Green Cities California

Master Environmental Assessment on Single-Use and Reusable Bags

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Green Cities California

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Table of Acronyms and Definitions

AB 2449	Assembly Bill 2449
ASTM	American Society for Testing and Materials
Biodegradable plastic	ASTM definition: A degradable plastic for which the degradation results from the action of naturally-occurring microorganisms such as fungi, bacteria, and algae.
Bioerodable plastic	ASTM definition: A degradable plastic for which the degradation results from oxidation and erosion of the plastic until only small plastic particles remain.
CEQA	California Environmental Quality Act
Compostable plastic	ASTM definition: A plastic that undergoes biological degradation during composting to yield carbon dioxide, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and leaves no visually distinguishable or toxic residues. A subset of biodegradable plastics, these plastics are typically made of corn, potato, or wheat starches.
CWA	Clean Water Act (federal)
Degradable plastic	ASTM definition: A plastic designed to undergo a significant change in its chemical structure under specific environmental conditions, resulting in a loss of some properties that may be measured by standard test methods appropriate to the plastic and the application in a period of time that determines its classification.
EIR	Environmental Impact Report
Grocery shopping bag	Bag used for grocery shopping at checkout
HDPE	High density polyethylene – typical material used in single-use plastic grocery bags
ISO	International Standards Organization
LCA	Life-Cycle Assessment/Analysis
LDPE	Low density polyethylene – typical material used in reusable plastic grocery bags
MEA	Master Environmental Assessment
NPDES	National Pollutant Discharge Elimination System
Oxodegradable plastic	ASTM definition: A degradable plastic for which the degradation results from oxidation.
Photodegradable plastic	ASTM definition: A degradable plastic for which the degradation results from the action of natural daylight.
POTW	Publicly Owned [Wastewater] Treatment Works

Retail shopping bag	Bag used for retail, rather than grocery, shopping; these bags typically have a larger capacity than single-use grocery bags
Reusable grocery bag	Grocery bag designed to be reused many times
RWQCB	Regional Water Quality Control Board
Single-use grocery bag	Bag designed for one use at a grocery store checkout counter; these bags may be reused at home as trash receptacles or for other uses, but are not considered reusable bags in this analysis because they are seldom re-used for groceries.
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
TMRP	Trash Monitoring and Reporting Plan
US EPA	United States Environmental Protection Agency

Executive Summary

The California Environmental Quality Act (CEQA) authorizes the use of Master Environmental Assessments (MEAs) “in order to provide information which may be used or referenced in EIRs or negative declarations” (CEQA Guidelines Section 15169). An MEA is not an Environmental Impact Report (EIR) or other CEQA analysis because it does not reach conclusions regarding local significance and does not propose either mitigation measures or alternatives.

This is a Master Environmental Assessment (MEA) on the subject of single-use, or disposable, grocery shopping bags (i.e., bags used at checkout in grocery stores). As such, it brings together a comprehensive collection of information about single-use grocery bags including existing regulations, life-cycle analysis, potential impacts on the environment, reusable bags, and the use of fees to encourage consumers to reuse bags. The information found herein will help cities and counties to determine the significance of actions that they may take to cut back on the use of single-use grocery bags.

This grocery bag MEA provides local governments a one-stop reference about the impacts of restricting the use of single-use grocery bags, or of imposing a fee or other restriction on single-use disposable grocery bags (see the discussion of AB 2449 and its restriction on fees). It can be used by local governments in the preparation of EIRs to assess the potential impacts of such ordinances. Using this MEA can help reduce the cost and time of preparation of agencies’ EIRs by reducing the need for independent research.

Appendix A. *References* contains the list of references cited in the MEA. Appendix B. *CEQA Guidelines MEA Provisions* contains the text of CEQA Guidelines Section 15169. Appendix C. *Detailed Description of Referenced Life-Cycle* Analyses consists of an annotated bibliography of the life-cycle assessments reviewed in this MEA.

Overview of Findings

- **Single-Use Plastic Bags:** Nearly 20 billion single-use high density polyethylene (HDPE) plastic grocery bags are used annually in California, and most end up in landfills or as litter. In fact, of the four types of bags considered, plastic bags had the greatest impact on litter.
- **Single-Use Paper Bags:** Kraft paper bags are recycled at a significantly higher rate than single-use plastic bags. Still, over its lifetime, a single-use paper bag has significantly larger greenhouse gas (GHG) emissions and results in greater atmospheric acidification, water consumption, and ozone production than plastic bags.
- **Single-Use Biodegradable Bags:** Although biodegradable bags are thought to be an eco-friendly alternative to HDPE plastic bags, they have greater environmental impacts at manufacture, resulting in more GHG emissions and water consumption than conventional plastic bags. In addition, biodegradable bags may degrade only under composting conditions. Therefore, when littered, they will have a similar impact on aesthetics and marine life as HDPE plastic bags.

- **Reusable Bags:** Reusable bags can be made from plastic or cloth and are designed to be used up to hundreds of times. Assuming the bags are reused at least a few times, reusable bags have significantly lower environmental impacts, on a per use basis, than single-use bags. Some of the reviewed LCAs indicate that use of the non-woven plastic reusable bag results in particularly large environmental benefits.
- **Effects of Policy Options on Single-Use Bags:** In other regions of the world, fees and bans on bags have resulted in dramatic drops in consumption. For instance, the Irish plastic bag tax immediately resulted in a greater than 90% reduction in use. Due to California law AB2449, no fee program on plastic bags can be introduced. However, bans on single-use plastic bags, as well as fees on other single-use bags, may be implemented to minimize use.

Comparative Impacts of Grocery Bag Types

Table 1 presents a general overview of the comparative impacts of single-use plastic, single-use paper, single-use biodegradable, and reusable bags, based on a review of previous life-cycle assessments.

