soil loading standards ▪ No estimates of volume placed into environment ▪ Based exclusively on WA data ▪ Limited survey of specific crops and chemicals ▪ Time series data possible as crops are reselected for survey ▪ Difficult to extrapolate due to high level content categories (Nitrogen, Phosphate, Potash) ▪ Does not track non-agricultural uses ▪ Does not track non-crop applications ▪ Provides volume state distribution data of high level content categories (Nitrogen, Phosphate, Potash)	Medium	High

NON-HAZARDOUS WASTE DATA GAPS

Ecology has developed an effective system for collecting information on the quantities of most traditional non-hazardous waste streams disposed at municipal solid waste landfills. The SWFA program's annual report, *Solid Waste in Washington State,* provides trend analysis and detailed, timely information on the quantities of non-hazardous waste disposed in and from Washington. Gaps in Ecology's information on non-hazardous waste fall into three categories:

- **Accuracy.** The data tracking systems that feed the totals reported in *Solid Waste in Washington State* rely largely on reporting by facilities and other enterprises. Because reporting thoroughness and consistency vary, gaps in information do arise. Such gaps affect the accuracy of reported waste and material flow quantities.
- **Coverage.** SWFA's waste tracking systems are tailored to monitor the MSW (including recycling), Moderate Risk Waste (MRW), and to some extent Construction & Demolition and Industrial waste flows. Several waste flows identified in the materials flow framework in Issue Paper #1, however, are not currently tracked by SWFA. Such gaps in information can be described as gaps in coverage**.** Many of these gaps relate to extraction wastes from the agriculture, forestry, and mining sectors. Others are material outputs from the economy such as carbon dioxide.
- **Characterization.** A third type of gap in Ecology's information is characterization – the composition or constituents of a given waste stream. For example, little is known about the composition of some industrial wastes, particularly those that are treated onsite; and little is known about possibly hazardous constituents in consumer products that are otherwise considered non-hazardous.

Table 2 presents the key gaps in Ecology's information concerning non-hazardous waste and material outputs in Washington. Note that the table is structured identical to Table 1 For a discussion of each column and the ratings used, see pages 4 and 7.

Table 2. Non-hazardous Waste Data Gaps

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
MSW, Disposal	Measurement precision affected by lack of scales in Douglas, Grant, Wenatchee Counties	Conversion factors are used in lieu of scales	Use of conversion factors is reasonably accurate	Low	Low
MSW, Disposal	Reporting categories poorly defined and used, result is that many types of waste are lumped into MSW	Reporting form for facilities	Serves overall purpose well, but MSW becomes a catch-all category	Medium	Medium
MSW, Disposal	Lack of recent composition data to assess priorities and measure progress	1992 waste composition study	Waste composition data is outdated	Medium/High	High
MSW/Other	Hazardous/toxic materials incorporated into product	Not tracked in any single system.	None exists	High	High
MSW, Recycling	Quantity (accuracy) due to non-reporting (especially for metals, construction & demolition, and tires)	Annual Recycling Survey	Overall good, but non-reporting deflates recycling totals	Medium	High
MSW, Recycling	Quantity of material diverted after it enters disposal facility	Annual Recycling Survey	May be under-reported or also counted as disposal	Medium	Low
Construction /Demolition, Recycling	Quantities reused or recycled	Recycling Survey (limited) & Compost facilities	Limited coverage in recycling survey	Medium	High
Construction /Demolition Waste	▪ Accuracy of total quantity ▪ Composition	Facility reporting for quantity; King County recently completed monitoring study	Quantity information is inaccurate due to reporting issues. King County monitoring study is useful but not necessarily applicable to state level.	Medium	High

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
Industrial Solid Waste	▪ Quantity ▪ Composition	Industrial Solid Waste Survey, 1992, has some information.	Survey is outdated	High	High
Industrial Waste	Quantities reused or recycled	None	N/A	Medium	Medium
Industrial on-site disposal	▪ Quantity ▪ Composition	Some required reporting for Hazardous waste	Limited SIC codes; many wastes not counted	Medium	Assessment Needed
MRW	MRW/Used oil collection by the dispersed network of collectors	MRW "database"	Not comprehensive as most is collected by private facilities	Low	Medium
MRW (HHW and CESQG)	Quantity and impacts of wastes that don't make it to collection facilities	None, although some other states (VT) have tried to estimate HHW stocks	Very limited	Medium	High

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
Biosolids (including metals)	▪ Quantity ▪ Composition	Biosolids Data Management System	▪ Tracks total annual biosolids volume, disposition (including transport offsite); samples concentrations of 9 metals regulated under 40CFR Part 503 (Ar, Cd, Cu, Hg, Pb, Mo, Ni, Se, and Zn). ▪ Provides ability to track biosolids production volumes, disposition methods, and generally estimate metals mass loading from year-to year.	Low	Medium
CO2 emissions	Quantity	▪ Washington State CTED study ▪ Easily estimated based on fossil fuel sales	▪ Fairly accurate ▪ Estimates can be made at relatively low cost	Low	Assessment Needed
Ag Waste	Quantity and composition of agricultural wastes	▪ Some tracking of pesticide sales by State ▪ World Resources Institute (WRI) standards can be used to estimate	Useful for order of magnitude analysis, but poor for actual management	Medium	Assessment Needed

Material Flow	Key Gap(s) in Ecology's Information	Current or Available Tracking System(s)	Tracking System Assessment	Relative Significance of Gap	Relevance to Beyond Waste key questions
Forestry Waste	Quantity and composition of forestry wastes	▪ Potential information from industry associations ▪ Estimates based on production and WRI standards	Useful for order of magnitude analysis, but poor for actual management	Medium	Assessment Needed
Soil Erosion	▪ Quantity	National Resource Conservation Service quantifies soil erosion in certain areas	Does not appear to track soil erosion at a state level	Low	Assessment Needed
Mining Wastes	Quantity and composition of mining wastes	▪ WA Dept. of Natural Resources tracks mining production in WA ▪ WRI has standards for waste ratios	Useful for order of magnitude analysis, but poor for actual management	Medium	Assessment Needed

EVALUATION OF SIGNIFICANCE OF GAPS

Table 1 and Table 2 above list a plethora of gaps and inconsistencies in the data, tracking systems, and information analysis capabilities that make it difficult for Ecology to carry out some of its currently mandated functions. The challenge as Ecology moves forward with the Beyond Waste planning effort is to determine what gaps to address and how best to overcome them, as well as what systems and data, if any, may not be needed in the future. Since resources are not unlimited, Ecology will need to establish priorities for what information and tracking systems are vital to meeting Ecology's responsibilities and to measuring progress towards achieving the Beyond Waste vision.

The key tracking system questions, as discussed in Chapter 1, provide a basis for this evaluation and setting of priorities, particularly in relation to the Beyond Waste vision. Included in Table 1 and Table 2 was a rating of each gap according to its relevance to answering the key questions. Gaps with "high" relevance to the key questions should receive priority attention. Gaps with "Assessment Needed" ratings should first be assessed through a combination of literature reviews, surveys, and monitoring studies. In Chapter 4, the consultant presents recommendations on the gaps that should be assessed (Recommendation #2) or patched in order to address the key questions (Recommendation #5).

While the recommendations in Chapter 4 will present the gaps that should receive priority attention, it is also useful to consider each key question individually, and the information gaps that, if addressed, could help answer the questions. Accordingly, following is a brief evaluation of the ability of the current waste tracking systems to address the key questions posed in Chapter 1.

1. **Total Waste: How much waste are we producing?** The current tracking systems provide relatively complete and accurate waste quantity information on 1) total municipal solid waste disposed; 2) biosolids generated; 3) construction and demolition wastes entering permitted facilities; 4) total toxic releases from reporting entities; and 5) hazardous wastes generated and managed by reporting entities. Key gaps and shortcomings include the following issues:

    - Much of the hazardous waste generated and disposed by conditionally exempt small quantity generators and individual residences is not reported or tracked. The only portion that is tracked is the amount that is collected by local MRW facilities or events.
    - Concentration of hazardous wastes contained in reported high-volume hazardous wastewaters is unknown.
    - Quantities of waste generated in the "other flows" category are unknown;
    - Quantities of certain types of extraction wastes are unknown;
    - Total recycled MSW data are incomplete and inaccurate due to reporting inconsistencies;
    - Total generated MSW is not accurate (the sum of disposed and recycled); and
    - The composition of the MSW stream statewide is unknown.

2. **Inputs & Efficiency: Are we reducing the use of materials over time?** Current systems provide very little direct information or understanding of efficiency, reduction in material use and wastes, and inputs needed per unit of output. The Toxics Release Inventory makes an effort to understand pollution prevention efficiencies by separating out source reduction activities (Section 8.10 on TRI Form R) and production changes associated with other factors, like reduced demand for product. Changes in production activity are captured in the production ratio or activity index (Section 8.9), through which the facility compares current year annual production to the previous year's production. Data are sometimes available on a case-by-case basis for certain facilities and industries. However, these data are not comprehensive and cannot be analyzed to provide an understanding of changes in materials efficiency over time.

3. **Return Flows & Eco-Effectiveness: How much and what is the value of "waste" output returned and reused as material inputs?** TRI records information on the quantities and methods of chemicals managed via onsite and offsite energy recovery and recycling. Additionally, certain dangerous waste management system codes identify hazardous waste quantities that are recycled. Current systems provide information on MSW diverted for recycling as a percentage of total generation (the MSW recycling rate). However, as noted above there are significant inconsistencies and inaccuracies in these self-reported data over time. Extensive data are also collected on biosolids reused through land application and recovered moderate risk waste. Some data on recovered construction and demolition (C&D) wastes are also available, but the statewide C&D recycling rate is unknown. Finally, data from waste exchanges (such as the re-usable building materials exchange) provides a very limited ability to estimate re-use of some materials.

   However, none of these tracking systems provides any understanding of the total quantity or value of "waste" material returned to the economy as a function of total material inputs. Accordingly, Ecology cannot measure Washington State's "reuse rate," which would provide a barometer on how well the state is doing on turning waste outputs into economic inputs.

4. **Risk & Inherent Hazard: Are we reducing risk from toxic materials and wastes?** Current systems provide accurate data on changes in hazardous waste outputs from generators who are required to report by federal law but generally do not provide concentration or composition information for specific waste streams. Also regulations provide for some tracking of the hazardous nature of some raw material and process good inputs.[3] However, this information does not provide an assessment of the inherent hazard of particular waste streams, nor the exposure risk associated with any given management option. Other key limitations and gaps include the following areas:

   - Hazardous waste outputs of exempt generators are not reported or measured.

[3] For example, under Washington State code, facilities that submit pollution prevention plans (i.e., TRI reporters and facilities thatgenerate more than 2,640 pounds of hazardous waste per year) arerequired to provide information on all processes that use products containing hazardous substances (or hazardous products). Quantity and chemical composition information (product name and CAS number) are required.

- Risk and inherent hazard associated with most component and finished good inputs are not tracked.
- Persistent Bioaccumulative Toxics (PBTs) and small quantities of toxic elements found in products and materials that are consumed in the economy and disposed in the MSW stream are not measured. The toxic element composition of the MSW waste stream is not well understood.
- The inherent hazard and risks associated with many of the other non-permitted output flows, such as pharmaceuticals and personal care products, are not known.

5. **Contribution to Vitality: Does eliminating wastes contribute to economic, environmental, and social vitality?** No tracking systems exist to measure the value creation associated with less waste and more materials reuse or efficiency. Some case studies are available for businesses and industry segments. Some limited information is available on job creation and economic activity associated with MSW recycling.
6. **Behavior Change: Are residents, businesses, and institutions taking actions to achieve beyond waste vision?** Ecology does not currently attempt to measure behavior change in any systematic way, though the agency is instituting new systems, such as the Toxic Reduction Investment and Management (TRIM) system that can track behavior change more systematically in the future. Some research has also been conducted at the local level.
7. **Beyond Waste Strategy Effectiveness: Are Ecology's strategies achieving their intended goals?** Systems will need to be put in place to measure the effectiveness of Beyond Waste strategies developed as part of this planning process. Currently, Ecology periodically evaluates the effectiveness of its programs.
8. **Capacity & Safety: Do we have adequate, safe facilities to handle remaining wastes?** Systems are in place to monitor the adequacy of permitted facilities. Shortcomings exist in understanding the location, adequacy, and safety of non-permitted facilities.

SUMMARY AND WRAP-UP

This chapter presented numerous gaps in Ecology's information concerning hazardous and non-hazardous waste and material flows. Some of these gaps are of relatively little consequence. For example, the use of volume-to-weight conversion factors instead of scales at some rural landfills does not dramatically hinder Ecology's ability to quantify the waste disposed in Washington. The ratings assigned in Table 2 reflect that this gap should be a low priority as Ecology considers what information systems to improve as it charts a course towards Beyond Waste. On the other hand, the lack of information on some other gaps greatly hinders Ecology's ability to understand key waste and material flows. For example, the lack of information on the sources, quantity, and composition of unreported hazardous waste (i.e., SQGs, wastewaters, hazardous waste in product) makes it difficult to assess the total quantity of hazardous wastes entering the environment.

The recommendations in Chapter 4 indicate which gaps should first be assessed and which should receive priority attention as Ecology improves its tracking of waste and material flows in Washington.

3. Material Flow and Waste Tracking: Conceptual Approaches

INTRODUCTION

As noted in the preceding chapters, the Washington State Department of Ecology currently tracks a diverse array of waste flows, using various reporting mechanisms and other data collection approaches. Yet despite these major efforts, significant gaps in the understanding of material and waste flows remain, making it difficult to answer certain key questions about material flows, waste streams, and progress over time. Accordingly, this project was designed to explore alternative conceptual approaches to improving the understanding of waste and material flows in Washington State.

An effective new approach should fill the most important information gaps identified in the previous sections as well as provide data to adequately address the central questions presented at the outset of this report:

- How much waste are we producing?
- Are we reducing the use of materials over time?
- How much and what is the value of "waste" output returned and reused as material inputs?
- Are we reducing risk from toxic materials and wastes?
- Does eliminating waste contribute to economic, environmental, and social vitality?
- Are residents, businesses, and institutions (economic sectors) taking actions to achieve the Beyond Waste vision?
- Are Ecology's Beyond Waste strategies achieving their intended goals?
- Do we have adequate, safe facilities to handle remaining wastes?

This chapter first outlines the attributes that an effective new tracking system should embody. Next, it explores four potential approaches to improving the understanding of waste and material flows in Washington, including a discussion and summary of how well these approaches perform with respect to evaluative criteria linked to the Beyond Waste Vision. The chapter concludes with a presentation of data gathering methods that could support the conceptual approaches.

ATTRIBUTES OF A GOOD TRACKING SYSTEM

An effective information system should not only track the movement of waste flows to monitor progress towards achieving the Beyond Waste vision and goals, but it should also help assess the impact and efficacy of policy and programmatic efforts designed to help achieve those objectives. The system needs to help answer the key questions outlined above as well as address significant data gaps and information needs identified

in the previous sections. Answering these questions will help the Department of Ecology know if it is "bending the curve" – that is, changing the current pattern of ever-increasing waste over time and moving instead towards Beyond Waste.

To help Washington state move beyond waste, Ecology needs to look beyond waste in its tracking systems. Fundamentally, the system should measure what matters – that is, it should focus on providing the necessary data to answer the key questions that are essential to tracking progress towards achievement of the Beyond Waste vision. Simultaneously, a system should not collect large quantities of data on wastes that do not matter or that are not critical to answering the key questions. By measuring what matters and looking beyond waste, Ecology may need to focus attention further "up the pipeline" and examine material flows from the raw inputs through the production and consumption process, rather than looking mainly at the waste output of those processes.