Table 1: Comparative Impacts of Grocery Bag Types

Environmental Issue[1]	Type of Bag			
	Single-use Plastic	**Single-use Paper**	**Single-use Biodegradable**	**Reusable (any type)**
Aesthetics (Primarily litter)	3	2	3	1
Agricultural Resources	Ins.	Ins.	Ins.	Ins.
Air Quality	2	3	3	1
- GHG Emissions	2	3	3	1
- Atmospheric Acidification and Criteria Pollutants	2	3	Ins.	1
- Ground-level Ozone	2	3	Ins.	1
Biological Resources (Primarily marine impacts)	3	2	3	1
Cultural Resources	Ins.	Ins.	Ins.	Ins.
Geology and Soils	Ins.	Ins.	Ins.	Ins.
Hazardous Materials	Sim.	Sim.	Sim.	Sim.
Hydrology and Water Quality	3	3[2]	3	1
- Hydrology	3	2	2	1
- Water Consumption	2	3	3	1
- Water Quality	3	3	3	1
Land Use and Planning	Ins.	Ins.	Ins.	Ins.
Mineral Resources	2[3]	3	3	1
Noise	Ins.	Ins.	Ins.	Ins.
Population and Housing	Ins.	Ins.	Ins.	Ins.
Public Services	3	2	3	1
Recreation	3[4]	2	3[4]	1
Transportation/ Traffic	Ins.	Ins.	Ins.	Ins.
Utility, Energy, and Service Systems	Ins.	Ins.	Ins.	Ins.
Solid Waste and Waste Reduction	3[5]	3[6]	3[7]	1

Table Notes:

General: Relative effects are on a general scale of 1 to 3, with 1 representing lowest relative impact. “Ins.” denotes insufficient information to make a judgment. “Sim.” denotes similar levels of indirect impacts.

(1) Issues based on the CEQA Guidelines, Appendix G, with the addition of solid waste and waste reduction.

(2) Paper bags are less likely to contribute to trash/litter in surface waters, but require substantially more water for manufacturing than plastic bags.

(3) Plastic bags require less fossil fuel in their manufacture than other bags.

(4) Single-use plastic and biodegradable bags as litter can have a detrimental effect on the quality of recreational experience. Anecdotally, single-use paper bags are less common in litter.

(5) Single-use plastic bags occupy less space than other bags in landfills, but have a low rate of recycling.

(6) Single-use paper bags are commonly made of recycled material and have a much higher rate of recycling than single-use plastic bags.

(7) Single-use biodegradable bags can contaminate the plastic bag waste stream, complicating recycling efforts. They do not decompose readily in open environments; there are concerns that they are disposed of as litter rather than put into the trash bin.

1. Introduction

1.1. Objectives and Target Audience

This Master Environmental Assessment (MEA) provides local governmental agencies in California with a one-stop reference about the impacts of adopting ordinances that restrict the use of single-use grocery bags, or of imposing a fee or other restriction on all single-use grocery bags. As discussed below, MEAs are authorized under the California Environmental Quality Act (CEQA) as a means of organizing information. This MEA can be used by local governments in the preparation of environmental analyses to assess the potential impacts of such ordinances. The MEA is intended to reduce the cost and time of preparation of agencies' CEQA documents by reducing the need for independent research. Other specific objectives of the MEA are:

- Educate agencies on environmental impacts of bags/fees/bans so that they can determine whether a more detailed analysis is warranted;
- Provide background material that agencies can use directly in an EIR (e.g., background information on life-cycle assessments (LCA), general information about the life cycle of bags, general impacts of bags, overall findings from relevant studies);
- Indicate which studies analyzed which impacts, so that agencies can access detailed information from the most relevant studies if necessary;
- Provide detailed information from the studies that are the most applicable to California;
- Provide quantitative results from previous studies that agencies can use to estimate impacts of local fees and bans.

A comprehensive literature search for information on single-use grocery bags and their potential environmental impacts forms the foundation of this MEA. The search included both popular and peer-reviewed articles from a large number of sources. The MEA provides an objective synthesis of the information.

1.2. Types of Bags Reviewed

This report covers single-use and reusable bags intended for grocery shopping. Other types of bags, particularly heavier plastic bags used for retail shopping and lightweight plastic produce bags, are not included in this analysis. The information about grocery bags is not comparable to retail shopping bags due to their different material components and weight per bag. Some single-use plastic, paper, and biodegradable bags may be used more than once, as household trash bags or other transport bags. However, because they are designed for single-use and are typically not brought back to a grocery store for reuse, they are considered single-use in this analysis and in the life-cycle assessments (LCAs) reviewed.

1.2.1. Single-use Plastic Bags

Single-use plastic bags include high density polyethylene (HDPE) bags that are commonly distributed at supermarkets. These lightweight, waterproof bags provide a convenient, hygienic carrying sack for grocery shoppers. They can be recycled at some facilities, although recycling rates are very low, and contamination in general recycling streams can cause recycling machine malfunction. The LCA conducted by Boustead Associates (2007) assumes a 5.2% rate of recycling for plastic bags, based on 2005 EPA data.[1] Concerns over the environmental impacts and negative aesthetic impact of littered bags and their effect on wildlife have led a number of communities to propose fees and bans on HDPE bags.

1.2.2. Single-use Paper Bags

Single-use paper bags, like their plastic counterparts, are intended for grocery shopping and then disposal. These bags have a larger carrying capacity than the HDPE plastic bags, and may also be recycled at end of life. They are recycled at greater rates than HDPE bags and may be made of recycled paper content. In fact, the LCA performed by Boustead Associates (2007) assumes that kraft paper bags contain 30% post-consumer recycled content and water-based inks, based on communication with Weyerhaeuser, the primary US paper bag manufacturer.[2] Boustead (2007) further assumes that paper bags are recycled at a rate of 21%, in accordance with EPA data from 2005.[3]

1.2.3. Single-use Biodegradable Bags

Single-use biodegradable bags are designed to degrade as a result of the action of naturally occurring microorganisms, such as fungi, algae, and bacteria.[4] These bags are typically made from synthetic or biologically produced polyesters such as polyhydroxyalkanoate (PHA) or polylactic acid (PLA), sugarcane, or vegetable starches such as corn or potatoes. Because biodegradable bags are not thought to pose the same environmental concerns at disposal, they are considered an alternative to HDPE plastic bags.[5] They are about the same size as HDPE bags, but degrade when placed in the proper environment (i.e., a composting facility). However, biodegradable bags may degrade slowly and while PHA-based bags will degrade in oceans and open lands, PLA-based bags will not degrade significantly in non-composting environments.[6] In addition, biodegradable bags cannot be recycled with HDPE bags because they contaminate the HDPE plastic.

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1 Boustead (2007).

2 Boustead (2007).

3 Boustead (2007).

4 ASTM definition of biodegradable plastics.

5 This MEA does not address "bioerodable", "photodegradable" or "oxodegradable" bags. Like biodegradable bags, these other bags will break down at end-of-life. However, they are made from synthetic oil-based plastics. Using light and heat, bioerodable bags break down by oxidation and erosion of the plastic until only small plastic particles remain. The degradation process can be halted in an anaerobic environment. Similarly, photodegradable and oxodegradable bags degrade as a result of natural daylight and oxidation, respectively. The small particles that remain after degradation may pose a risk to wildlife that inadvertently ingest them.