To meet Ecology's information needs effectively, a good tracking system should embody various attributes. Such a system should:

- Be **feasible** and practical to implement. Implementation feasibility encompasses such issues as **cost**, **data availability**, complexity of **reporting requirements**, **legislative or regulatory requirements**, as well as **private-sector issues** and concerns. A revised system should not be too costly to implement, nor should it entail major new data collection requirements. The system should provide the most knowledge for the least burden and cost. To maximize feasibility, it should be based, to the greatest extent possible, on the data already collected and tracked by Ecology as well as other government agencies and other entities such as trade associations.
- Track **significance**. While providing an overview of the overall system, the tracking methods need to help the agency focus on the most significant issues and problems as well as identify and prioritize emerging topics as needed.
- **Represent** the range of material and waste flows. A tracking approach needs to present a true, accurate, and reliable portrayal of significant wastes, materials, and trends. It should cover the key variables of interest that will enable Ecology to measure overall progress towards achieving the Beyond Waste vision.
- Be **flexible** and **adaptive**. Some current systems were adopted in response to a crisis and have remained unchanged over time, though they may no longer appropriately address current needs. A new approach should allow for reevaluation of the tracking methods over time, so that the system can address emerging issues, remain relevant over time, and continually meet the needs of decision-makers and the public.
- Maintain **consistency** over time, as appropriate. Though flexibility is a key attribute, as the new system evolves and adapts, it must retain the ability to measure real change over time. Accordingly, an element of consistency and the ability to track changes with respect to a common baseline or index are also useful.
- Be **easily understandable**, meaningful, and **useful** to and used by critical customers, including the public, program managers, local governments, elected officials, and other decision-makers and stakeholders. The system should also facilitate forecasting or development of future projections based on current and past results. To be useful to program managers and decision-makers, the system

needs to track the impact of waste reduction/elimination activities and policies over time. The system should allow for stakeholder input and include positive measures of progress.

- Promote **accountability** and **feedback**. The tracking system should provide clear goals and measures by which progress can be monitored over time. Like the current recycling objectives, such measures can set standards and help inform parties of their progress. Also, the standards can help make those responsible for change more accountable for meeting the established goals.

The subsequent sections of this chapter outline four alternative conceptual approaches to waste tracking and discuss how they perform relative to these criteria.

ALTERNATIVE CONCEPTUAL APPROACHES/DIRECTIONS

The following section outlines four potential approaches or strategic directions for improving the tracking and understanding of material flows and wastes in Washington State. This section of the report briefly describes each of the four approaches and reviews its performance with respect to the evaluative criteria outlined in the previous section:

- **Patchwork Approach** – applies specific fixes to improve existing tracking systems;
- **Expansion of Waste Tracking** – significantly broadens existing tracking systems;
- **Materials Accounting** – tracks all material inputs and outputs, from extraction, through production and use, to disposal;
- **Indicators Approach** – tracks a subset of materials and wastes tailored for measuring key variables of interest in achieving the Beyond Waste vision.

It is important to note that these four approaches are not necessarily mutually exclusive nor do clear boundaries exist between each of them. Three of the strategies – materials accounting, expansion, and patchwork – can be viewed along a continuum, with materials accounting being the most far-reaching of the approaches and patchwork the least intensive. The difference between expanding the current system and patching it is particularly imprecise, and overlaps certainly exist. Generally, we view the patchwork option as more focused on essentially maintaining the status quo, with some improvements, while the expansion approach greatly broadens the current tracking systems. The final package of recommendations may incorporate elements of various approaches.

PATCHWORK APPROACH

Of the various conceptual approaches to improving the existing waste tracking system, this option is the narrowest in scope. Under the “patch the existing system" approach, the existing system would be fine-tuned to address specific problems or deficiencies. In this option, specific “plugs” are identified to fill the various gaps that have been identified in existing tracking systems. Accordingly, the existing system would function better under this approach, but no new materials or waste flows would be added to the tracking system. The aim of this approach is to complete a series of technical fixes that could be implemented without the need for new legislative authority or major administrative hurdles.

Because the patchwork approach essentially builds on existing waste tracking systems, it retains many of the benefits and limitations of those systems. Accordingly, the patchwork approach would create a system that is not significantly more flexible or adaptive than existing systems, though small modifications could continue to be made over time. In terms of how well such a system would represent the overall range of material and waste flows as well as track and prioritize significant issues, the patchwork approach would be similar to the existing tracking systems. Patching the system would also perform similarly to the existing systems when it comes to how understandable and useful the system is for the public and key stakeholders. The system would not be any more understandable, though it would negate the need to build or learn about a new system for those who are already familiar with the existing tracking methods.

A benefit of this approach is that it allows the waste tracking system to maintain a great deal of consistency over time, since under the new approach, existing systems would remain largely unchanged. In terms of feasibility, this approach is also the easiest to adopt. It may not accomplish all of the goals desired in a new tracking system, but it entails a relatively small amount of new resources and little or no new regulatory burdens, legislation, or data collection requirements.

For more information, Appendix A illustrates potential approaches to patching some key gaps in Ecology's information concerning hazardous wastes. Although approaches and possible data sources are only presented for three examples, similar resources could be developed for other flows of interest.

EXPANSION OF WASTE TRACKING

The approach of expanding the current tracking system goes beyond the patchwork approach. This approach would involve tracking a broader array of materials, more categories of waste generators, and new waste generators that have not previously reported information to various tracking systems. For example, this approach could entail requiring companies in a broader range of NAICS/SIC codes to report their use and release of toxic substances or to record CAS (Chemical Abstracts Service) numbers on their dangerous waste form submittals. New materials could be added to the lists of those tracked under existing systems, and reporting requirements could be extended to smaller facilities that were previously exempt from tracking. Expansions of the current tracking systems could also address mining, agricultural, or industrial solid wastes, for example, through reporting and/or direct monitoring, similar to what is currently undertaken for municipal solid waste.

Unlike the materials accounting approach, the expansion option would focus mainly on expanding the knowledge of waste streams, rather than covering all material inputs and processes. While the patchwork approach could be adopted without significant new legislative authority, the expansion option would involve more hurdles to implementation, though it still essentially maintains a version the existing tracking system.

Like the patchwork option, the expansion approach does not significantly alter many of the attributes of existing waste tracking systems. Accordingly, the expanded system would not necessarily be more flexible or adaptive than existing systems, though new expansions could help meet the needs of future program managers. An expanded system also would not necessarily help focus attention on particularly significant issues or prioritize emerging topics, though future system expansions could address such needs as they arise.

The expanded system alone would generally not be any more user-friendly or accessible than existing tracking methods, though its structure would remain familiar for those already accustomed to the existing approaches. However, the improvements in data tracking and coverage that the expansion would entail should increase the utility of the system for decision-makers.

The expansion approach does offer several advantages, however. Primarily, it would enable the tracking system to represent more fully the range of waste flows occurring in Washington. As with the patchwork approach, the expansion of waste tracking would also generally maintain consistency over time with current tracking systems. Regarding its feasibility, the expansion would require more resources than the patchwork approach to implement, but it would represent less of a shift from existing systems than the materials accounting and indicators approaches outlined in the subsequent sections. The expansion would require some new resources, regulatory burdens, and reporting requirements. In particular, it is anticipated that new legislative authority would be necessary for implementing some portions of the expansion, particularly regarding expanding the covered waste types and repealing existing exemptions for certain categories of waste generators. An additional challenge for expanding legislative authority is the fact that some of the existing authority for waste tracking derives from federal statutes, such as RCRA and EPCRA, rather than state law.

MATERIALS ACCOUNTING

The consultant team's Issue Paper #1 -- Waste and Material Flows in Washington presented a conceptual model to address material and waste flows in the State of Washington. Whereas most tracking in the U.S. has focused on flows of wastes, or non-product output, several initiatives have also targeted material inputs and materials contained in products. Whether tracked at the level of an entire economy or of a specific industrial facility or process, such material and waste flow tracking approaches are commonly referred to as Materials Accounting, or in some cases as mass balance.

Under a materials accounting approach, it is expected that the total quantity of material inputs will equal the total quantity of material outputs in products and wastes. At the state level, this means that the sum of beginning inventories and materials brought into the state's economy in finished goods/components and raw materials should equal the sum of exports of materials, components, and finished goods (materials shipped as product or waste) and outputs from the economy (material releases to the air, water, or land), materials transformed or treated on site, and ending inventories (see Figure 1).

Materials accounting approaches can fill important information gaps about material and waste flows that can impact the environment. Materials accounting can enhance understanding of substances that enter the environment through products, upon their use, disposal, or incineration. Materials accounting can also uncover untracked industrial wastes, uncollected wastes, unreported discharges to air and water, and dissipative use and losses.

Materials accounting techniques have been applied at the macro-economy level and at the facility level. In the U.S., the World Resources Institute (WRI) has led efforts to estimate materials accounting and flow information for the U.S. economy. By implementing materials accounting at the level of Washington State, Ecology could compare materials entering the economy to materials exiting the economy, in order to discover and quantify large, untracked waste flows. For example, if a large number of computers are sold in Washington annually, but only a certain smaller number are found

to be disposed or recovered, then the remainder may be assumed to have been placed in storage or otherwise stockpiled.

Materials accounting has also been applied at the facility level, with particular focus on tracking toxic substances. This is also referred to as a mass balance approach, although a true engineering mass balance is typically significantly more precise than is required for broader material and waste tracking needs.[4] In order to implement materials accounting at the state level, data from individual facilities would be essential.

Currently, materials accounting is required for hazardous materials in New Jersey, Massachusetts, and the City of Eugene, Oregon. The reach of materials accounting is potentially enormous and essentially a policy decision. Both the level required and the material threshold amounts will drive the cost of compliance. For instance New Jersey has a threshold of 25,000 manufactured pounds or 10,000 pounds used per year of targeted toxic chemicals. Reports for each targeted chemical are filed with the state on a process level basis for each facility.

In application, materials accounting has proven more effective at examining toxic and hazardous materials flows than federally mandated programs. Advocates state that current TRI and other reporting programs only capture a small portion of the toxics being moved within a state. By focusing on materials recycled, generated, transferred, or released TRI fails to identify toxics being placed into the environment as product or those converted to another chemical. In addition, some believe that TRI allows chemical leakage that goes unreported. New Jersey's Department of Environmental Protection has found that materials accounting tracks 20% to 80% more polluting releases than currently reported to the various individual regulatory programs with jurisdiction.

A number of studies have identified the benefits of using materials accounting.[5] These benefits include:

- Quantifying targeted (or significant) materials in consumer products
- Tracking the movements of significant materials through communities
- Identifying potential occupational exposure
- Measuring material use efficiency
- Identifying source reduction opportunities
- Measuring source reductions
- Identifying pollution prevention opportunities
- Cross-checking reported release data

Materials accounting implementation faces many significant hurdles. The lack of political will to implement such a comprehensive system is perhaps one of the most important obstacles. Detractors contend that materials accounting has several flaws. These include:

[4] See the following report for a detailed description of materials accounting and mass balance approaches: National Research Council. *Tracking Toxic Substances at Industrial Facilities: Engineering Mass Balance Versus Materials Accounting*. Washington, DC: National Academy Press, 1990.

[5] See National Pollution Prevention Roundtable and Industrial Pollution Prevention Council (1999), INFORM (1995 and 2002), National Research Council 2002, and Dorfman and Wise 1997.

- Large reporting burden for facilities
- Inefficiency
- Little correlation to pollution prevention
- Failure to provide meaningful risk information to stakeholders
- Minimal accessible information for regulators and the community

Opponents point out that Eugene's program expands the number of materials tracked over TRI by a factor of nine, but TRI still captures more than 90% of the total volume of pollution releases. Studies estimate the additional cost to a facility of materials accounting over and above other reporting requirements to be between $366 and $596 per chemical.[6]

In many cases, facility business reporting systems do not coincide with reporting requirements, making it difficult to collect data reported to regulators. Large resource investments must be made to comply. Even after this investment, in some instances opportunities to translate information into useful business decision data are diminished.

An agency's start-up costs to establish a materials accounting tracking system are difficult to estimate based on Massachusetts and New Jersey's experience due to differences in computer technology. A National Pollution Prevention Roundtable reports states that New Jersey made substantial investments and relied on early 1980s technology. Although hardware is now much cheaper, the "peopleware" (FTEs needed to design and train users) and providing virtual access could more than offset these savings. The recurring costs to the states for collecting, managing, and releasing facility-level data are between $50,000 and $60,000 annually for the two statewide programs.[7]

Facilities with pollution abatement systems to mitigate the impact of pollution releases may be reporting based on levels prior to treatment, rendering exposure measurements difficult. Detractors also point out that certain toxic materials become inert when combined with others during the production process. Materials accounting may fail to relate this information to stakeholders.

Several vocal opponents also state that accounting for all material flows may force facilities to reveal trade secrets to competitors. Product shipped and chemical inputs are the two pieces of information most often cited. Massachusetts, New Jersey, and Eugene have provisions protecting certain information from public release. Recently, detractors have also stated that publication of facilities' current inventories of onsite toxic materials may prove detrimental to the current focus on national security.

Materials accounting would require a change in current legislation and administrative regulations. In light of the above issues, mustering the public support and political will to shift Washington State to materials accounting would likely be difficult.

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[6] National Pollution Prevention Roundtable and Industrial Pollution Prevention Council. *Materials Accounting Project: Final Report – Stakeholder and NJ/MA Facility Interviews*. April 1999.
[7] National Pollution Prevention Roundtable and Industrial Pollution Prevention Council. *Materials Accounting Project: Final Report – Stakeholder and NJ/MA Facility Interviews*. April 1999.

INDICATORS APPROACH

Unlike the three options outlined above, the indicators approach represents a fundamental shift in the system of progressively tracking more and more wastes and materials. The goal of the indicators approach is to use information differently and more efficiently. Rather than trying to track all materials, all of the time, the indicators approach proposes to monitor a carefully selected system of information in a more strategic manner.

In designing this conceptual approach, we use the economic system – and its measures – as a useful example. While the U.S. economy as a whole is a complex, dynamic, and massive system, economic tracking is able to distill a relatively small number of measures that can help present a good picture of the state of the system as a whole. For example, such economic indicators as the Consumer Price Index, Dow Jones Industrial Average, and Gross Domestic Product can provide measures of overall economic progress or decline.

Similarly, an indicator-based system can help assess the state of waste flows, waste reduction, and progress towards achieving the Beyond Waste vision in Washington State. Rather than tracking all aspects of the range of material and waste flows, some indicators could focus on subsets of selected materials and products, similar to the way the Consumer Price Index tracks cost changes over time by studying a "basket" of consumer goods and services. Potential indicators of progress towards achieving the Beyond Waste vision could include both conventional measures such as recycling rates as well as new approaches like tracking the toxic substances contained in a typical "basket" of consumer goods. Indicators are also commonly used by other organizations to track and communicate environmental progress.[8]

The indicators option offers several advantages over the other conceptual approaches, though it poses significant implementation challenges as well. A potential drawback to the indicators approach is the ability to maintain consistency over time. Once the new system is established, maintaining consistency is not a problem, but comparing post-indicators results with current, or pre-indicators, information could present difficulties, depending on the extent to which existing tracking systems continue to be maintained over time. In terms of feasibility, this approach represents a rather significant shift from current tracking methods, which could pose challenges, again depending on the extent to which existing tracking is maintained or eliminated. In terms of resource requirements and regulatory burdens, the indicators approach would focus on using existing data collection methods and requirements rather than a significant expansion; this emphasis would improve the feasibility of the approach.