6 CIWMB (2009b).

1.2.4. Reusable Bags

Reusable bags, or “bags for life,” are made of various materials including polyethylene (PE) plastic, polypropylene (PP) plastics, multiple types of cloth (cotton canvas, nylon, etc.), and recycled plastic beverage containers (polyethylene terephthalate, or PET), among others. The state of California defines these bags as “a bag with handles that is specifically designed and manufactured for multiple reuse and is either made of cloth or other machine washable fabric, and/or thick, durable plastic (at least 2.25 mils thick).”[7] Due to their larger size and weight, they require more material consumption in manufacture on a bag-to-bag comparison than disposable bags. However, these bags are intended for reuse up to hundreds of times and are commonly made of recycled content. It is commonly believed that the frequent reuse outweighs greater per bag energy and material use.

1.3. General Scope of Research

The MEA includes existing research related to the environmental impacts of different types of grocery shopping bags, including single-use bags (paper and plastic) as well as reusable bags. To the extent that reliable information regarding different types of plastic, paper, and reusable materials is available in the literature, they are included in the MEA. Areas of impact that are discussed include aesthetics, energy, air emissions, water quality, and waste. All stages in the lifecycle of bags are addressed, including upstream, land use, manufacturing, distribution, use, and end-of-life effects, to the extent that this information is available in the literature. The MEA also examines the pertinent studies that evaluated the impacts of fees and bans on the consumption of grocery shopping bags.

1.4. MEA in the Context of CEQA

Pursuant to CEQA Guidelines Section 15169, an MEA is an organized collection of information, such as an inventory or data base, to be used in the preparation of Environmental Impact Reports (EIRs) and other CEQA analyses. The full text of CEQA Guidelines Section 15169 is presented in Appendix B. CEQA Guidelines MEA Provisions, of this MEA.

An MEA is not an EIR. An EIR is an analysis of a project’s potential for significant environmental impacts that is used to inform the planning and decision making process. The purpose of an EIR is to identify:

- Potentially significant impacts of the proposed project on the environment;
- Significant impacts that are considered unavoidable because they cannot be mitigated below a level of significance;
- Feasible mitigation measures that will reduce or avoid those significant impacts; and
- A range of reasonable and feasible alternatives to the project that would substantially reduce one or more of the project’s significant environmental impacts, while meeting most or all of the project’s objectives.

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[7] City of Palo Alto Website. Bring Your Own Bag News Detail. Available at: http://www.cityofpaloalto.org/

In contrast, an MEA is a collection of information that may be used in the preparation of an EIR or other CEQA document. Unlike an EIR, an MEA does not:

- Analyze a specific project;
- Identify thresholds of project significance and the significant effects of a project;
- Analyze and compare the potential impacts of a range of project alternatives;
- Adopt mitigation measures to avoid or reduce the significant impacts of a project.

CEQA describes the process for the preparation and public review of EIRs. None of that process applies to MEAs. For example, there is no specified public review period for an MEA; an MEA need not be certified or adopted by the public agency in order for the agency to rely on its information; and an MEA, by itself, will not be the basis for approving any project.

2. Methodology

The preparers conducted a comprehensive literature review of readily-available studies from the United States and abroad. Topics included the environmental impacts of single-use and reusable bags, comparative analyses of imposing fees or bans on single-use bags, as well as mitigation strategies that might be included as part of life-cycle studies. ICF International, the primary researcher, is affiliated with the Harmer E. Davis Library at UC Berkeley, which provides access to most electronic peer-reviewed journals worldwide. Additionally, relevant studies were also provided by Green Cities California (GCC), the Ocean Protection Council, the Clean Seas Coalition, and other stakeholders. The methodology used to select and summarize the findings presented in this MEA is outlined below:

1. Determination of research areas and data sources;
2. Review and synthesis of available studies;
3. Analysis of gaps.

A draft MEA was prepared for review and comment from internal staff, the Ocean Protection Council Science Advisory Team, and other key stakeholders. The final version of the MEA incorporates many of these comments.

2.1. Research Areas and Data Sources

ICF International compiled studies based on a literature search using the UC Berkeley online journal resources as well as reports provided by the Ocean Protection Council and other stakeholders. The review prioritized recent, California or Western US-based, peer-reviewed or widely cited studies. Studies were organized into four categories, with some overlap:

- **Life-cycle assessments (LCA)**: LCA studies typically evaluate the environmental effects of bags, including all life-cycle phases from the extraction of raw materials to end-of-life. Many widely-cited LCAs, peer-reviewed papers, and reviews of previous LCAs were identified, analyzed, and summarized;

- **Other impacts and scientific/technical assessments**: because a comprehensive review of the countless studies that assess the various environmental impacts and technical characteristics of plastics would require significant time and have limited relevance for this MEA, the review focused primarily on those studies that directly address grocery bags or have particular relevance to post-disposal plastic bags;

- **Fees and bans assessments and policy reviews**: many cities, counties, states, and countries have implemented or are considering implementing taxes, levies, bans, or educational efforts to minimize use of single-use grocery bags. To better understand the impacts of various regulatory methods, reports and proposed legislation to ban plastic bags in California cities and other regions were also reviewed;

- **Other studies with helpful reference lists**: a few additional reports were reviewed because of their exceptional lists of references. Although these reports themselves were not used in the MEA, their references were reviewed and considered for inclusion in the MEA.

2.2. Review and Synthesis of Available Studies

After a thorough literature review, ICF International developed a condensed list of particularly relevant studies using the following criteria:

- **Credibility of publication**: while some publications are peer-reviewed, other studies are published internally without external peer review. Because the objective of an MEA is to include non-biased studies, the researchers divided the studies in the following categories in rough order of bias: non-peer reviewed studies from industry (interested in the study), non-peer reviewed studies from non-profit/governmental agencies, peer-reviewed studies from industry, peer reviewed studies from non-profit/governmental agencies, and peer-reviewed studies with a scientific focus conducted by academics. The underlying concern is the use of reliable and representative data, since the organization responsible for the study (or peer reviewers) should perform some kind of data quality assessment;

- **Soundness and robustness of methodology**: independently of the organization conducting the study or the data sources, it is important to prioritize those studies that rely on established, robust, and transparent methodologies. For example, life-cycle studies that follow the guidelines established by the International Standards Organization standard 14000 on environmental management systems (ISO 14000) are probably more trustworthy than those that do not, all else being equal;