In terms of its benefits, the indicators approach would be highly flexible and adaptive over time. It is envisioned as a learning system that can incorporate new information and priorities over time as needed. Though it does not purport to track all flows, a well-designed Beyond Waste indicators system could *represent* the range of material and waste flows without tracking each in detail. Though it represents a shift from existing tracking approaches, the indicators system is intended to be easily understandable and accessible to both decision-makers and the public. Because the indicators would be

[8] For a summary of the use of indicators for measuring sustainable development, see Meadows, Donella. *Indicators and Information Systems for Sustainable Development.* Hartland, VT: The Sustainability Institute, 1998. In addition, Washington-based organizations such as Sustainable Seattle and Northwest Environment Watch have used indicators as a means of evaluating community health and sustainability.

structured based with input from key stakeholders, they would be designed from the start to be useful to those in need of the resulting information. Specific indicators could also be included to track the progress of Beyond Waste strategies over time.

ASSESSMENT OF CONCEPTUAL APPROACHES

The sections above described various attributes, including advantages and disadvantages, of the various conceptual approaches to waste tracking. Table 3 below provides a brief summary of these approaches regarding their implementation feasibility and other evaluative criteria presented at the beginning of this chapter. The evaluation assesses each approach in terms of the improvement it offers over the status quo of Ecology's existing tracking systems. The summary table assesses the degree to which each conceptual approach:

- Is **feasible to implement**, given such issues as costs and resource constraints, data availability and reporting requirements, regulatory burdens, the need for new legislative authority, and private-sector concerns;
- **Tracks significance**, helping Ecology to focus on the most significant issues and problems as well as to identify and prioritize emerging topics as needed;
- **Represents flows & materials**, presenting an accurate picture of material flows and waste generation in the state;
- Is **flexible & adaptive**, allowing for reevaluation of the tracking methods as needed over time, so that the system can address emerging issues, remain relevant, and continually meet the needs of decision-makers and the public;
- Remains **consistent over time**, as appropriate, to measure real change over time with respect to a common baseline;
- Provides **understandable & useful results** for critical customers, including the public, program managers, local governments, elected officials, and other decision-makers and stakeholders; and
- Promotes **accountability & feedback**, providing clear goals and measures by which progress can be monitored over time and holding those responsible for change accountable for meeting the established goals.

Following this assessment, Chapter 4 presents and discusses our recommended strategy for improving Ecology's tracking of material and waste flows.

Table 3. Summary Assessment of Conceptual Approaches

	Feasible to Implement (cost, data, reporting, private-sector concerns, legislative/ regulatory requirements)	**Tracks Significance**	**Represents Flows & Materials**	**Flexible & Adaptive**	**Consistent over Time**	**Understandable & Useful Results**	**Accountability & Feedback**
Patchwork Approach	**high** ▪ Maintains existing systems, lower costs ▪ Data needs generally understood, relatively few new data needed ▪ Private-sector concerns may hinder collection of some needed data ▪ Minimal legislative & regulatory requirements	**low** Little change from existing systems	**low** Offers only limited improvements on existing tracking systems	**low** Not a flexible system; maintains existing statutory obligations and reporting requirements	**high** Essentially maintains existing systems	**low/medium** Similar to existing tracking systems; not easier to understand, but does not entail learning a new system	**low** Little change from existing systems
Expansion of Waste Tracking	**medium/high** ▪ Essentially maintains existing systems, but new data needs require identification ▪ Significant amounts of new data are needed, may raise private-sector concerns ▪ Expanded legislative authority and some new reporting requirements needed	**low/medium** Little change from existing systems, though expansion efforts could focus on significant areas as needed	**low/medium** Improves existing waste tracking, but does not look at material inputs and products, a key to waste prevention	**low/medium** Little change from existing systems, though expansion efforts could focus on emerging priority areas as needed	**high** Essentially maintains existing systems, with expanded coverage	**low/medium** Similar to existing tracking systems; not easier to understand, but does not entail learning a new system	**low** Little change from existing systems

	Feasible to Implement (cost, data, reporting, private-sector concerns, legislative/ regulatory requirements)	**Tracks Significance**	**Represents Flows & Materials**	**Flexible & Adaptive**	**Consistent over Time**	**Understandable & Useful Results**	**Accountability & Feedback**
Materials Accounting	**low** ▪ Complete redesign of existing tracking systems and major new system design needed ▪ Many needed data may be difficult to obtain, due to sheer volumes, lack of tracking, as well as privacy concerns ▪ Major expansion in reporting and legislative authority would be necessary; costly	**low/medium** System would track all materials, including those of significance, though it does not prioritize or identify particularly significant flows	**high** Tracks all inputs, products, and outputs, but volume of information may hinder focusing on high priorities and strategic areas of interest	**low** Little flexibility in tracking system	**medium** Continues tracking of currently tracked flows, though methods may change with new system	**low** Huge volumes of data may impair utility of results and ease of understanding	**low** System provides lots of data, but does not include mechanisms for accountability and feedback

	Feasible to Implement (cost, data, reporting, private-sector concerns, legislative/ regulatory requirements)	**Tracks Significance**	**Represents Flows & Materials**	**Flexible & Adaptive**	**Consistent over Time**	**Understandable & Useful Results**	**Accountability & Feedback**
Indicators Approach	**medium** ▪ Challenging to shape system and define appropriate indicators ▪ Few broad new data needs; some expanded tracking in targeted areas may be needed, which could raise private-sector concerns ▪ Requires changes in waste tracking philosophy; legislative approval may be needed to modify existing reporting requirements	**high** Indicators are designed to focus on key flows and materials determined to be priority areas of significance	**high** Tracks key information on material flows and wastes of interest; focuses on key goals and progress	**high** System allows flexibility, and indicators can adapt over time to focus on priorities as needed	**low/medium** Adoption requires shift from existing tracking systems, though once implemented the indicators can maintain some consistency over time	**high** Indicators are designed to be useful and easily understandable to agency staff, policymakers, and the public	**high** Indicators present clear, measurable objectives that can be monitored over time and used to hold responsible parties accountable for progress

DATA COLLECTION OPTIONS

When considering alternative approaches to track new material and waste flows, or to fill data gaps, Ecology should keep in mind that four primary data collection options are available. These include required reporting, voluntary reporting, estimation and extrapolation, and direct monitoring. These data collection options are described below with examples. Table 4 summarizes the options and the benefits and challenges typically associated with each.

Table 4. Summary of Data Collection Approaches

Data Collection Approach	Description	Benefits	Challenges
Required Reporting	Selected economic actors are required to periodically report specific information.	▪ High participation rates in reporting program giving relatively comprehensive information ▪ Relatively high degree of accuracy of reported information ▪ Data can be linked to specific sources	▪ Implementation can be expensive ▪ Economic burden on reporters can be high ▪ Confidential business information challenges can arise ▪ Legislation or rulemaking are often required, which can be costly or politically difficult to implement
Voluntary Reporting	Selected economic actors are asked to report information on a voluntary basis	▪ Implementation can be less expensive than required reporting ▪ Legislation and rulemaking are not required, which can be costly or create political opposition ▪ Approach provides information on actual performance of economic actors in the state	▪ Participation rates are often significantly lower than for required reporting ▪ Data can be less accurate than for required reporting
Direct Monitoring	State (or its agents) directly monitor and collect information on material and waste flows	▪ Approach provides information on actual material and waste flows in Washington ▪ Implementing agency has significant control over data collection process and accuracy ▪ Relatively cost-effective if there are a limited number of observation points from which to monitor ▪ Approach does not impose significant economic burden on economic actors	▪ Costs can be high if multiple monitoring points are necessary ▪ Extrapolating data can produce inaccurate results ▪ Accessibility to direct monitoring points can be limited ▪ Political difficulty
Extrapolation and Estimation	Existing data from other sources is used to estimate data on material and waste flows for a different population	▪ Relatively inexpensive to implement ▪ Relatively quick to implement ▪ Legislation and rulemaking are not required, and political opposition is typically low	▪ Estimates can be less accurate, particularly when based on many assumptions that may not hold true ▪ Existing data sources are fragmented and not always reliable or applicable.

Required Reporting

Legislation and rulemaking can be used to require individuals and/or organizations in certain economic sectors to report periodically on waste generation and material use. Such requirements establish criteria that determine which parties are required to provide detailed accounts of their behavior/activities, often using threshold levels (e.g., quantity of waste or emissions) and/or sector designations (e.g., selected SIC or NAICS codes). Reporting can be required at a routine time interval (e.g., monthly, annually) or triggered by a transaction (e.g., at time of material purchase or waste disposal). Examples of required reporting systems currently operating in Washington include the Toxics Release Inventory and the Dangerous Waste Reporting programs.

Mandated reporting programs have important advantages. Participation in mandatory reporting programs tends to be high, due to the potential for legal enforcement and fines. The reported information typically has a relatively high degree of accuracy for this reason as well.

Primary challenges to establishing mandatory reporting programs include potential economic burden and political opposition. This situation may be especially true where parties lack the technical or information infrastructure needed to track the information. Required reporting initiatives generally come at a cost to both the reporting parties and the government agency responsible for administering and managing the reporting program. Common cost areas for reporters and administering agencies are listed in the Selecting Appropriate Data Collection Options section below.

Organizations, including local governments, may also oppose new reporting requirements due to business confidentiality and competitiveness concerns or fears that the availability of such information could galvanize public or agency support for additional regulation. Since mandatory reporting typically requires new legislation or rulemaking, political opposition can create significant obstacles to this approach.

Voluntary Reporting

Government agencies can sponsor or support voluntary reporting initiatives as a means to collect data on material and waste flows in Washington. Voluntary reporting programs are typically similar to required reporting programs in that they have established guidelines for what information to report and how to report it. Voluntary reporting is gaining wider recognition as an option, as pressures rise from investors, customers, and the public for greater corporate transparency. For example, a growing cadre of companies participates in the Global Reporting Initiative (GRI) and publicly reports various types of environmental information annually. In addition to its general reporting protocol, the GRI is developing sector-specific reporting protocols for several industries, including mining.

Because voluntary reporting initiatives generally do not necessitate legislative or regulatory changes, they typically encounter less political opposition than do mandatory reporting initiatives. Discussions with industry groups or individual companies can sometimes secure willingness to voluntarily share information on environmental performance or activities with government agencies. Periodic mail or telephone surveys can also be used to collect voluntary information related to material use and waste generation.

A key drawback of voluntary reporting programs is the possibility of low participation. The presence of incentives can encourage participation in voluntary reporting programs.

For example, some industry sectors or individual organizations may consider voluntary reporting as an alternative to head off potential mandatory reporting requirements in the future. Alternatively, voluntary reporting of certain information can be linked to broader voluntary programs that provide incentives for improved environmental performance, such as EPA's Performance Track Program and Envirostars. In addition, there may be ways to structure voluntary reporting to allay participants' concerns about confidentiality or other issues. For example, data could be aggregated without attribution to individual reporters.

Direct Monitoring

Direct monitoring of waste management and other behaviors by government agencies or designated third party representatives is a third data collection approach. Direct monitoring can provide reliable data about material or waste flows at certain locations, during certain processes, or about the presence of contaminants in the environment (e.g., chemical concentrations in surface waters). For example, scales at landfills or transfer stations can be used to measure the amount of waste disposed at these sites. The Washington Department of Ecology manages or participates in several programs that routinely monitor air and water quality to determine concentration levels of various chemicals.

Direct monitoring can be used in other ways to collect material use and waste data. For example, a "clean sweeps" program could be developed to periodically audit a handful of companies to identify and quantify significant material and waste flows. Government agency staff or third party contractors could conduct the audits. Aggregating data under an industry sector, without reference to company names or locations, could preserve confidentiality of business information. The results of such audits might be useful for drawing broader conclusions about material use and waste generation practices in certain industry sectors. As another example, a composition analysis of garbage for selected households (a form of direct monitoring) can be used to draw broader conclusions about household waste generation.

Direct monitoring approaches have two primary advantages. First, they do not typically impose significant economic burden on the economic actor sector(s) involved with the material flow or waste. This can result in less political opposition than might be present for a required reporting approach. Second, direct monitoring approaches often give the implementing government agency significant control over the frequency, focus, and accuracy of data collected.

A primary drawback to direct monitoring is the possibly significant consumption of public resources by the implementing government agency. Direct monitoring can be most useful when only a limited number of observation points are necessary to produce useful information. For example, the cost of using scales for monitoring waste shipments to landfills is much more manageable if there are 10 landfills to monitor than if there are 1,000. Similarly, the audit approach described above would be most useful in cases where there are likely to be similar material flow use and waste generation behaviors exhibited by organizations in an industry sector. This enables direct observations of a small number of sites to enhance understanding of broader practices.

Extrapolation & Estimation

Under this information gathering approach, one uses data from another population or from a small number of data points to extrapolate or estimate material flow or waste

generation levels for a different or broader population.[9] This approach assumes that the general population is known and exhibits similar behavior to that from which the extrapolations are drawn. Extrapolation and estimation approaches enable the Department of Ecology to use limited data to develop a picture of the current state of material and waste flows in Washington.

Extrapolation and estimation approaches can be used in many ways. One technique is to develop estimates for Washington State based on aggregate data for the U.S. or another state. Population size or economic activity data can be used to normalize and adjust such data for Washington. While this technique is rather crude, it can quickly and inexpensively generate order of magnitude estimates of material and waste flows in Washington.

Another technique is to identify an average level of material use or waste generation for an individual (e.g., household, industrial facility) in an Economic Actor Sector, and then to multiply that average by the total number of similar individuals in the state. A variety of sources may hold information on the average level of material use or waste generation for a particular Economic Actor Sector or industry. Data collected from voluntary reporting or direct monitoring programs can be used to derive averages. Non-governmental organizations and trade or industry associations may also be willing to share averages developed from industry benchmarking initiatives. Academic and government studies and reports, including those from other states and countries, can also provide useful information for extrapolation and estimation. For example, this approach has been useful for plugging data gaps in Washington related to mercury releases into the environment. The quantity of mercury released in amalgam from dentist offices is not captured in the Toxics Release Inventory reporting system. However, based on studies from Europe and other states that contain information on the average level of amalgam waste per dental patient or office and the average mercury concentrations in amalgam wastes, it is possible to estimate mercury releases from dentists in Washington.

The National Agricultural Statistics Service (NASS) Agricultural Chemical Use reports provide a good example of extrapolation based on representative in-state data. Farmers within Washington State are surveyed on current use of pesticides and fertilizers for producing crops. Survey results include the percent of land area treated, number of applications, rates per application, rates per crop year, and total pounds of chemical applied. Based on registered active ingredient concentrations, the NASS calculates the average volume of active ingredients applied to an acre of cropland to grow a particular product. NASS also conducts annual surveys on the quantity of acres in production for given crops. Using these two datasets, NASS is able to multiply the average volume of chemicals applied to an acre of land times the number of production acres to estimate the total volume of chemicals used by commercial agriculture in Washington State.

There are several important advantages of using extrapolation and estimation approaches. As stated earlier, they can provide a quick and inexpensive way of quantifying a material or waste flow. While extrapolation and estimation approaches typically require some staff time for research and calculation, they do not require elaborate reporting or data management structures necessitated by other data collection

[9] Related to extrapolation is the concept of “basket” indexes, where data on a limited number of items or materials is used as a representative indicator of the behavior of a larger system. The Consumer Price Index is such a basket, which is meant to be representative of the cost of consumer goods even though it doesn’t track the price of all possible consumer purchases.

techniques. Extrapolation and estimation techniques typically generate order of magnitude estimates, which, while they may not be highly accurate or precise, are often sufficient to inform decision-making or identify areas needing further study or data collection. Second, these approaches can be refined over time as more information becomes available. For example, estimates of mercury-containing amalgam releases from dentist offices could be refined based on survey results demonstrating variation in amalgam releases by different types of dentist offices. Third, use of these approaches does not require legislation or rulemaking, potentially making this a cost-effective and politically feasible alternative to required reporting.