- **Appropriate documentation**: while an MEA could simply summarize the conclusions from different studies individually, GCC believes the results from studies should be compiled and summarized for readability. As a result, the appropriate documentation of data sources, methods, input parameters, system boundaries, and assumptions is important to ensure that the results from different studies are comparable. For example, the results from two studies should only be compared if the same processes are included in both of them;

- **Use of appropriate functional unit**: because results from a study are reported in terms of a functional unit, it is important that studies consider a functional unit that enables the comparison with other studies. Typical functional units in the considered studies are one bag (sometimes two bags in the case of double-bagging) or a household consumption of grocery bags over a given amount of time;

- **Geographic representativeness**: because the objective of the MEA is to assist local governmental agencies in California in the development of EIRs, the focus is on those studies that provide results and insights that are applicable to California. To the extent possible, the researchers prioritized studies that address bags with similar materials, manufacturing processes, and end-of-life fates as those in California;

- **Age of study**: because the material composition, manufacturing processes, and end-of-life processes associated with different types of bags can evolve rapidly or even become obsolete, more recent studies were prioritized over older studies.

To the extent possible, results, conclusions, and insights regarding the environmental effects of different types of bags were summarized across studies to improve readability. If different studies had conflicting results, the researchers attempted to include as much information as possible to identify the reasons for such discrepancy. In the event that a particular study provided very relevant results applicable to California, those results were presented individually. The results of individual studies are also presented in Appendix C. *Detailed Description of Referenced Life-Cycle Analyses*, of this MEA.

2.3. Gap Analysis

Following the selection of studies, ICF International identified areas that are not properly addressed by the current literature. Although the MEA is not intended to provide original research, it is important to identify such gaps where future research may be needed. The main gaps in the current literature are:

- Detailed, quantitative analysis of litter impacts: It is difficult to fully quantify the impact of conventional plastic, biodegradable plastic, and paper single-use bags on litter. Because litter is the main category in which plastic bags are significantly worse than paper bags (plastic bags do not break down and can be injurious to wildlife), it is important to establish the relative significance of this visual and indirect wildlife impact area compared to other environmental impact areas.
- Detailed California-specific comparison of various types of reusable bags to better understand which of these bags are the most sustainable.
- Detailed analysis of environmental impacts, using California-specific plastic and paper bag recycling rates, paper bag recycled content, landfill methane recovery rates, and transport distances for manufacture, distribution, and disposal.
- Detailed area-specific analysis of land use and planning impacts of switching from conventional HDPE plastic bags that are made from fossil fuels, to bags made from plant-based resources.
- Comparison of the effectiveness of fees and other regulations in affecting the consumption of single-use grocery bags in California and the United States. Along this line, there is no study of whether California's AB 2449 (discussed in Section 3.3.1 below) has either reduced plastic bag use or resulted in an increase in the recycling rate.

3. Environmental Assessment

3.1. Summary

This section presents information garnered from multiple reports. The information presented here is based on reviewed life-cycle analyses (LCAs) of single-use and reusable grocery bags. Each analysis compares the bags using a different functional unit and varying assumptions regarding material transport distances, end-of-life disposal practices, etc. Consequently, direct comparison of various studies is problematic and potentially misleading. Similarly, it is not always possible to equate the results of a previous study with predictable impacts in a California setting.

The number of times a bag is used and the volume of groceries carried in an average bag directly impact the per use environmental impacts of the bag. Some of the LCAs reviewed in this report assume that single-use bags are not reused at all. Although these bags are not generally brought back to a grocery store for reuse, both high density polyethylene (HDPE) plastic bags and paper bags are frequently used as domestic waste bin liners, and HDPE plastic bags are commonly used to pick up pet waste. In addition, the energy sources used in studies of bag use in regions outside California may be significantly different from the energy mix within the state. More detailed information about specific report assumptions can be found in Appendix C. *Detailed Description of Referenced Life-Cycle Analyses*, of this MEA.

Four general types of bags are reviewed in the literature, and are the subject of this MEA:

- single-use HDPE plastic bags,
- single-use kraft paper bags,
- biodegradable single-use plastic bags, and
- reusable bags.

Many LCAs factor in the unequal carrying capacity and frequency of reuse for each type of bag when determining overall environmental impacts. For instance, in one year, a typical consumer/household who requires as many as 500-600 single-use plastic bags may consume approximately 150-450 paper bags, 500-600 biodegradable plastic bags, or 1-3 reusable bags in place of the plastic bags.[8]

End-of-life disposal significantly impacts lifecycle emissions and environmental impacts. Some studies assume no recycling of single-use bags, whereas others assume precise percentages of bags sent for recycling, landfill, and combustion for energy recovery. For instance, the Boustead Associates (2007) study is United States-based and, based on EPA data from 2005, assumes that 21% of paper bags are recycled, 14% sent for combustion, and 65% sent to landfills. Similarly it is assumed that 5% of plastic bags are recycled, 14% are sent for combustion, and 81% are landfilled.[9] These end-of-life assumptions more closely reflect the real world than the assumptions of no recycling for either paper or plastic. As noted in the Hyder Consulting study (2007), the end-of-life destination for these bags "is

[8] County of Los Angeles (2007); ExcelPlas Australia (2004) and Environment Australia (2002) assume similar relative quantities of bags. AEA Technology (2009) estimates that 1 paper bag has the same capacity as 8 plastic bags. However, other reports including Franklin Associates (1990) and the County of Los Angeles (2007) suggest the ratio is closer to 1:1.5 or 1:2. The number of reusable bags consumed per year reflects the longer than 1 year lifetime of these bags (i.e., 1.5 reusable bags consumed per year could represent the use of 6 reusable bags, each with an average lifetime of 4 years).In addition to carrying capacity, grocery bagging habits at checkout largely determine the number of bags used by consumers annually.

[9] Boustead Associates (2007).

crucial, with greater environmental savings achieved from recycling all bags at the end of their useful life."[10] Conclusions regarding precise emissions and environmental impacts associated with single-use bags in California would require a study with end-of-life assumptions specific to California. Such study has not been produced to date.

The review of LCAs in this chapter suggests that a switch to reusable bags will result in significant environmental benefits. Paper bags, though less impacting to the environment in litter, aesthetics, and biological areas, are not a clear alternative to HDPE plastic bags, because air emissions, waste production, and water pollution associated with their life cycles are equal to or greater than those for plastic bags. For example, the 2002 Environment Australia report suggests that a shift from plastic to paper single-use bags may result in potential gains in litter reduction that could be offset by higher resource consumption. They found that even if biodegradable bags help with the litter situation, which is debatable, they would not significantly lower resource use, and cannot be recycled with single-use plastic bags (they contaminate the plastic). A shift from single-use disposable plastic bags to reusable bags would provide the best environmental gains over the full life cycle of the bags.[11] These findings are consistent with conclusions from the other LCAs.