Two primary challenges arise with the use of extrapolation and estimation. First, extrapolation and estimation approaches are usually less precise, and occasionally less accurate, than other data collection approaches. Multiple assumptions must be made when using extrapolation and estimation techniques that in some cases can magnify inaccuracies in data estimates. Second, finding reliable and applicable data on which to base estimates can be challenging. Furthermore, estimation and extrapolation techniques can require significant detective work to assemble a patchwork of useful information. Issues related to the quality, age, and applicability of data often must be addressed to ensure defensible estimates.

Selecting Appropriate Data Collection Options

Selecting the appropriate data collection approach involves careful consideration of a variety of factors and trade-offs – economic, political, and programmatic. While there is no easy formula for determining which data collection approach is most appropriate in a particular situation, there are several steps, principles, and factors to consider. Key steps include the following:

1. Identify the objectives of a potential data collection effort.
2. Identify the type of data desired, including the level of detail and data accuracy desired.
3. Identify the potential data collection approaches that could be used to collect the data.
4. Identify the potential costs and benefits associated with each data collection approach.
5. Weigh the various costs, benefits, and trade-offs to select an optimal approach.

First, clearly identify the desired outcome of data collection. Clear identification of the data collection objectives enables one to select options for data collection that may be most relevant. In some cases, the primary goal of data collection may be to obtain data to inform Ecology's program activities and decision-making. For example, Ecology may want to obtain data to improve its understanding of the volume of certain waste streams from particular economic actor sectors in order to target intervention activities. In other cases, Ecology may also want to use data collection as a means to influence the behavior of various economic actors. Requiring economic actors to track and report data may cause the actors to modify their behavior so as to drop below reporting thresholds or to lessen scrutiny from the agency or public. For example, the public availability of Toxic Release Inventory data has prompted many companies to reduce their emissions of TRI chemicals. To the extent that Ecology is primarily interested in collecting data to inform department program development and decision-making, it may

often be more appropriate to select a data collection approach (e.g., extrapolation and estimation, limited direct monitoring) that is less intrusive to private entities. To the extent that Ecology requires more comprehensive data or hopes to influence EAS behavior change, direct reporting may be a preferable option.

Second, given the desired objective, identify the specific type(s), level of detail, and accuracy of data that are needed to meet the desired objective. In some cases, aggregate data may suffice; in others, data for specific actors is required. This step may involve developing a continuum of options.

Third, identify the range of data collection approaches that could be used to collect the data types identified in step two. The four main data collection approaches discussed earlier in this section can be used to structure this effort. Brainstorming can be a useful approach for generating creative data collection ideas.

Fourth, weigh the costs and benefits of implementing a given data collection approach. These costs and benefits may relate to funding and staff resources, political readiness, or other factors. The questions below are designed to assist Ecology in weighing a few of the various trade-offs to select an appropriate data collection approach.

Data Collection Cost and Challenge Questions

The questions below are designed to help understand the costs and challenges associated with implementing and managing a data collection approach. As illustrated by the questions, it is important to consider non-governmental costs associated with each data collection approach, as well as less tangible costs or challenges.

- What are the costs to the government of implementing and managing data collection process?
- Are there activities that the program may not be able to pursue due to resource constraints if this data collection approach is selected?
- What are the costs to private economic actor sectors of implementing the data collection process?
- How many actors would be affected by the data collection approach?
- What is the anticipated political opposition to implementing a given data collection process
- Does the implementation require a new legislative change or appropriation?

Table 5 presents a sample of direct costs to data reporters and the implementing government agency that should be considered when addressing the questions above.

Table 5. Sample Direct Cost Areas Associated with Data Collection Approaches

Reporters	Government Agency
▪ Staff time for collecting, managing, and reporting information ▪ Measurement equipment (e.g., scales, monitoring equipment, meters) ▪ Information systems for calculating and managing data	▪ Staff time for collecting, managing, and reporting information ▪ Information systems for calculating and managing data ▪ Measurement equipment for direct monitoring ▪ Cost of developing, publishing, disseminating, and marketing reporting guidelines, materials, and forms ▪ Training and outreach programs to inform reporters of reporting requirements and procedures ▪ Cost of managing confidential business information ▪ Cost of processing data and/or making data publicly available

Data Collection Benefit Questions

The questions below are designed to help identify factors that affect the relative benefits that could be derived from implementation of a data collection approach.

- How does Ecology anticipate using the data collected?
- What value does Ecology believe will result from using the information collected? For example, is it anticipated that there is significant environmental risk associated with the activity for which the data collection approach will target?
- Is it anticipated that implementation of the data collection approach will leverage behavior change that will result in environmental benefits? If so, is it anticipated the benefits will be minor or significant? [Note: this question can be very difficult to answer, but it is often linked to factors such as the degree to which this EAS responds to public opinion and pressures, and the technical and economic feasibility of actors in the EAS to change behavior to affect their environmental impacts.]
- What degree of accuracy is anticipated to result from the data collection approach?

Finally, identification of the data collection objectives and costs and benefits associated with various data collection options enables one to weigh the trade-offs. While there is no magic formula, the goal is to find the optimal data collection approach to address the identified needs, objectives, and resource constraints. This involves taking into consideration the relative costs and benefits of the various data collection options that arise from discussing the questions above.

4. Recommendations and Conclusions

To improve information and decision-making regarding waste flows and help track progress towards the Beyond Waste vision, our research and analysis suggests several strategies that the Washington State Department of Ecology should pursue. This chapter presents and discusses these recommendations and then outlines a plan for implementing the proposed new approach. The chapter concludes with a discussion of the benefits of the new approach, possible pitfalls and challenges, and next steps.

RECOMMENDATION 1: ADOPT MATERIAL FLOW FRAMEWORK

Like other efforts, waste-related programs are designed to achieve results. Along these lines, programs are typically structured to make progress on the performance measures on which they are evaluated. Conversely, determining what is measured also influences how priorities are set. To achieve the Beyond Waste vision, it is important to look beyond waste in terms of tracking systems. If waste is the sole measure of interest, marginal waste reduction may occur over time, but it will be difficult to move towards a more holistic view of the system, and achieving the Beyond Waste vision could prove difficult.

Yesterday's raw materials are formed into today's products, and today's products become the wastes of tomorrow. As a result, focusing attention on the "upstream" areas – materials inputs and products – can help anticipate and prevent future wastes. Accordingly, we recommend that Ecology adopt a material flow framework on which to build its Beyond Waste strategy. We anticipate such an effort would be similar to the approach outlined in Consultant Team Issue Paper #1 -- Waste and Material Flows in Washington, but we leave open the possibility of modification. However, it is important to note that this recommendation does not comprise an endorsement of a full-scale materials accounting approach. Chapter 3 outlined such a proposal, as well as its shortcomings and high resource requirements.

In contrast, the material flow framework recommended here would help chart, in a broad sense, the origins and rest stops of materials as they move through the state. The key benefit of the material flow framework is a paradigm shift that inherently expands Ecology's view of how materials progress through Washington's economy. Such a well-defined map would allow Ecology to pinpoint opportunities for substantive change throughout the system, to facilitate prevention before waste occurs and help the agency make progress towards the Beyond Waste vision.

RECOMMENDATION 2: ASSESS UNTRACKED FLOWS

The research conducted for this paper confirms that Ecology lacks a complete understanding of the characteristics of much of the material and waste flows that move through the Washington economy. Valid data are not available on the quantity of some of these flows (e.g., agricultural wastes) or the potential inherent hazards associated with many of these flows (e.g., products that contain toxic substances). Ecology does have a relatively complete understanding of the quantity and the toxicity of most of the regulated flows. However, there are many unknowns associated with unregulated flows.

Accordingly, the consultant team recommends that Ecology conduct assessments to better characterize significant, unknown flows and wastes. An initial list of high priority flows and wastes that need further assessment is presented below. The flows listed below in Table 6 were first presented in Table 1 and Table 2 as information gaps, but their relevance and importance to the Beyond Waste vision cannot be determined without further information beyond the scope of this project.

Please note that Table 6 presents only those gaps that require assessment before their relevance to Beyond Waste planning needs can be determined. Gaps that are highly relevant, and should receive priority attention for patching, are presented in Recommendation 5.

Table 6: Waste or Material Flows Needing Assessment

Flow	Possible Means of Assessment
Personal care products and pharmaceuticals	Conduct review of emerging literature. The USGS and U.S. EPA are both interested in this issue and have committed substantial staff resources to better understanding these flows.[10] Concurrently, consider funding composition analyses through Publicly Owned Treatment Works (POTWs) or universities.
Industrial onsite disposal	Conduct survey of major industries to determine their onsite disposal practices. Conduct analysis of toxicological data and environmental impacts of the range of wastes and practices identified in the survey.
Mining wastes	Conduct review of scientific studies. Pursue monitoring of discharges or releases from mining activities if academic studies suggest such wastes are significant.
Agricultural waste	Conduct survey of current management practices. Conduct review of scientific literature to assess impact of the range of practices identified in the survey.
Forestry waste	Conduct survey of current management practices. Conduct review of scientific literature to assess impact of the range of practices identified in the survey.
Soil erosion	Determine whether soil erosion falls within the scope of Beyond Waste Management efforts. Coordinate with the Natural Resources Conservation Service and the Washington State Department of Agriculture to estimate the extent, magnitude, and significance of erosion.
Carbon Dioxide (CO_2) and other greenhouse gasses	Determine whether CO_2 and other greenhouse gas emissions fall within the scope of Beyond Waste management efforts. Coordinate with other state agencies and academic institutions to quantify gases and their impact.

RECOMMENDATION 3: DETERMINE AND RANK SIGNIFICANCE OF MATERIAL AND WASTE FLOWS

Given the multitude of flows and wastes – tracked and untracked – Ecology needs a rigorous methodology to establish priorities for which materials and wastes to manage and address and in which order. Although beyond the scope of this project, comprehensive waste and material flow priorities are needed to support the targeting of individual, significant flows and guide associated waste reduction efforts. Such an assessment of significance should be adaptive and flexible to allow for evolving

[10] The website *http://www.epa.gov/nerlesd1/chemistry/pharma/overview.htm* contains valuable information related to this topic.

knowledge about many flows and substances, but it should be comprehensive so that no key wastes or materials are omitted from consideration. The consultant's Issue Paper #1 -- Waste and Material Flows in Washington made some preliminary assessments of significant flows, but Ecology needs a long-term, scientifically grounded, and rigorous methodology for determining priority material flows and waste streams.

The methodology for determining significance should primarily consider both the magnitude of each flow (i.e., the annual quantity generated) and a measure of toxicity or inherent hazard grounded in rigorous scientific assessments of the constituent materials. Assessments of magnitude should use the best available data, which in some cases could be estimates or extrapolations grounded in limited but defensible data and calculations. Assessments of toxicity or inherent hazard should be accomplished using the concept of *vigilance*, described below. Other possible dimensions to an assessment of significance include opportunity for beneficial use, the cost/benefit of eliminating the waste or material flow, federal regulations, and political considerations. An overall numerical ranking or qualitative rating (such as *high*, *medium*, or *low* priority) could then be assigned by developing a weighting system incorporating all of the dimensions discussed here.

USING THE CONCEPT OF VIGILANCE TO ESTABLISH SIGNIFICANCE

Issue Paper #1 introduced the concept of a Vigilance Index for rating the degree of concern that individual flows represent. Flows (chemical substances, products, input materials, and wastes) that receive a high vigilance rating represent important Beyond Waste priorities because they require strict management efforts to ensure their production, handling, use, and/or disposition occur within the boundaries of currently accepted environmental and human health risk. Although such flows can be created, used, and disposed within the bounds of acceptable risk, their inherent hazard creates the need for complex and costly management efforts as well as an elaborate and expensive infrastructure for compliance assurance. The complexity and cost of such efforts leave them susceptible to either inadvertent mistakes or deliberate avoidance, resulting in the constant potential for substantial environmental and human health impacts to occur. The management efforts also consume substantial private and public financial resources that could otherwise be directed to more productive activities if the flows ceased to exist. From a precautionary and cost-to-society standpoint, flows that receive a high vigilance rating are important targets for elimination as products and/or waste streams. In this context, achieving the Beyond Waste vision for high-vigilance flows also becomes a "Beyond Ecology" vision, whereby major portions of the agency's current compliance assurance efforts would no longer be required or could be redirected as their targets would have disappeared.

RECOMMENDATION 4: ADOPT INDICATOR APPROACH

To keep track of the flows and wastes of significance, Ecology should implement an indicator-based approach to tracking material flows and waste. As discussed in Chapter 3, such an approach represents a fundamental shift from trying to count all wastes and materials. Instead, the indicators approach strategically uses selected information to provide a clear picture of materials and wastes.

A well-designed indicators system can provide significant strength and support to Ecology's current tracking endeavors that measure waste alone. The indicators

approach also has the potential to provide more useful and meaningful information to a broader audience while streamlining data tracking and management responsibilities.

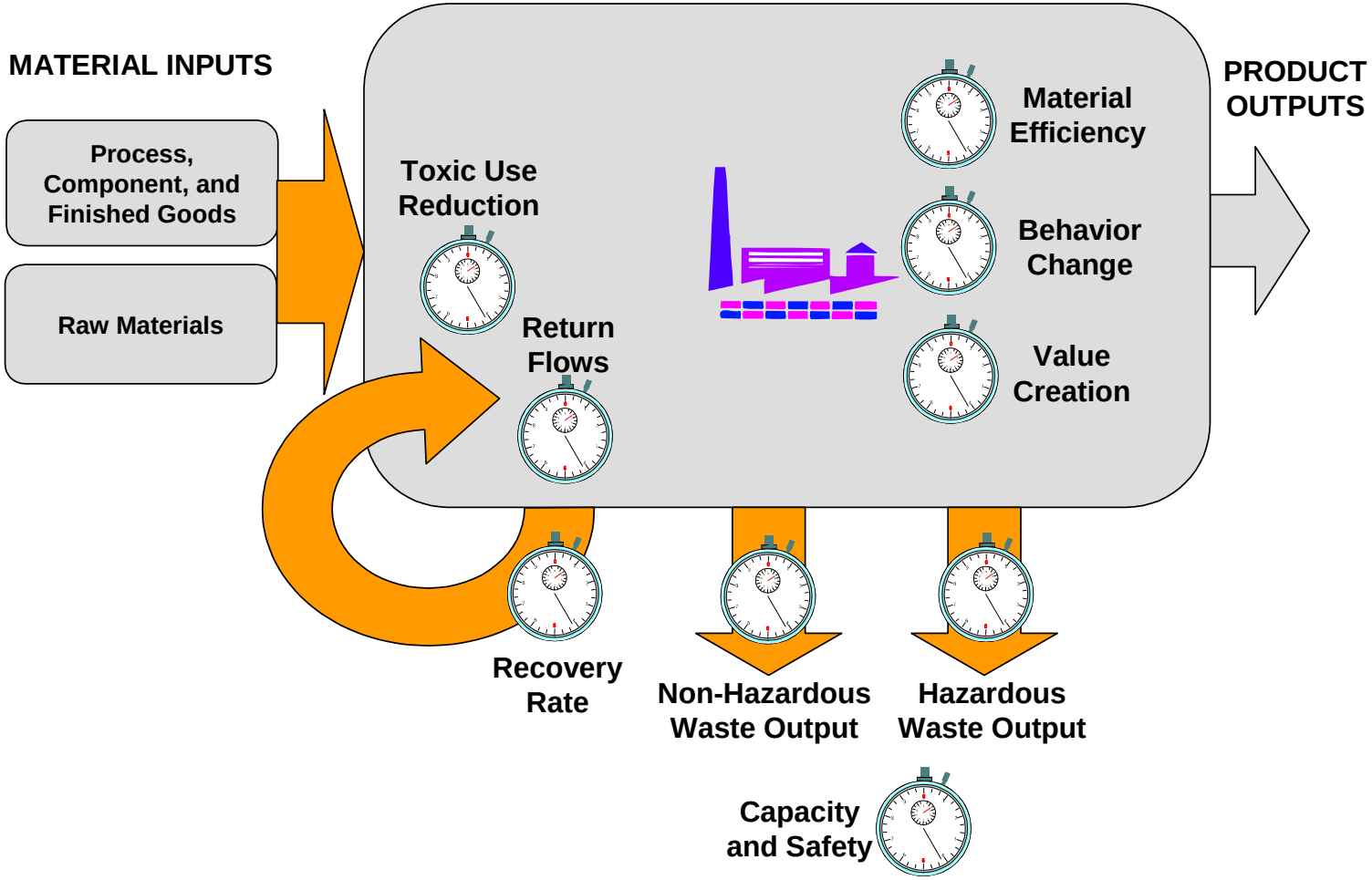
The indicators system could include tracking of the following types of measures:

- **Hazardous Waste Output** – *Is the generation of hazardous wastes declining?* Measures could include the amount of selected hazardous materials disposed or released into the environment.
- **Non-hazardous Waste Output** – *Is less non-hazardous material being disposed or incinerated?* Measures could include the change in total non-hazardous waste disposed over time.
- **Toxic Use Reduction** – *Is the use of toxic substances declining?* Measures could include the amount of material use in relevant industries, for selected toxic substances.
- **Material Efficiency** – *Is production efficiency improving, as materials are converted to products with less waste?* Measures could include the amount of product outputs, material inputs, and waste outputs.
- **Return Flows** – *How much of the economy's inputs come from "waste" outputs?* Measures could include the reused content of a basket of goods over time and the dollar value of recycled feedstock as a percentage of total or virgin input.
- **Recovery Rate** – *What percentage of "waste" outputs are we recovering for reuse?* Measures could include recycling rates for municipal solid waste, construction and demolition materials, as well as hazardous wastes.
- **Behavior Change** – *Are residents, businesses, and institutions taking action to move beyond waste?* Examples of potential types of indicators could include the number of LEED-certified buildings[11], environmentally preferable purchasing choices, or recycling capture rate studies. Additional indicators could focus on product design that facilitates material reuse or recycling.
- **Value Creation** – *Are companies realizing economic gains through waste reduction and reuse?* Measures could include job creation, cost savings (e.g., opportunity costs, disposal costs), and value creation from waste outputs.
- **Capacity & Safety** – *Do we have adequate, safe facilities to handle remaining wastes?* Measures could include supply and demand balances as well as absolute capacity relative to projected supply.

Figure 2 provides a schematic representation of how these indicators might be used to help track the system of waste and material flows in Washington State.

[11] LEED stands for Leadership in Energy and Environmental Design. LEED certification is a program of the U.S. Green Building Council.

Figure 2. Indicators Approach Overview



In addition to the individual indicators, a related option is to develop an aggregated Beyond Waste index that presents compiled results of the progress for each indicator. This approach offers advantages as a communication tool for sharing information with the public in an easily accessible, understandable manner. Such an index could help clearly show (in a single measure) the current status of progress towards the Beyond Waste vision and could serve as a strong motivator for behavior change. However, such an index is not a scientific tool, and a potential disadvantage is that the important details of the individual indicators could become lost in oversimplification. We recommend further exploration of the index concept as a potential accompaniment to a set of indicators for tracking materials and wastes. One possible partner in this endeavor would be Northwest Environment Watch, who in 2003 and 2004 is developing a regional index that will monitor how the Northwest is doing at creating an environmentally sound economy.[12]

The consultant team recommends that Ecology implement an indicators approach over the other alternatives described in Chapter 3 for several reasons:

- The indicators approach offers the highest potential to effectively track both material flows and wastes, given available resources. Achieving the Beyond Waste vision requires that Ecology focus on how to eliminate and manage materials before they become wastes. Tracking all those flows is an enormous, essentially impossible task. By using indicators to keep track of materials and wastes of significance at select points in their lifecycles (e.g. when incorporated into products or when disposed), Ecology can quickly and can without great expense begin monitoring progress towards the Beyond Waste vision.
- Beyond Waste indicators can be designed to be understandable and meaningful to a broad audience, both within and outside the agency. Experience in Washington and elsewhere with TRI data has already shown that public access to and understanding of environmental information can leverage significant behavior change. It is therefore likely that broad dissemination of clear, concise Beyond Waste indicators will strengthen public support for and commitment to the Beyond Waste vision.
- There is a high potential that the indicators approach can and will work. If well implemented, it offers promise of better data and understanding for the same or fewer resources. The indicators approach involves using data collection and analysis techniques such as sampling, baskets, and indexing that are designed to be representative of the underlying trends and flows. This representativeness is a key advantage of the indicators system.
- The indicators approach by its design is flexible and adaptive and therefore remains useful over time. It provides a dynamic, significant improvement over the existing systems, which remain static even as underlying flows and problems change.

[12] Northwest Environment Watch. "The NEW Indicators Project." http://www.northwestwatch.org/topics/measuring.html

DEVELOPING SUCCESSFUL INDICATORS

Developing successful indicators is a challenging but achievable endeavor. In 1996, The Balaton Group, an international group of scholars and activists, met to share experiences on using indicators for tracking sustainable development. Their report highlighted the following qualities of a good indicator:[13]

- **Clear in value:** no uncertainty about which direction is positive and which is negative;
- **Clear in content**: easily understandable, with units that make sense, expressed in imaginable, not eye-glazing, numbers.
- **Compelling**: interesting, exciting, suggestive of effective action.
- **Policy-relevant**: for all stakeholders in the system, including the least powerful
- **Feasibile**: measurable at reasonable cost
- **Sufficient**: not too much information to comprehend, not too little to give an adequate picture of the situation
- **Timely**: can be calculated without long delays.
- **Appropriate in scale**: not too broad or too detailed.
- **Democratic**: stakeholders should have input to indicator choice and have access to results.
- **Supplementary:** should include what people can't measure for themselves
- **Participatory**: should make use of what people can measure for themselves and compile it to provide geographic or time overviews
- **Hierarchical:** so a use can delve down to details if desired but can also get the general message quickly.
- **Physical:** money and prices are noisy, inflatable, slippery, and unstably exchangeable. Since sustainable development is to a large extent concerned with physical things, it's best wherever possible to measure it in physical units.
- **Leading**: so they can provide information in time to act on it.
- **Tentative:** up for discussion, learning, and change.

However, it is extremely difficult to develop indicators that meet all these criteria. Furthermore, some of the important aspects of Beyond Waste that should be tracked (such as value creation) contradict the criteria above.

Nonetheless, the consultant has assembled some initial possible indicators, using the above criteria as reference points but not absolute necessities, that we believe offer starting points for tracking progress towards the overall Beyond Waste vision as well as monitoring the success of the Industrial, Organics, and Green Building initiatives/activities discussed in Issue Papers #3 - #5. These indicators are presented in Table 7 - Table 10. Note they are not intended to be an exhaustive list of everything

[13] Meadows, Donella. Indicators and Information Systems for Sustainable Development. Hartland, VT: The Sustainability Institute, 1998.

Ecology (or its partners) should be tracking. Rather, they are proposed as candidates for a core group of indicators that Ecology, stakeholders, and the public could collectively use to measure progress towards the Beyond Waste vision.

The ultimate development of any Beyond Waste indicators should be participatory, as the criteria above note, and be developed with some stakeholder input. The indicators listed here are proposed as starting points for consideration in this discussion. Note that some of the indicators are well-suited to broad public use, as they could be captivating and easily communicable (such as *solid waste disposed per person* or *total toxic material inputs*), while others would more likely be suited for use as internal performance metrics (such as *reported attitude and behavior change* or *remaining capacity at hazardous waste facilities*).

Finally, it is important to note that not all of the indicators can be constructed with existing "off the shelf" data. In particular,

- Some of the indicators require collecting entirely new types of information. For example, one of the proposed indicators involves creating a "basket" of goods and monitoring the toxic constituents, recyclability, and other Beyond Waste attributes;
- Others require working with other Washington partners to compile enough information to calculate the indicator; and
- Several indicators are based on data Ecology already collects, either in existing form, or after improvements as suggested in Recommendation #5.

Table 7: Initial List of Potential Overall Beyond Waste Indicators

Indicators	Possible Data Collection Approaches and Sources	Rationale	Indicator Type *(See Figure 2)*
Total solid waste disposed, in aggregate and per person (with detail available on breakdown of MSW, Industrial, C&D)	Current tracking system, with upgrades discussed in Recommendation 5 and population estimates by Washington Office of Financial Management.	This could serve as the fundamental indicator measuring progress towards eliminating waste.	Non-Hazardous Waste Output
Ratio of recycled feedstock to virgin feedstock in Washington's manufacturing sector	Survey of manufacturers. May be possible to combine efforts with King County's current statewide survey of manufacturers using recycled feedstock.	This measure should increase as more "wastes" are used as "resources".	Return Flows
"Beyond Waste" attributes of a typical "basket" of goods	Decide what products to include in sample, and then measure their attributes/contents annually or biennially. This approach could be pursued with other state or federal (EPA) partners. See Appendix B for a further description of this approach.	Measuring the attributes of all products in the economy is technically impossible. A basket approach would allow the State to measure change, over time, in selected attributes of the representative sample.	Material Efficiency, Toxic Use Reduction, Behavior Change
Toxic material inputs, in aggregated and per person	Choose a small number of priority materials, and use US Geological Survey method to estimate total inputs, including those in products.[14] Information from the toxics tax database may be helpful.	Provides an indication of behavior change and future quantities of toxic materials requiring vigilant management	Toxic Use Reduction, Behavior Change
Chemical "body burdens"	Sampling of human blood, urine, and breast milk for dangerous metals and synthetic chemicals, patterned after US Centers for Disease Control and Prevention's program, begun in 1999. May involve acquiring data from them, supplementing their data, or emulating their approach. Would certainly involve teaming with other Washington agencies, such as the Dept. of Health.	Although the year-to-year resolution of this indicator is limited, over time progress toward Beyond Waste should result in fewer chemicals in the environment and fewer in our bodies. This measurement is directly relevant to human health.	Toxic Use Reduction

[14] United States Geological Survey, *Total Materials Consumption: An Estimation Methodology and Example Using Lead – A Materials Flow Analysis.* USGS Circular 1183, 1999.

Indicators	Possible Data Collection Approaches and Sources	Rationale	Indicator Type *(See Figure 2)*
MSW Recycling Rate, including individual technical and organic material recycling rates, and at the local level as well.	Existing statewide recycling survey, with improvements.	Proves measure of progress and accountability.	Recovery Rate
Fraction of Gross State Product Spent on Waste Disposal	Dollars spent on waste disposal could be calculated by multiplying the tons of waste disposed at each landfill by its tip fee, and summing the results.	Provides an indirect measure of value creation, as this indicator would track the lost resources. A decrease in this indicator would be caused by value creation or increased material efficiency	Value Creation Efficiency
Reported Attitude and Behavior Change	Biennial survey of residents and businesses about attitudes, practices concerning waste, materials, etc.	Such a survey could measure the effectiveness of education and promotion campaigns.	Behavior Change
Tons of waste disposed per dollar of Gross State Product	Current tracking systems	Provides a measure of the material intensity and efficiency of Washington's economy.	Efficiency
Fraction of waste management sites (both hazardous and non-hazardous) operating safely	Monitoring to determine safety, as related to human exposure or migration to the environment (such as to groundwater).	Provides a measure of the safety of current facilities at containing waste, especially hazardous or toxic materials.	Capacity & Safety
Capacity remaining, in years, for both hazardous and non-hazardous waste facilities, given predicted future waste flows	Survey of facility operators to determine present volume, then calculate capacity in years based on projected future waste generation	Provides a measure of the remaining capacity of facilities. Could answer the question "If the transition to Beyond Waste happens in 30 years, then do we already have enough capacity to handle what wastes will be generated until then?"	Capacity & Safety

Table 8: Initial List of Potential Beyond Waste Indicators--Organics

Indicators	Possible Data Collection Approaches and Sources	Rationale	Indicator Type *(See Figure 2)*
Total generation per capita, and fraction of total composition, of organics in MSW stream	Statewide or composite of local waste composition studies.	Periodic waste composition studies will be necessary to measure the quantity of organic materials remaining in the waste stream.	Non-Hazardous Waste Output
Soil quality – organic matter content and toxics content	First conduct baseline study by randomly sampling residential and agricultural soils. Then conduct annual or biennial random sampling to establish trend analysis.	Soil health is vital to plant, animal, and human survival. A primary way to improve soil is to add recycled organic matter. In addition, measuring the toxic content of soils can serve as a proxy measure for the quantities of toxics in the environment, as well as address concerns over use of biosolids in agricultural settings.	Value Creation
Number of farms without effective organic waste management	Link with other Ecology programs (especially Dairy Manure Management) and other state agencies (Dept. of Ag, Cooperative Extension) to survey or consolidate information on the number of farms that do not meet predetermined "Beyond Waste" standards.	Agricultural practices are a huge source of organic materials. While most are already handled effectively, some practices (tree or crop stubble burning, dairy manure runoff, etc.) contribute to pollution and do not treat organic wastes as resources.	Behavior Change
Fraction of cities and counties in Washington with cost-effective residential organics recovery programs	Survey of local governments. This indicator should be relatively feasible to monitor through the partnership of local governments recommended in Issue Paper #4 – Establishing the Organics Cycle.	One of the primary 10-year goals suggested by the consultant was for the establishment of cost-effective organics programs that include food waste.	Behavior Change
Fraction of residents and businesses served by recovery programs	The residential fraction could be tabulated by surveying local governments, as above. The commercial fraction could be estimated through the same survey, or through a survey of businesses in certain industry groups (restaurants, grocery stores, etc.)	This would provide a measure of how widespread organics recovery programs have become.	Behavior Change

Table 9: Initial List of Potential Beyond Waste Indicators – Industrial Sector

Indicators	Possible Data Collection Approaches and Sources	Rationale	Indicator Type *(See Figure 2)*
Total Hazardous waste output and Hazardous waste output normalized against business activity NOTE: can also be done on an industry-specific basis	Current HWIMSy tracking system, with upgrades discussed elsewhere in this report plus gross state product information held by the Department of Commerce (as a measure of annual business activity)	This is one of two fundamental indicators of progress towards Beyond Waste in the industrial sector.	Hazardous Waste Output
Toxic releases (total)/year and possibly releases of PBTs/year	Toxics Release Inventory	This is the second of two fundamental indicators of progress towards Beyond Waste in the industrial sector.	Hazardous Waste Output
Average reduction in waste generation/substance use targeted by Beyond Waste/Cleaner Production Challenge participants	Annual Beyond Waste/Cleaner Production Challenge reports, possibly augmented by P2 plan updates and/or TRI information	This indicator will monitor the behavior change of the industrial community and relates to the fundamental indicator of progress toward Beyond Waste.	Behavior Change Toxic Use Reduction
Fraction of industrial actors that have implemented continuous improvement Environmental Management Programs.	Survey of industrial sector actors.	This indicator will monitor the behavior change of the industrial community.	Behavior Change