More recently, Herrera et al (2008) conducted a review of previous LCAs and also concluded that in almost all cases a switch to reusable bags would result in the most environmental benefits. Most of the reviewed studies also showed that paper bags had a greater impact on the environment than single-use plastic bags, due to a larger resource requirement for production and transport.

Although reusable bags present the best environmental impact throughout their life cycle, the plastic bag industry has contended that they may pose potential health hazards. They assert that because single-use bags are usually disposed of after their first use, they do not accumulate bacteria and other pathogens. A concern with reusable bags, then, is that their reuse could create unhygienic environments and promote food-borne illnesses, unless they are laundered regularly. This may be a minor concern, because reusable bags do not require special washing care and would likely be washed on a regular basis along with a household's regular laundry load.

3.2. Life-Cycle Assessment

Many of the studies analyzed in this MEA were based on a life-cycle assessment (LCA) methodology. A conventional process-based LCA was introduced by the Society of Environmental Toxicology and Chemistry in 1991 (SETAC 1991), which defines an LCA as:

> "The life-cycle assessment is an objective process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and material usage and environmental releases, to assess the impact of those energy and material uses and releases on the environment, and to evaluate and implement opportunities to effect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing extracting and processing raw materials;

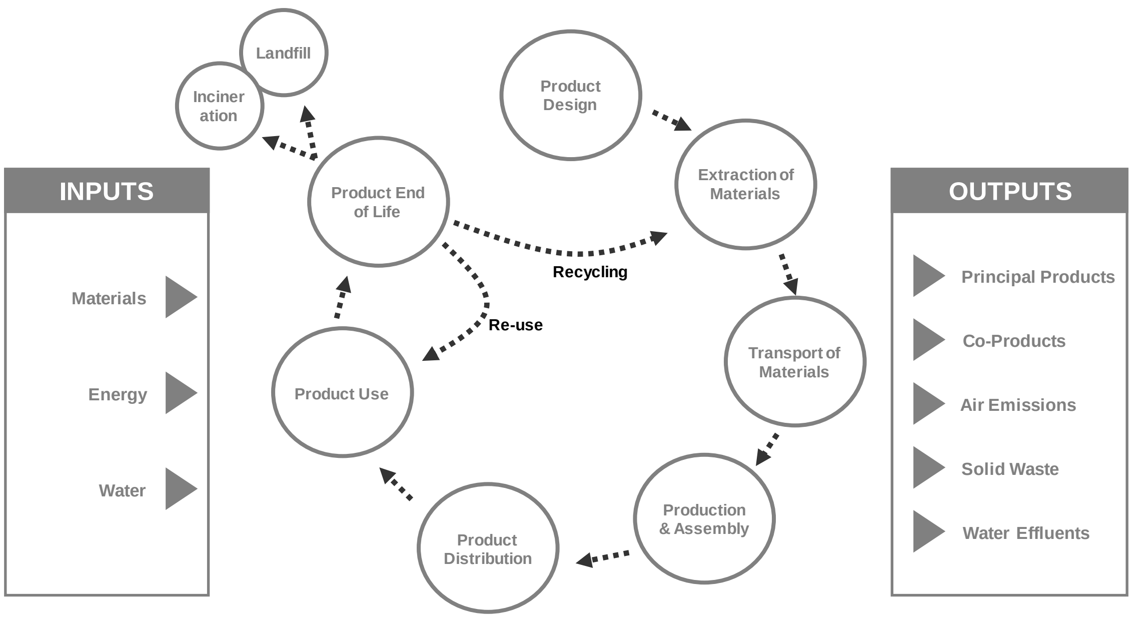
10 Hyder Consulting (2007).

11 Environment Australia (2002).

manufacturing, transportation, and distribution; use/reuse/maintenance; recycling; and final disposal."

LCA is also endorsed by the ISO 14001 series as the preferred methodology for the assessment of environmental impacts of products and processes (ISO 2007). All life-cycle phases of a product need to be identified, including product design, extraction of raw materials, all production stages, assembly, distribution, use, and finally its disposal, reuse, or recycling (Figure 1).

Figure 1. LCA Framework



Source: Adapted from SETAC (1991)

The definition of specific processes included in each life-cycle phase is also required. This is usually referred to as the definition of system boundaries, which also considers geographic and temporal boundaries. After the system boundaries are defined, inputs (e.g., energy, water) and outputs (e.g., air emissions, noise, water discharge, accidents) are associated with each process. By selecting a common functional unit (e.g., one single-use paper bag), it is possible to quantify the environmental effects of all life-cycle phases of a product.

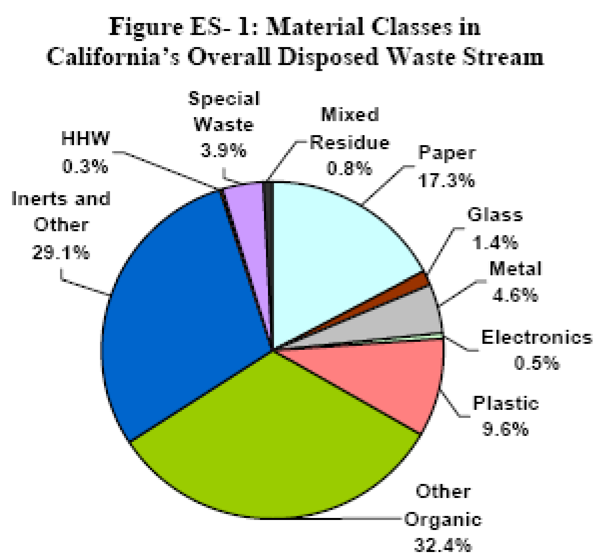
Although this model enables very specific analyses, its heavy data requirements make it time consuming and costly, especially when attempts are made to include suppliers upstream in the supply chain. Due to great variability in setting system boundaries, the comparison of two LCAs of the same product is not always straight-forward. Other challenges in comparing two LCAs involve the actual definition of a product, the use of different functional units and input parameters, and the application of different LCA methodologies. When comparing bags produced and disposed in different countries, material selection, manufacturing technologies, energy mixes, and end-of-life fates can be widely different and are not always comparable.