Table 10: Initial List of Potential Beyond Waste Indicators – Green Building

Indicators	Possible Data Collection Approaches and Sources	Rationale	Indicator Type *(See Figure 2)*
Total Construction and Demolition waste disposed, per person, including detail on activity that generated that waste (residential remodel, commercial new construction, etc.)	The current tracking system could form the basis, with enhancements (such as improved use of categories on reporting form) discussed elsewhere in this report. A statewide C&D waste comp study (or disposal facility survey) would be needed to provide detail on activities that generated the waste.	This is a fundamental indicator of progress towards Beyond Waste in the building sector.	Non-hazardous waste output
C&D Recycling Rate, including measure of down-cycling	Current statewide recycling survey and periodic statewide waste composition study.	This is another fundamental indicator progress towards Beyond Waste in the building sector.	Recovery Rate
Job creation, through creation of new green building industries.	Use SIC codes, employment data, and perhaps survey of firms to track the number of jobs, over time, in deconstruction, manufacturers of green building materials,	Tracks one aspect of the positive economic impact of green building.	Value Creation
Fraction of new buildings that are "built green", including detail on new residential, commercial, and institutional structures.	Number of such buildings registered with the consultant's proposed statewide green building program compared to the total number of buildings receiving permits. A survey could also help quantify "built green" buildings that don't officially certify but still qualify.	This indicator will track the extent to which new buildings are being "built green."	Behavior Change
Fraction of remodeled buildings that are upgraded to "built green" standards, including detail on new residential, commercial, and institutional structures.	Number of such buildings registered with the consultant's proposed statewide green building program compared to the total number of remodels occurring (as reported on permits). The data for this indicator could also be gathered by a survey of remodelers.	This indicator will track the extent to which consumers use green building principles in remodels.	Behavior Change
Ratio of buildings deconstructed to those that are demolished	Data from permitting agency, but may require adding new reporting requirement to such permits.	Deconstruction (rather than demolition) will be a fundamental industry in moving towards Beyond Waste in the building sector.	Behavior Change
Market share of building materials that contain toxic constituents	The easiest means would be to obtain data from industry associations on market share of target products. An alternate approach would be to conduct a survey of builders or suppliers.	Building materials can off-gas or leach toxic materials into the environment, affecting human and environmental health.	Toxic Use Reduction

RECOMMENDATION 5: ADDRESS SIGNIFICANT GAPS

Although this report does not recommend adoption of the full "patchwork" approach as outlined in Chapter 3, we do recommend that Ecology conduct some strategic patching to provide sufficient data to support the indicators and answer the key questions posed at this beginning of this report. Once the exact set of indicators has been finalized, Ecology should determine the specific data requirements for the selected indicators and focus on filling any major information gaps in existing tracking system to support those indicators.[15]

Still, regardless of the indicators chosen, some gaps in the existing systems will need to be addressed in order to acquire better information on waste generation, return flows, and inherent hazards, in order to answer the key questions posed in Chapter 1. Table 11 and Table 12 present those gaps and suggest possible solutions for both hazardous and non-hazardous wastes. The consultant rated these gaps as highly relevant to the Beyond Waste key questions in Table 1 and Table 2.

The closing of these gaps is anticipated to require relatively few resources and be tied directly to the key questions posed in Chapter 1. Other gaps may also need to be addressed (primarily concerning flows not currently tracked by Ecology or its partners), pending assessment as suggested in Recommendation 2.

For further discussion of possible approaches to addressing these hazardous waste data gaps, see Appendix A.

Table 11. Hazardous Waste Data Gaps to Address

Gap	Possible Solution
The lack of information on the **composition of hazardous wastes** makes it difficult to assess the inherent hazard of specific waste streams.	▪ Consider requiring facilities to report chemical Chemical Abstracts Service (CAS) numbers on dangerous waste reporting forms. This would facilitate linking Toxics Release Inventory and Dangerous Waste data. Note: This may require a regulatory change such as that accomplished by Oregon.
Little is known about the **inherent hazard** of specific waste streams. As a result, Ecology is limited in its ability to assess the appropriateness of specific management options; identify areas of high exposure potential; and/or track changes in the toxicity of the state's waste streams, or those of individual facilities, over time.	▪ Implement a hazard weighting methodology (e.g., EPA's) to assign values to different waste streams. Generally, these methodologies necessitate knowing about the chemical composition, concentration, and exposure pathways (in this case, disposition) of specific wastes of concern. See Appendix A for more detail.

[15] The exact set of indicators should be finalized by Ecology after specific waste reduction strategies have been chosen and possibly after Recommendations 2 and 3 have been completed.

Gap	Possible Solution
Lack of information on the **sources, quantity, and composition of unreported hazardous waste** (e.g., SQGs, wastewaters, hazardous waste in products), as a result of reporting exemptions and underreporting, makes it difficult to assess the total quantity of hazardous wastes entering the environment.	▪ Fully utilize information collected internally (e.g., during technical assistance and compliance assurance visits) to develop generic waste generator profiles for important industries. ▪ Review earlier Dangerous Waste reports and profiles to identify industry sources of hazardous wastes that are currently exempted from being reported. Extrapolate waste volumes based on business establishment data supplied by the BEA to estimate quantity of exempt hazardous waste generated in the state.
Uncertainty about the **composition, volume, and inherent hazard of pesticides and fertilizers** being placed into natural environment hinders ability to measure the costs and benefits of use.	▪ Fully utilize information collected by other state agencies, the National Agricultural Statistical Service, and other reports to estimate volumes and composition. ▪ Further expansion of reporting requirements may be needed to provide information on the inherent hazard of these products.
The lack of knowledge about amount and type of **hazardous/toxic materials incorporated into products** (e.g., heavy metals in electronics, cadmium in tires, or chemicals in carpets that are later off-gassed) may contribute to their improper disposal and/or use as well as the likelihood of their unintended release to the environment**.**	▪ Examine product profiles developed elsewhere (e.g., through material accounting exercises in New Jersey and Massachusetts) to better understand materials and substances incorporated into products. ▪ Review Washington state facilities' annual pollution prevention plans for descriptions (product name and CAS number) of hazardous substances used during processes. Note: Substance use does not necessarily imply that the substance is incorporated into a given product. This information must be compared to wastes and releases. ▪ Conduct a survey of MSW landfills, incinerators, and other management facilities to determine how specific waste streams of interest (e.g., electronic wastes, automobiles) are managed.

Table 12 presents the gaps that should receive priority attention concerning non-hazardous waste.

Table 12. Non-Hazardous Waste Data Gaps to Address

Gap	Possible Solution
The variable use of **reporting categories on the facility reporting form** inhibits accurate information on MSW, industrial, and construction/demolition waste flows.	▪ Conduct education regarding proper use of the MSW facility reporting form; conduct follow-up with reporters, if necessary, to obtain accurate information. ▪ If necessary, require that facilities track and report in the appropriate categories.
The lack of a **recent statewide waste composition study** inhibits Ecology's ability to understand components and changes over time and thus to design and measure the effectiveness of Beyond Waste strategies.	▪ Conduct statewide MSW composition study on a 5- or 10-year cycle.
The lack of knowledge concerning the **composition and disposition of construction/demolition and industrial solid wastes** makes it difficult to design Beyond Waste strategies and measure their effectiveness.	▪ Concurrently (or in conjunction with) the statewide MSW composition study, conduct sampling study to characterize construction/demolition and industrial solid wastes.
Instances of **non-reporting in the annual recycling survey** make it difficult to discern true trends and accurately track how much "waste" output is returned as material input.	▪ Consider making survey response mandatory, discussing feasibility and approaches with the State of Oregon.
Recycling or diversion of construction/demolition and industrial materials is not thoroughly tracked, limiting Ecology's knowledge about total recycling and diversion in the state.	▪ In addition to the recycling rate, develop a diversion rate that includes these materials; expand the focus of the recycling survey to gather the required information.
The lack of information on the **quantities of Moderate Risk Waste not collected for proper treatment** makes it difficult to assess the effectiveness of MRW collection programs and the potential impacts of improperly disposed MRW.	▪ Conduct an initial study to estimate total MRW generation. ▪ Pending results of initial study, establish ongoing survey or sampling to track MRW generation trends over time.

RECOMMENDATION 6: ADOPT ALTERNATIVE DATA COLLECTION METHODS AND MAXIMIZE DATA USE

Plugging strategic data gaps will help to inform both policy directions and program activities at Ecology. As noted previously, several methods exist to collect information related to material flows through the Washington economy. These include census-based data collection, profiling studies (e.g., of specific industry sectors), and/or statistically representative sampling activities. In many cases, however, these options may represent significant financial and staff resource commitments for Ecology and possibly for regulated entities.

Given Ecology's resource constraints, a major thrust of the Beyond Waste vision should be to find ways for the agency to maximize the utility of information and data that staff already collect during regular visits with the regulated community as well as to employ survey and extrapolation techniques (including data collected by other agencies) in place of reporting, where possible. Following are brief discussions of these approaches.

USE INFORMATION COLLECTED DURING ONSITE VISITS TO FILL DATA GAPS

Ecology's onsite activities, such as technical assistance and compliance assurance visits, likely generate data that would be useful to understanding Beyond Waste opportunities and critical to defining Beyond Waste progress. With a minimal additional effort, these regular face-to-face interactions with waste generators may yield useful information to help fill important data gaps, including those gaps related to small-quantity-generators (SQGs), wastewaters, dangerous waste incorporated into products, and industrial wastes regulated under RCRA Subtitle D. This data collection option alone may minimize additional necessary costs to the agency and to the regulated community.

Waste generators provide detailed and sensitive information regarding their particular manufacturing processes to Ecology staff (e.g., during toxics reduction or compliance assurance visits) in hopes of receiving suggestions and guidance on ways to improve their processes. As a rule, this information remains known only to those individuals involved in the outreach efforts and is rarely compiled in a systematic way. With a modest data collection effort and information system structure, Ecology could gather comparative information on such topics as the following:

- Types of hazardous materials used in production process;
- Amount and type of material that emerges as non-product output and its specific sources;
- Waste disposition methods and volume (including wastewaters); and
- The number of employees at each establishment.

The types of hazardous waste used in the production process could help identify inputs and other associated upstream material flows, providing potential material flow target information. The amount and type of material that emerges as non-product output provides information on the downstream side of production and could possibly be used to make inferences about dangerous wastes incorporated into product. Disposition data would provide better information on where waste goes after the generator finds no more use for the material. Employment figures would allow Ecology to develop a better understanding of the waste-to-employee relationship and inform analysis of SQGs.

The data elements listed above are only suggestions that are intended to address specific areas that interest Ecology. Clearly, onsite visits could yield other information that Ecology could use to fill important data gaps. Key material flows that could be better understood through this information include generation by industry sector for SQGs, hazardous wastewaters generation, dangerous waste incorporated into products, and Industrial D wastes.

For a suggested approach to organizing data collected during onsite visits, see Appendix C.

USE SURVEY AND EXTRAPOLATION IN PLACE OF REPORTING

Extrapolation and estimation approaches enable the Department of Ecology to use limited data to develop a picture of the current state of material and waste flows in Washington. As discussed in Chapter 3 (page 38), extrapolation can provide a quick and inexpensive, yet reasonably accurate, means of quantifying a material or waste flow.

A highly relevant approach is to use limited sampling data to quantify wastes on a per-unit basis and then use a survey of possible waste generators to extrapolate the per-unit estimates up to the state level. To continue an example used in Issue Paper #1, the quantity of mercury-containing amalgam released from dentist offices in Washington can be estimated by either sampling at a number of representative dentist offices or by using averages determined by other states or industry studies. These averages for individual dentist offices can then be extrapolated based on a survey all dentist offices in Washington that would determine their size, if they use mercury, and how they store and treat any mercury amalgam they do use. Similar approaches could be used for a wide variety of wastes and generator types.

Survey and extrapolation approaches are cost-effective, as they do not require elaborate reporting or data management structures required by other data collection techniques. Use of these approaches is also politically feasible, as they do not require legislation or rulemaking.

Ecology should use survey and extrapolation techniques, combined with limited sampling, whenever practical in place of elaborate reporting requirements.

RECOMMENDATION 7: CONDUCT PERIODIC EVALUATION AND REVIEW

To ensure that the tracking system remains responsive to changing needs over time, the system's management should include a mechanism for periodic reassessment and revision. On a regular basis, as well as when specific needs emerge, managers should reexamine the tracking system to determine if it continues to cover the key issues of interest or if it needs modification. This review should determine whether any new substances, material flows, or risks warrant increased attention by Ecology and its partners. Such an approach would also allow flexibility in that it would allow for the tracking of certain key waste streams, such as electronics, for a limited amount of time.

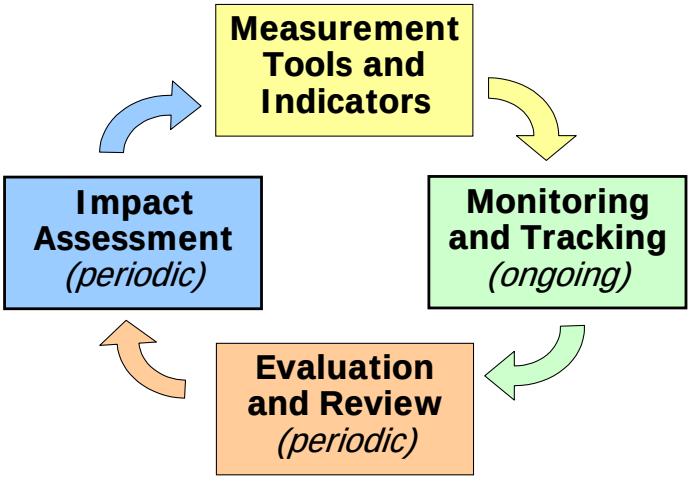
Methods such as statistical sampling or surveys could be used to help identify and characterize emerging issues. Sampling could include composition studies or examinations of industrial waste streams to identify key changes in flows. Additionally,

surveys that draw on research efforts underway in other jurisdictions may help highlight emerging waste streams. Emerging issues such as biologically active compounds (e.g., pharmaceuticals) may need special assessments conducted. Results of such special studies should be integrated back into the overall indicator tracking system, rather than relegated to stand-alone reports.

This feedback mechanism, for both special assessments as well as general periodic reviews, would help the tracking system adapt and evolve over time to meet the dynamic needs of Ecology program managers and the Beyond Waste vision itself.

Figure 3 displays how evaluation and review would function in the proposed conceptual approach. Note that the development of **measurement tools and indicators** allow **monitoring and tracking**, but that periodic **evaluation and review** is necessary to ensure that the tracking system and indicators are responsive to changing needs and priorities. An important tool in such evaluation would be **impact assessments** (which set priorities according to significance) such as those proposed in Recommendations 2 and 3.

Figure 3: Proposed Conceptual Approach to Waste Tracking



TRANSITION PLAN/IMPLEMENTATION STRATEGY

Following the approach outlined below, the Department of Ecology could implement these recommendations within two to five years. Because the indicator approach represents the core of the proposed strategy, this implementation plan focuses on development of the indicators, though the other recommendations would become elements of this approach.