The following sections compare life-cycle impacts of various types of single-use and reusable bags, based on previous LCAs. Some of these studies were useful to the extent that they reviewed previous studies. Others provided additional information, analyses, and conclusions. Appendix C. *Detailed Description of Referenced* Life-Cycle Analyses provides a summary of the main findings, functional units, and limitations of these studies. Section 3.4 summarizes the results of the individual studies by impact area. Due to the varying functional units and geographic locations of these studies, a direct comparison of results is not always possible.

3.2.1. Single-use Plastic Bags

Single-use disposable plastic grocery bags are typically made of thin, lightweight high density polyethylene (HDPE) 2.[12] For consumers, they offer a hygienic, odorless, and sturdy carrying sack. Currently, almost 20 billion of these plastic grocery bags are consumed annually in California.[13] According to a study conducted by Cascadia Consulting Group for the California Integrated Waste Management Board (CIWMB 2009), plastic of all types makes up almost 10% of California's disposed waste stream, as shown in Figure 2.[14]

Figure 2: Make-up of California disposed waste stream, according to the California 2008 Waste Characterization Study (CIWMB 2009)



Plastic grocery and other merchandise bags – defined in the CIWMB 2009 study as "plastic shopping bags used to contain merchandise to transport from the place of purchase, given out by the store with the purchase" – are only a small part of the total plastic in the waste stream. Plastic bags account for 0.3% of the total waste stream, or approximately 123,400

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12 Hyder Consulting (2007).

13 CIWMB (2007b).

14 CIWMB (2009).

tons. Of this total, grocery bags are estimated to account for 44% by weight.[15] Overall, plastic grocery bags therefore represent approximately 0.13% of the waste stream (plastic produce bags are not included in these numbers).

Conventional single-use plastic bags are a product of the petrochemical industry. Their life cycle begins with the conversion of crude oil or natural gas into hydrocarbon monomers, which are then further processed into polymers.[16] These polymers are heated to form plastic resins, which are then blown through tubes to create the air pocket of the bag. Once cooled, the plastic film is then stretched to the desired size of the bag and cut into individual bags.

The plastic resin pellets are a concern when released into the environment. The California State Water Resources Control Board describes the problem as follows:

> "Preproduction plastic is a problematic type of litter due to its small size and persistence. One pound of pelletized HDPE plastic can contain approximately 22,000 pellets. Preproduction plastic slowly photodegrades over time by breaking down into smaller and smaller pieces and researchers are unclear as to how long it takes some petroleum-based plastics to degrade. Depending on the plastic type, estimates range from one to ten years up to several centuries to fully degrade.
>
> "Once in the environment, preproduction plastic resin pellets, powders, and production scrap can be mistaken for food by marine life. They also contribute to California's litter problem, which state and local agencies spend millions of dollars per year on collecting. Preproduction plastic discharges pose a significant threat to California's marine environment, which is an important part of California's $46-billion dollar ocean-dependent, tourism economy."[17]

None of the LCAs reviewed for this MEA quantitatively analyzed the effects of improper release of resin pellets into the environment.

Typical single-use plastic bags are approximately 5-9 grams (g) in weight, and can be purchased in bulk for approximately 2-5 cents per bag.[18] Plastic bags made of recycled materials cost approximately twice as much as those made from virgin materials.[19] Many of the plastic bag manufacturers in California do not manufacture plastic grocery bags.[20]

Once manufactured, the bags are packaged and shipped to distributors who sell them to grocery stores throughout the state. Because no environmental impacts associated with the consumer use of plastic bags before disposal or discard have been identified or analyzed,

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15 CIWMB (2009).

16 Herrera et al (2008); County of Los Angeles (2009).

17 State Water Resources Control Board (2010).

18 Estimated weight: AEA Technology (2009); www.usplastic.com

19 AEA Technology 2009.

20 Telephone communication with multiple plastic bag manufacturers in California and ICF international; the manufacturers reported that although they make many types of plastic retail and small lightweight bags, they do not make plastic grocery bags.

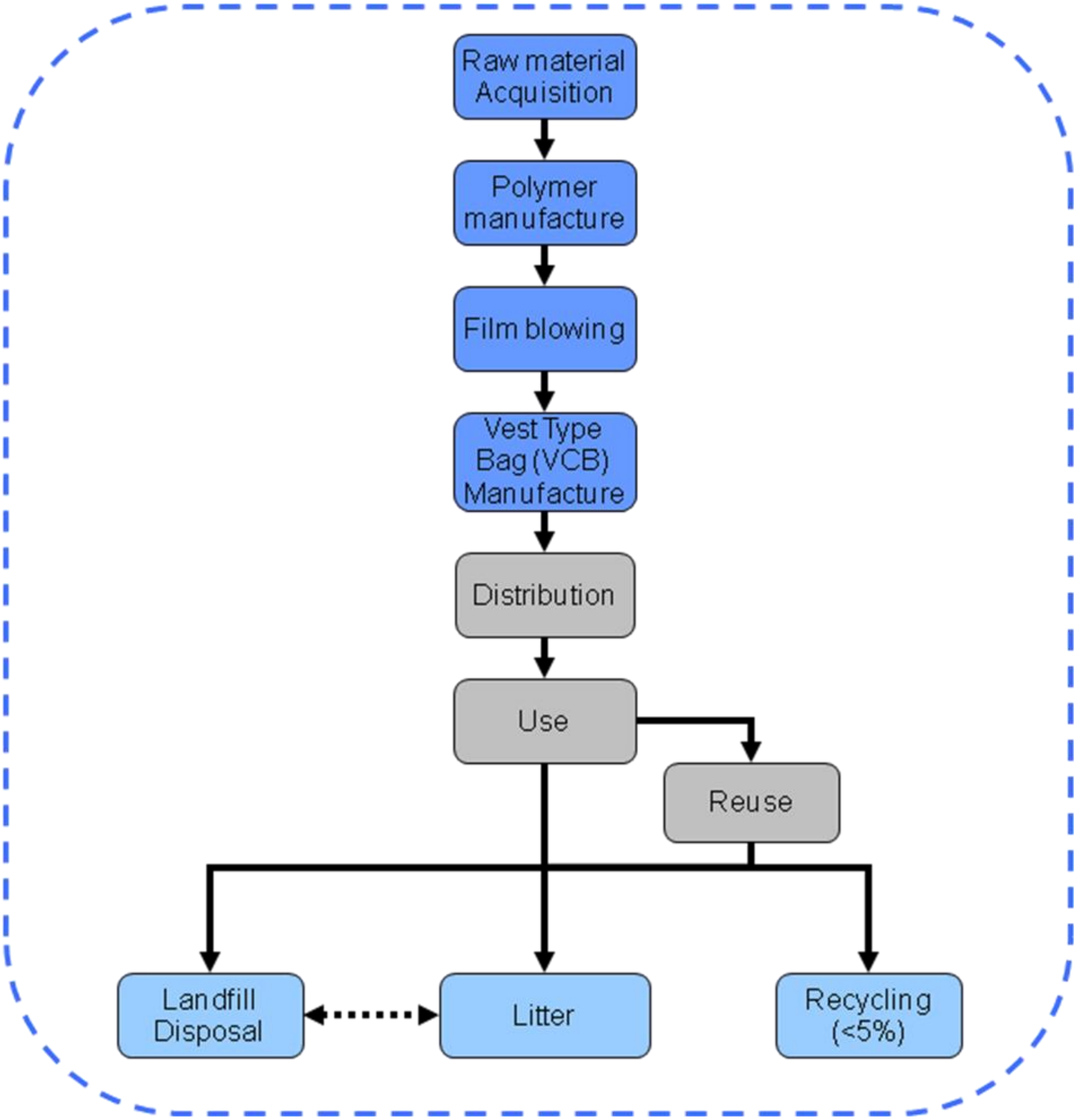
this stage in the life cycle is not included in most studies. Rather, the LCA literature focuses on manufacture, distribution, and end-of-life treatment (i.e., disposal).

Customers may reuse the bags at home, but eventually the bags will be disposed in the landfill or recycling facility or discarded as litter. The majority of bags end up as litter or in the landfill, and even those in the landfill may be blown away as litter due to their light weight. Although some recycling facilities will handle plastic bags, most reject them because they can get caught in the machinery and cause malfunctioning, or are contaminated after use. Indeed, only approximately 5% of the plastic bags in California and nationwide are currently recycled.[21]

In 2006, California enacted AB 2449 (Chapter 845, Statutes of 2006), which became effective on July 1, 2007. The statute provides that stores that provide plastic carryout bags to customers must provide at least one plastic bag collection bin in an accessible spot to collect used bags for recycling. The store operator must also make reusable bags available to shoppers for purchase. AB 2449 is discussed below in the Regulatory Environment section. As of this time, there is no study of whether AB 2449 has either reduced single-use plastic bag use or resulted in an increase in the recycling rate. Figure 3 outlines the general life cycle of the plastic bag.

21 US EPA 2005 Characterization of Municipal Solid Waste, Table 7, as reported in County of Los Angeles (2007); the LCA conducted by Boustead Associates (2007) assumes a 5.2% rate of recycling for plastic bags, based on 2005 EPA data.

Figure 3: Life Cycle of Plastic Single-Use Bag



3.2.2. *Single-use Paper Bags*

Like plastic grocery shopping bags, single-use paper bags are distributed free of charge to customers at grocery stores, and are intended for one use before disposal. Paper products make up 17% of the California disposal waste stream.[22] A subcategory, paper bags – including bags and sheets made from kraft paper; the paper may be brown or white, and examples include paper grocery bags, fast food bags, department store bags, and heavyweight sheets of kraft packing paper – make up 0.4% of the total disposal waste stream, or approximately 155,800 tons. Approximately 21% of paper bags nationwide are recycled.[23] Although the percent is assumed to be similar within California, there is anecdotal evidence that California may have substantially higher rates. The City of San Francisco's Department of the Environment estimates that at least 60% of paper bags are recycled in the City.[24] Similarly, according to StopWaste, Alameda County currently achieves a 60-80% paper bag recycling rate.[25]

In addition, paper bags themselves may be made of post-consumer recycled paper. Weyerhaeuser, a major kraft paper bag manufacturer, reported to Boustead Associates (2007) that its unbleached kraft grocery bag contains approximately 30% post-consumer recycled content.[26] Anecdotal evidence suggests that kraft paper bags with substantially higher post-consumer recycled content are also available. In particular, San Francisco has set a minimum 40% recycled content level for paper bags distributed within the city. StopWaste reports this and other similar requirements have led most supermarkets in California to switch to 40% recycled content paper bags.[27]

Paper grocery bags are typically produced from kraft paper and weigh anywhere from 50-100 g, depending on whether or not the bag includes handles.[28] These bags can be purchased in bulk for approximately 15-25 cents per bag.[29] Kraft paper bags are manufactured from a pulp that is produced by digesting a material into its fibrous constituents via chemical and/or mechanical means.[30] Kraft pulp is produced by chemical separation of cellulose from lignin.[31] Chemicals used in this process include caustic sodas, sodium hydroxide, sodium sulfide, and chlorine compounds.[32] Processed and then dried and shaped into large rolls, the paper is then printed, formed into bags, baled, and then distributed to grocery stores. After use, the bags are frequently reused as waste basket liners. Ultimately, while about 20% of paper bags are recycled, the remaining 80% are landfilled, left as litter, or composted. Because they are significantly heavier than plastic

22 CIWMB (2009).

23 US EPA 2005 Characterization of Municipal Solid Waste, Table 4. As reported in the County of Los Angeles (2007).

24 City of San Francisco (2010).

25 StopWaste. 2010. Comments provided to Green Cities California on draft MEA.

26 Boustead Associates (2007).

27 StopWaste. 2010. Comments provided to Green Cities California on draft MEA. Statement is based sources at Californians Against Waste.

28 AEA Technology 2009.

29 www.mrtakeoutbags.com; City of Pasadena (2008).