TRANSITIONING TO NEW SYSTEM –HWTR AND SWFA PROGRAMS

To transition to the proposed indicator-based tracking system, the HWTR and SWFA programs could work together to:

- **Establish an indicators planning team** involving the key staff members responsible for advancing the Beyond Waste vision, including members of both the hazardous waste (HWTR) and solid waste (SWFA) program. This group

would develop and agree upon a set of indicators designed to track progress towards the Beyond Waste goals, using the consultant's proposed indicators in Recommendation 4 as a basis, and the information included in the following section. This group would then manage the transition to the new system, including the following items.

- **Identify data sources and responsibilities.** The planning team would determine what data sources already exist to support the indicators, what data can be obtained from other organizations, and where new sampling, surveying, extrapolation, or other techniques would be required. The team would also determine what respective roles the HWTR and SWFA programs should play. If necessary, subgroups could be developed to focus on specific indicators. These subgroups could also: identify areas in which regulatory or reporting responsibilities could be streamlined, through changes in information collection systems; involve interested stakeholders; and collaborate with others, such as the federal government and relevant industry associations, to obtain useful data and streamline reporting responsibilities. The bulk of this process could take place in 6 – 12 months.
- **Begin tracking new indicators.** Once the overall strategy is in place, the indicators team could move forward with implementation of the indicators approach to tracking progress. The first step could be to start tracking indicators for which data is already collected, after improving the quality of this data (as discussed in Recommendation #5). Once these indicators are in place, a staged implementation plan should include the phase-in of one or two of the new indicators on a pilot basis, complete with an evaluation of the efficacy of the pilot. This approach would enable the indicators team to address any issues or problems prior to full-scale roll-out of the program. Some additional resources would be needed during the planning and initial implementation period, but over time the indicators approach should not require significant new resources, particularly as elements of the existing tracking system may no longer be needed.
- **Develop a new, joint "Beyond Waste" Annual Report**, focusing on the new indicators and the success of Beyond Waste initiatives. This new joint report could replace existing annual reports such as the SWFA program's *Solid Waste in Washington State* and the HWTR program's *Reducing Toxics in Washington* and *Dangerous Waste Annual Report*. Much of the content of these existing reports could feed into the new Beyond Waste Annual Report, and detail on existing programs could be included as appendices until no longer needed.

BENEFITS OF NEW APPROACH

The recommendations described above outline a path by which Ecology can move towards its vision of Beyond Waste and help measure progress towards the adoption of that vision – and the consequent changes in behavior – throughout society in Washington. The recommended strategy offers an effective, feasible method for answering the key questions outlined in Chapter 1 and monitoring progress towards the Beyond Waste vision.

Using a material flow framework, rather than focusing on wastes alone, would allow Ecology to view the broader system in which wastes are created and take a proactive approach to reducing and preventing waste. Addressing significant gaps in current

waste tracking systems would not only improve existing information but would also provide better data on the recommended Beyond Waste indicators. The indicator approach, coupled with periodic assessment and evaluation, would enable Ecology to answer the key questions and measure progress in moving Beyond Waste.

The recommended approach creates a flexible system that can adapt over time, while maintaining core consistency to allow monitoring changes and trends over time. The tracking system provides a representative view of overall material and waste flows and also allows Ecology to identify and focus on elements of particular significance. The resulting body of indicators is designed to be easily understandable and communicable by and for both decision-makers and the public. As a result, the system also provides for accountability and feedback, as all parties have clear measures by which they can track progress and determine where additional changes are needed to achieve the Beyond Waste vision. This package of recommendations is designed to facilitate the Washington State Department of Ecology's efforts to advance the Beyond Waste vision in the state and measure progress over time towards achieving that goal.

PITFALLS AND CHALLENGES

Transitioning to a new data collection system will certainly involve pitfalls and challenges. These potential obstacles will likely include the following issues:

- Managing the transition from the existing system to a new one;
- Obtaining additional resources, as needed, to manage the transition;
- Potentially addressing federal regulatory requirements, which may involve maintaining data systems that might not be needed for the indicators approach but are necessary to meet federal requirements;
- Defining indicators and obtaining data for those indicators that are representative of underlying material flows and wastes;
- Working with other agencies to obtain needed data for the indicators (e.g. Washington State Department of Natural Resources, Office of Financial Management, Washington State Department of Agriculture);
- Acquiring additional staff with new skill sets (e.g., economics, statistics);
- Maintaining consistency and representativeness of the selected indicators as priorities, and therefore the components of the basket-based indicators, change over time; and
- Educating existing staff to adapt to the new system.

The charge for Ecology will be to overcome these challenges through the following efforts:

- Strategic and systematic implementation of the new system;
- Creating teams of talented staff to develop initial indicators and data collection systems;
- Forging effective alliances with other agencies; and

- Determining where and how to relax or reduce current data collection and analysis efforts to create resources and support from critical customers for the alternative approach.[16]

[16] While Ecology may encounter internal resistance to reducing current data collection efforts, it may be that some data can be collected less frequently. For example, several years ago local governments placed strong emphasis on annual or semi-annual waste composition studies. However, most have found that waste composition studies on 5- or 10-year intervals are sufficient for planning purposes.

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Glossary

Following are definitions of some key terms that may need clarification.

Biological material.[17] A biodegradable material posing no immediate or eventual hazard to living systems that can be used for human purposes and can safely return to the environment to feed environmental processes. They can be safely be returned to the soil and consumed by organisms.

Biologically Active Compound. A material that has direct physiological effect on a plant, animal, or microorganism. Examples of biologically active compounds include antibiotics, hormones, endocrine disruptors. Most such compounds enter the environment as pharmaceuticals or personal care products.

Composites. Materials or products made of combinations of biological, technical, and/or "unmarketable" materials.

Economic actor sector. A broad group of organizations and/or individuals whose similar actions or decisions related to the use, consumption, or exchange of goods and services have a large impact on material and waste flows within the state. Examples of key economic actor sectors in Washington include residential, agriculture, and primary metals.

Extraction Wastes are wastes generated at the point of original extraction or harvest of a material. Examples include mining overburden and tailings, forestry slash, and crop residues.

Indicator. A measurement that reflects the status of a system. Examples include the Dow Jones Industrial average, the oil pressure of an engine, or the "ecological footprint" of an individual or community. This report proposes several new indicators to assess progress towards the Beyond Waste Vision.

Persistent Bioaccumulative Toxics (PBTs) are highly toxic, long-lasting substances that can build up in the food chain to levels that are harmful to human and ecosystem health. Examples of PBTs include heavy metals (like mercury), dioxins, and Polychlorinated Biphenyls (PCBs).

Polychlorinated Biphenyls (PCBs) are human-made chemicals that occur as oily liquids or solids, are colorless to light yellow, and have no smell or taste. Because they do not easily burn and are good insulators, PCBs have been used widely as coolants and lubricants. There are no known natural sources of PCBs in our environment. Manufacturing of PCBs stopping in the Unites States in 1977 because they were found to build up in our environment and cause harmful effects.

Technical material.[17] A material that remains in a closed-loop system of manufacture, reuse, and recovery (the technical metabolism), maintaining its value through many product life cycles. These valuable resources, such as plastic or metal, are typically lost when items are disposed.

Unmarketables.[17] Materials that cannot be maintained safely in either biological or technical cycles.

[17] Definition adapted from McDonough Braungart Design Chemistry, *http://www.mbdc.com/c2c_home.htm*

Appendix A: Further Discussion of Hazardous Waste Information Gaps – Inherent Hazard, CESQG, and Pesticides/Fertilizers

Error! Reference source not found. presented the highest-priority gaps in tracking of hazardous waste. These gaps need to be addressed in order to answer the key questions presented in Chapter 1. Following is some further discussion of possible approaches to addressing three of these gaps.

DATA GAP: LACK OF KNOWLEDGE ABOUT THE INHERENT HAZARD OF SPECIFIC WASTES

Although Ecology collects detailed quantity information on hazardous waste management and toxic releases, less is known about the inherent hazard or risk posed by specific toxic releases to air, land, and water. As a result, Ecology's current ability to target specific material and waste flows, economic actor sectors, and/or management types for attention and assistance depends, mainly, on what is known about the quantities of toxic materials introduced to the environment or specific interest at the Agency, in the public, or, possibly, in the Legislature.

To address this important data gap, Ecology should consider utilizing a toxicity weighting methodology, such as the one designed by EPA Office of Pollution Prevention and Toxicity (OPPT). The EPA model (the "Risk Screening Environmental Indicators Model")[18] assigns a toxicity weight for a given Toxics Release Inventory (TRI) release based on the single most sensitive adverse human health effect (cancer/non-cancer) for any given pathway (oral and/or inhalation). The model does not consider differences in the severity of effects. In this model, the "higher" the weight, the greater risk/inherent hazard posed by the material in question.

The EPA model requires knowledge of: (1) quantity released (typically extracted from a TRI report); (2) chemical-specific toxicity; (3) pathway-specific exposure potential (also, typically, from TRI); and (4) size of the potentially exposed human population. Other risk/toxicity weighting methodologies have been developed by the National Institute for Occupational Safety and Health, Santa Clara Center for Occupational Safety and Health (SCCOSH), and others may also be worthwhile.[19]

[18] See *http://www.epa.gov/opptintr/env_ind/method.htm*, http://www.epa.gov/oppt/env_ind/, http://www.epa.gov/oppt/env_ind/esmeth.htm and/or http://www.epa.gov/oppt/env_ind/estox.htm for a discussion of EPA's methodology/model. The model is a computer application and was reviewed by EPA's Science Advisory Board in 1997.

[19] See the 1998 World Bank paper "Accounting for Toxicity Risks in Pollution Control: Does it Matter?" for a brief discussion of several risk weighting methodologies from around the world. http://www.worldbank.org/nipr/work_paper/risks/index.htm#TopOfPage

Although the toxicity weighting methodology can only help identify the relative risk-based impacts of different releases or transfers of chemicals on the general population, it may represent a useful tool to Ecology for targeting flows, industries, or exposure pathways/management methods for attention in the Beyond Waste workplan.

NOTE: It might be possible to substitute Dangerous Waste data for TRI data if Ecology were to collect information on the composition of the dangerous waste generated. The addition of a Chemical CAS (Chemical Abstracts Service) number field to the Dangerous Waste reporting form may resolve this issue.

DATA GAP: LACK OF KNOWLEDGE OF THE HAZARDOUS WASTES GENERATED BY CONDITIONALLY EXEMPT SMALL QUANTITY GENERATORS

As previously noted, Small Quantity Generators (SQGs) are not required by law to report detailed waste generation information that might otherwise be useful to understand progress toward Beyond Waste. Due to the broad spectrum of generator types as well as their variable management practices and relatively small individual waste output, comprehensive reporting would be overly burdensome to both generators and Ecology. Still, data gap somewhat constrains Ecology's ability to fully understand the sources, composition, and quantity of hazardous waste generation in the state. If deemed important, an effort to close the SQG data gap could combine the following four sources of information:

- ·Ecology's annual estimates of the number of SQGs (taken from the Hazardous Waste Information Management System outputs and compared to U.S. Census Bureau information);
- ·structured data taken from technical assistance and compliance assurance visits;
- ·existing profiles completed by other agencies; and/or
- ·new industry profiles funded by Ecology.

A description of how these data could be used to fill the gap is included below.

Reporting SQGs

The first step of the process will be to identify, by NAICS code, industry sectors that are typically associated with small generator activity. Currently all establishments generating Dangerous Wastes in Washington State are required to self-identify and are given a Dangerous Waste identification number. Ecology could use the HWIMSy database to draw out the specific NAICS codes currently used by SQGs in Washington State. A literature review could compare the list of industry sectors the HWIMSy database identifies to previous state and national studies. The comparison would allow Ecology to be confident that potentially important SQGs are not disregarded and/or are failing to self-identify.

The next step is to profile the waste type, form, source, and management for all detailed reporters, Large Quantity Generators (LQGs) and Medium Quantity Generators (MQGs) in the selected sectors from HWIMSy. Using this data and a literature review for SQGs,

Ecology could establish "generic SQG generator profiles." Included in each profile would be the percentages of waste type typically generated by each industry sector, as well as the other waste characteristics listed above (form, source, and management). The main focus of the literature review would be to confirm that SQGs studied in the past reasonably conform to the characterizations derived from the LQG and MQG data, except for volume. Generation and Management of CESQG Waste references several studies, including two by Ecology, that may be starting points from which to develop profiles. Other sources for waste stream profiles should be sought and used for reference.

After generic SQG generator profiles have been established, Ecology would count the number of SQGs, by industry sector, currently listed in the HWIMSy database. The number of SQGS multiplied by 2640 pounds (220 pounds every month), the maximum amount of dangerous waste generation allowed under state law prior to being required to report more detailed information as an MQG, would create an upper boundary for the total volume of dangerous waste self-identified SQGs could possibly produce each year within the state. This information would be useful to Ecology in determining to what extent SQGs are a priority for program attention (relative to MQgs and LQGs).

Although the estimated raw volume of dangerous waste generated in the state by SQGs is helpful, more detailed analysis is needed to refine program activities and Beyond Waste progress estimations. Most industry sectors generate only a select number of specific (often predictable) wastes as they provide goods and services to consumers (e.g., drycleaners use perchloroethylene and auto maintenance shops use other solvents). The generic generation profiles would be used to identify these waste types as a percentage of total dangerous waste from the sector. Ecology would apply these percentages to each sector's dangerous waste total to create an estimate of the upper volume boundary of specific waste types being generated each year within the state by notifying SQGs. Again, this information can help inform Ecology program priorities and areas of focus.

Refining Generator Profiles

The use of onsite activity information, discussed elsewhere in this report, would allow Ecology to move away from these rough upper boundary estimates to more detailed measures of SQG dangerous waste generation within the state. Anecdotal information from onsite activity and profiles funded by other agencies outside Washington State could also clarify generator profiles. As statistically significant and pertinent samples become available from the routinization of onsite activity data collection and management, these data could help Ecology normalize generation/management data based on various factors like the number of employees at a given establishment. These factors would provide a greater amount of certainty and allow more rigorous estimation methods.

Non-Reporting SQGs

Ecology has expressed concern over possible under-reporting by SQGs. Ecology can use data collected by other sources to estimate the possible number of non-reporters and the volumes of dangerous waste they may generate. Currently, the U.S. Census Bureau, in cooperation with the Small Business Administration, annually publishes data on the number of firms operating within the United States in the Statistics of U.S. Businesses Report. Information collected includes sales, establishments, and number of

employees for each firm. These data items are taken from the Standard Statistical Establishment List, a file of all known single and multi-establishment employer companies maintained and updated by the U.S. Census Bureau. The annual Company Organization Survey provides individual establishment information for multi-establishment companies. Data for single-establishment companies are obtained from various Census Bureau programs, such as the Annual Survey of Manufactures and Current Business Surveys, as well as from administrative records of the Internal Revenue Service, the Social Security Administration, and the Bureau of Labor Statistics. All data are reported by NAICS code.

As noted earlier, the difference between the total number of SQGs in HWIMSy and the Census Bureau data could indicate underreporting. The total number of establishments by NAICS code in HWIMSy subtracted from the total number of establishments in the census data gives a rough estimate of potential non-reporters. Where Ecology deems prudent, the estimation procedure used for reporting SQGs could be replicated for these potential non-reporters to capture this potential volume of dangerous waste. Ecology should routinely perform these analyses to identify industry sectors for outreach and compliance efforts as well as to monitor significant changes to the estimated waste volumes.

DATA GAP: UNCERTAINTY ABOUT THE COMPOSITION, VOLUME, AND INHERENT HAZARD OF PESTICIDES AND FERTILIZERS

The analysis below explores various sources of pesticide and fertilizer data in greater detail. This section is meant to highlight possible avenues to data already available to Ecology as it plugs the gaps identified in Chapter 2. Similar sources may be available to Ecology for other untracked flows but have not been researched. Although not exhaustive the sources below represents several currently used by policy makers and program managers as they deal with these two specific material flows.

PESTICIDE AND FERTILIZER DATA GAPS

Currently there are no Ecology programs monitoring the flow of pesticides or fertilizers through Washington State. Some information on these two material flows, including pesticide chemical composition and fertilizer distribution, is tracked by the Washington State Department of Agriculture. Ecology maintains data on metals concentrations in fertilizers. Several of the sources listed below estimate pesticide or fertilizer use on agricultural crops. Studies indicate that agricultural pesticide use accounts for 77% of the active ingredients used in the United States. Limited information is available for the Industrial/Commercial/Governmental and Home & Garden use at the state level. This gap reflects the difficult challenge of collecting this information in an open and diffuse distribution and use system.

SOURCES OF DATA ON BOTH PESTICIDES & FERTILIZERS

National Agricultural Statistical Services – U.S. Department of Agriculture (USDA)

Derived from periodic farmer surveys, information is limited to chemicals applied to crops (not fence lines, ditches, etc.) for specific fruits, vegetables, nuts, and field crops. In even years vegetables are targeted, while fruits are surveyed in odd years. Field crops surveyed annually include corn, upland cotton, soybeans, sugar beets, winter wheat, durum wheat, and spring wheat. The types of fruit or vegetable crops change from year to year, but it may be possible to derive time series data as crops are resurveyed. Data collection began in 1995.

A sampling of producers is chosen to establish the estimation base. Once a farm is selected, the operator is interviewed and a sample filed chosen on which chemical use is collected. The National Agricultural Statistical Services (NASS) combines the use survey with its annual crop acreage estimates to extrapolate statewide chemical usage. Low survey responses may limit the ability to produce statistically significant estimates for various active ingredients.

Survey results include estimates of the percent of area treated, number of applications, rates per application, rates per crop year, and total pounds of chemical applied. Data are summarized for the active ingredients of pesticides and other chemicals applied. Pesticide data are collected for specific formulations of trade name products and then converted to active ingredients. Therefore, the estimates associated with a particular active ingredient may represent applications of several trade name products. This survey excludes any chemical treatments applied after harvest.

Standardized reports are published on a regular basis and available at *www.nass.usda.gov/wa/rlsetoc.htm*. In addition it is possible to request "Special Tabulations." The Special Tabulations differ from NASS published reports in the following ways:

- Output is limited to a specific analytic purpose.
- Output is customized to a specific request.
- Many Special Tabulations are based on a statistical model or a specified set of assumptions. Tables using these assumptions are derived from the Census of Agriculture or NASS surveys and, when published, carry the appropriate disclaimers.
- Some output is longitudinal and used to track census/survey to census/survey changes and to make comparisons over time. These data sets are not complete, being limited to reports meeting specific criteria.

The fees associated with acquiring a Special Tabulation depends on the nature of the request. There is a minimum charge of $500 for a simple report. More complex reports are billed based on $500 per staff day needed to create the report.

SOURCES OF PESTICIDE DATA

NCFAP National Pesticide Use Database, 1992 and 1997

The NCFAP National Pesticide Use Database is a compilation of records from a wide variety of sources estimating pesticide use on 87 different crops around the country.

According to the survey Washington has 39 of those crops currently under cultivation. The database is fairly inclusive, holding nearly 90% of national acreage for most crops.

Sources include in the database include:

- NASS survey records (4,080 of 17,098 records in 1997)
- Reports for individual states and selected crops funded by Cooperative State Research Education and Extension Services and National Agricultural Pesticide Impact Assessment Program (1,646 of 17,098 records in 1997)
- USDA Crop Profiles (1,256 of 17,098 records in 1997)
- State of California Department of Pesticide Regulation Annual Report (1,312 of 17,098 records in 1997)
- Survey of Extension Service Specialists (4,662 of 17,098 records in 1997)
- Other (821 of 17,098 records in 1997)

Because of data gaps for many states and crops, some records have been calculated based on the data from a nearby state. Twenty-one percent of 1997 Washington State records are based on coefficients from nearby states. The NCFAP acknowledges it is unclear as to how accurate this procedure is. The database website proclaims, "There is no way to determine the accuracy of any of the estimates in the database" and the NCFAP "makes no claims of statistical accuracy with regard to the national pesticide use database." However, the widespread use of this source by other federal and state agencies indicates that it is commonly accepted as one of the best options for tracking this information.

Although 1992 and 1997 are benchmark years for the database, the data are derived from use estimates made between 1990 to 1993 and 1994 to 1998, respectively. The NCFAP states that databases are more accurately described as circa 1992 and circa 1997. This database is limited to cropland uses of pesticides. This leaves out fence lines, irrigation ditches, and other none productive acreage.

Washington state data are available for download at the following website: *ncfap.org/database/ingredient/default.asp*.

EPA Report, Pesticides Industry Sales and Usage: 1996 and 1997 Market Estimates

This report is a consolidation of numerous public and private databases including the NASS and NCFAP sources. According to employees at the EPA, other data was contributed by outside sources not used in NASS and NCFAP data. The report's focus and large overlap with NASS and NCFAP indicates that this may be a good source of information for Ecology's evaluation of Beyond Waste progress, but could be used to illuminate non-agricultural pesticide use trends at the national level. Important information includes pesticide use by the home/garden and industrial/commercial/governmental sectors not currently found in other sources. As described on the EPA website:

> "This report is designed to provide contemporary and historical economic information on the U.S. pesticide producing and using sectors covered by state and federal regulatory programs. Economic profile information is provided on a variety of topics, particularly the pesticide market in terms of dollar values and

quantities of active ingredient. Reports have been issued on this topic by the EPA Pesticide Program covering the years since 1979.

In this report, quantities and dollar values for pesticide usage are reported with separate breakouts for agriculture, home/garden (homeowner applications), and industrial/commercial/governmental (professional market). They are also reported by commonly used pesticide class categories, e.g., herbicides/plant growth regulators and insecticides/miticides.

There is no program at EPA, nor at any other agency, devoted specifically to estimation of the overall pesticide market in quantitative and dollar terms each year. Accordingly, this report is prepared based on the best available information from the public domain and proprietary sources. The numbers presented in the report should be considered approximate rather than precise values with known statistical properties.

The Agency has available a wide variety of published and proprietary information upon which to base estimates. Extensive files and library materials on pesticide usage are maintained at the Pesticide Data Center in the Biological and Economic Analysis Division, Office of Pesticide Programs, EPA. For the agricultural sector, which accounts for a majority of use of conventional pesticides, the Agency has available five national data bases/services including those from the U.S. Department of Agriculture plus a number of more specific and limited data sources. For the non-agricultural sector, there is a similar number of sources of information. For both the agricultural and non-agricultural estimates, use is made of proprietary data sources, with the permission of vendors. The proprietary sources used by EPA are well known organizations, which are also utilized by registrants and other private sector firms.

The methods used by the various sources of information to make estimates vary from large statistically based grower/user samples or panels (e.g., 15,000-20,000 respondents annually) to use of more limited interview/survey approaches of growers, applicators, pesticide suppliers, and pest management consultants. Each source (and its method) must be considered on its merits in judging the usefulness and relevance to making annual market estimates. Corroboration and cross checking are done where possible."

The report's highlights and tables can be downloaded from the following site: *www.epa.gov/oppbead1/pestsales/97pestsales/intro.htm#highlights*.

SOURCES OF FERTILIZER DATA

Washington State Department of Agriculture

WSDA's Pesticide Management Division is responsible for regulating the labeling and distribution of commercial fertilizers within Washington State. There are several programs and systems that currently collect and store data that could be used to track material flow through Washington.

Fertilizer Registration Program. A registration program currently attempts to track distribution. Under this program, registrants submit a form, copies of a laboratory analysis, the product label, and Ecology's questionnaire identifying waste-derived and micronutrient based fertilizers. This information is made public via a website.

Fertilizer Tonnage Reporting. Annual or Semi-annual "Commercial Fertilizer Tonnage Reports" are required of every licensed distributor in Washington. This form is set up to track the inspection fees owed to the WSDA for all fertilizer exchanged and catalogs the

raw tonnage moved within the state. The report currently tracks the quantity of active ingredients as reported by registrants. WSDA staff concedes that a fair amount of fertilizer sales may go unreported. The agency commits some field staff time to looking for these unreported transactions. Registrants are not required to report information on specific products that could be cross-referenced with the Fertilizer Product Database. It is believed registrants would contend that specific product sales volumes are confidential business information useful to competitors.

Fertilizer Product Database. WSDA's fertilizer product database provides information on the metals concentrations of each of the nine heavy metals (arsenic, cadmium, cobalt, mercury, molybdenum, lead, nickel, selenium, and zinc) for which Washington State has developed soil loading standards. The registrants may list a higher concentration than laboratory results in order to create a safety factor. All calculations in the database emanate from these numbers and the state default application rates or company listed maximum application rates on the registration application. Metals concentrations and other information for all registered product for each registrant are accessible at:

www-app2.wa.gov/agr/product1.asp (Sorted by product name)

www-app2.wa.gov/agr/supply1.asp (Sorted by registrant)

Washington State Department of Ecology

Ecology maintains a database on waste-derived fertilizers that are registered for distribution and available to consumers in Washington State. This database was created after The Fertilizer Regulation Act of 1998 required the Washington State Department of Ecology (Ecology) to review registration applications for waste-derived and micronutrient fertilizers. The database is available online at:

http://apps.ecy.wa.gov/fertilizer/index.html

Appendix B: Creating a Basket-Type Indicator

OVERVIEW OF BASKET-TYPE INDICATORS

In recommendation 4 of this report, the consultant suggests using a basket-type indicator (an "index") to monitor the "Beyond Waste" attributes of goods in Washington's economy. A basket index tracks a select, but representative, sample of a large population to monitor changes in that population.

One of the most well known such "basket" index is the Consumer Price Index (CPI). The CPI is an indicator of the changes in the prices paid by consumers for a representative basket of goods and services. To calculate the CPI, research staff collect approximately 80,000 prices each month on various goods and services purchased by consumers.[20] These prices are then compiled into an index, which is used as the most common measure of inflation.

To compile the CPI, staff at the Bureau of Labor Statistics first survey consumers to see what they purchase and where they buy it. Statisticians then perform a random selection of these products, within certain categories such as "Food and Beverages", to determine what products to price and where to price them. After a product is selected, its price is monitored at the same location for 5 years. The CPI is tabulated by a mathematical combination of all 80,000 monthly price checks.

APPLICABILITY TO BEYOND WASTE

In moving toward Beyond Waste, it will be useful to monitor the changing composition and attributes of products in the marketplace. Initiatives pursued as part of Beyond Waste planning will hopefully influence these attributes towards waste and toxics minimization or elimination. However, completely monitoring all products in the marketplace would be an impossible task. As an alternative, the consultant proposes monitoring a select group of products to provide an indicator of changing product design.

POSSIBLE APPROACHES

One possibility initially considered by the consultant was to obtain the list of products included in the CPI and measure their environmental, or "Beyond Waste" attributes. In pursuing this idea, the consultant interviewed a staff member at the Bureau of Labor Statistics (BLS) to determine whether the State of Washington could obtain the list of products. Unfortunately, the BLS does not release the products it selects. Furthermore, the list of products they do sample is extremely comprehensive, and it would not be feasible to monitor the attributes of all of them.

The consultant therefore proposes the following alternative approaches to developing a basket of goods with which to monitor progress towards "Beyond Waste". The core element of both of these approaches is that they monitor attributes such as number and

[20] Joe Chelana, Dept. of Labor, Bureau of Labor Statistics, personal communication to Peter Erickson, Cascadia Consulting Group, February 4, 2003

concentration of toxic constituents, recyclability or compostability, recycled content, packaging efficiency, presence of non-renewable materials, willingness or ability of the manufacturer to take it back for re-use and entry into a technical nutrient cycle, etc.

1. **Identify a limited number of specific product categories to monitor in Washington.** The State could focus on a limited number of product categories that were deemed to be particularly significant or representative. The State could select product categories, such as computers, and then develop a sampling plan to measure specific makes and models sold in Washington over time. This approach could be particularly useful for products that are manufactured in Washington, or for products for which a Beyond Waste initiative has targeted specific design changes.
2. **Partner with other states or the federal government (likely EPA) to develop a regional program.** One drawback of the above program is that its results would not likely be that particular to Washington, since most products sold in Washington are also sold in other states. Therefore, the State could team with other Western States (or the federal EPA) to develop a regional (rather than state-specific) program to monitor product attributes. The benefit of this approach would be the ability to share resources and knowledge.

In either case, it will be challenging to develop a robust and representative, yet flexible, basket-type indicator. A key success factor in developing such an indicator will be to gain sufficient statistical and scientific expertise to select appropriate products and develop a sampling and testing plan.

Appendix C: A Step-Wise Approach to Organizing Data Collected During Onsite Visits

As discussed in Recommendation 6, some data gaps can be filled by making minimal additions to Ecology's existing onsite activities, such as technical assistance and compliance assurance visits.

There are several steps needed to create this low-cost data source.

1. Ecology should examine data currently collected during technical assistance and compliance assurance visits to identify overlap between information already gathered and data useful to Beyond Waste.
2. Ecology should capitalize on these opportunities by structuring and automating data collection and management. A standardized process, based on the needs of the onsite professionals and the specific industries, should be created to consistently capture the same information and simplify database compilation. At a minimum, Ecology should strive to build a data set of high quality anecdotal information for better profiling generator activity. These information will need to be captured and stored in a systematic fashion (be it electronic or paper).
3. At all times, Ecology must keep in mind that generators consider some of the information gathered during technical assistance and compliance assurance visits confidential business information and share it based on expectations of it remaining confidential. Therefore, as the information moves from use for site-specific purposes to Beyond Waste tracking, Ecology must strip information that identifies the individual facility and/or reveals any proprietary information. Failure to make the information "generic" and representative of the industry as a whole may stifle generators' willingness to open up it operations to onsite outreach efforts.
4. Next, the pattern of onsite activity should be examined to discern the opportunity to generate a statistically significant sample of any industry in any given year.

Where possible, Ecology should seek to add to these data holdings in a structured fashion. This is not to say that onsite visits should be scheduled according to what information gaps need to be filled. Rather, Ecology staff should strive to collect this important information over the course of regular visits. As well, to the extent staff have discretion in scheduling onsite visits, they should consider making review of sectors/facilities representing high priority data gaps a program priority. Doing so will facilitate the transition from anecdotal information towards statistically valid data that could be applied in further refining profiles and estimates. Alternatively, a proactive annual planning effort could create a more opportunities for creating significant samples. For instance, the annual planning process could be set-up to cycle through 10 targeted industry sectors over a five-year period (i.e., two specific sectors receive priority attention every five years). Over time, again, the agency's information resources would expand considerably.

TRIANGULATING WITH OTHER DATA SOURCES

It is unlikely that Ecology will be able to fully understand these important information gaps through data collected during onsite visits. The challenge for Ecology, therefore, will be to cross-reference the new structured onsite activity data with other information sources. One option is to review information gathered by other state or federal agencies. Data sources could include completed industry profiles, *pertinent* Materials Accounting data from Massachusetts, New Jersey, or Eugene, Oregon, and published case studies of specific important generating establishments. Another opportunity would be to strategically sponsor or execute waste profiling studies of specific industry sectors.