30 FRIDGE (2002).

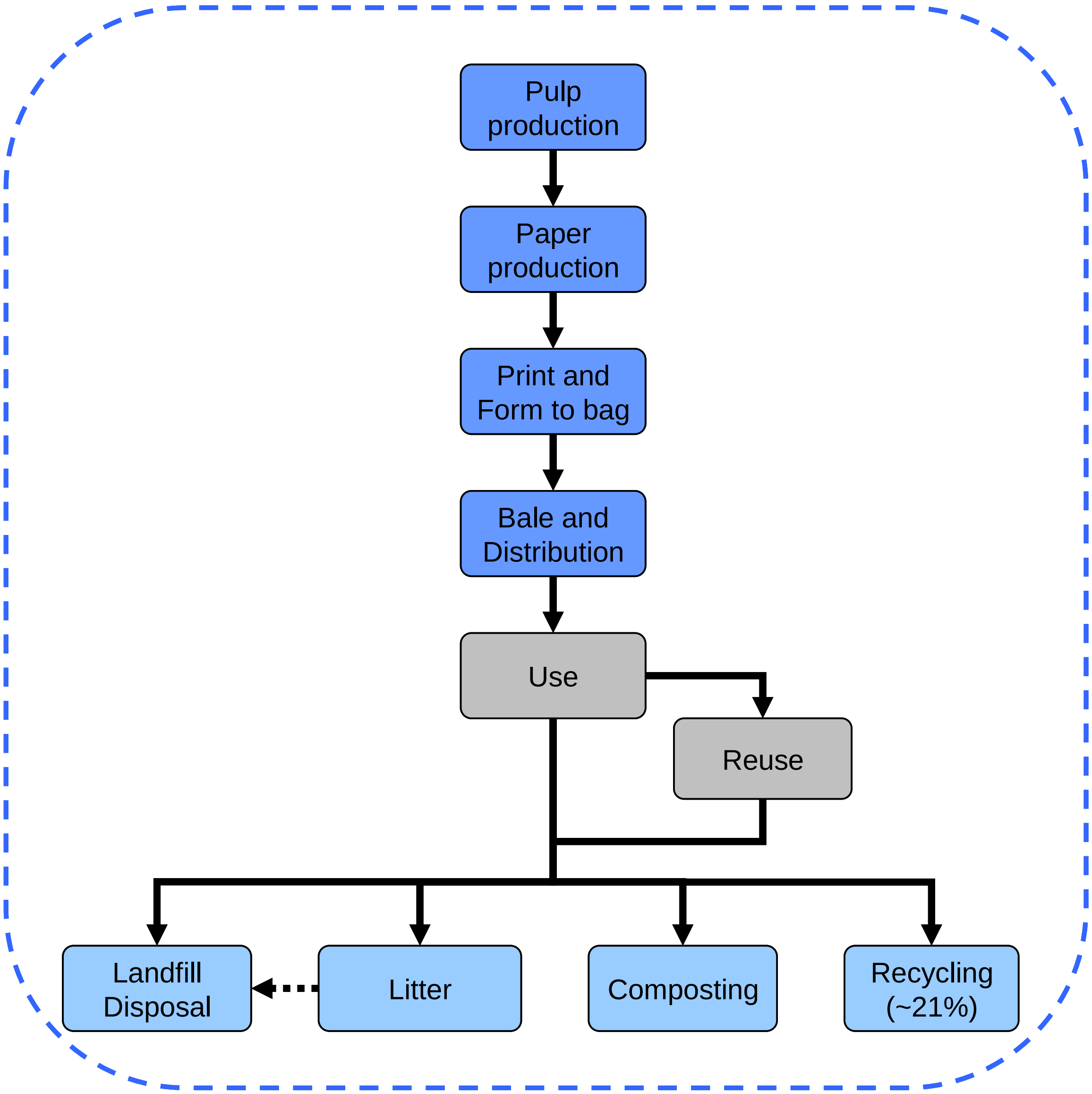
31 Environmental Paper Network (2007).

32 Environmental Paper Network (2007).

bags, paper bags are less likely to be blown off landfills as litter. And those bags that are left as litter may decompose.[33]

The figure below outlines the general life cycle of the paper bag.

Figure 4: Life Cycle of Kraft Paper Bag



3.2.3. Single-use Biodegradable Bags

This MEA focuses primarily on compostable and other biodegradable bags, which are the primary types of degradable plastic grocery bags.[34] Biodegradable bags are generally

[33] Greene (2007).

viewed as an eco-friendly alternative to HDPE plastic bags because they are advertised as being as strong as conventional plastic bags and will decompose at end of life rather than persist and pose aesthetic and health hazards.[35] Multiple types of degradable bags are currently available, distinguished by their material components. They are composed of thermoplastic starch-based polymers, which are made with at least 90% starch from renewable resources such as corn, potato, tapioca, or wheat, or from polyesters, manufactured from hydrocarbons, or starch–polyester blends.[36]

Biodegradable plastics are defined according to the American Society for Testing and Materials (ASTM) D6400 standards as degradable in the presence of naturally occurring microorganisms.[37] These plastics are capable of undergoing decomposition into carbon dioxide, methane, water, inorganic compounds, or biomass.[38] Compostable plastics are a subset of biodegradable plastics that are defined according to ASTM D6400 standards as those biodegradable plastics that will decompose during composting at a rate consistent with other known compostable materials and leave no visible distinguishable or toxic residue.[39] Many biodegradable plastic bags made of corn or potato starch, sugarcane, or polylactic (PLA) or polyhydroxyalkanoate (PHA) acid are considered compostable. However, while PHA-based bags will degrade in oceans and open lands, PLA-based bags will not degrade significantly in non-composting environments.[40] According to Greene (2007), polyethylene plastic bags produced with starch additives are not certified as compostable plastics because after disintegration they will leave small plastic fragments in the compost.[41] Two of the biodegradable plastics currently on the market are the corn-starched based polymer marketed by Novamont known as 'Mater-Bi,' and 'EcoFlex,' which is made of a polyester polymer. Ruiz (2007) examined both the Mater-Bi and EcoFlex bags to determine their ability to degrade in an aerobic composting environment. Both of these bags disintegrated within 30-60 days under laboratory composting conditions.[42] Mohee et al. (2006) also tested the rate of composting for Mater-Bi bags compared with plastic bags

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34 Other degradable plastics include oxodegradable polymers, which undergo controlled degradation when initiated by natural daylight, heat, or mechanical stress, photodegradable polymers, which break down when ultraviolet light breaks the chemical bonds, and water-soluble polymers, which dissolve in water at a particular temperature range and then biodegrade in contact with microorganisms (James and Grant 2005, Hyder Consulting 2007, CIWMB 2009b). However, researchers at California State University Chico Research Foundation tested the degradation of oxodegradable and photodegradable bags in composting conditions, and found that they did not degrade (CIWMB 2007). Furthermore, these bags reduced the quality of recycled plastics when introduced into the recycling stream and so must be kept separate to avoid contaminating the recycling stream (CIWMB 2007). This MEA does not address these other types of degradable plastics, instead focusing primarily on biodegradable plastics.

35 According to www.ecoproducts.com, the BioBag compostable trash liner will biodegrade in as little as 45 days if disposed at a commercial compost facility. On the shelf they will be stable for up to two years.

36 James and Grant (2005).

37 Greene (2007).

38 Greene (2007).

39 CIWMB (2008).

40 CIWMB (2009b).

41 Greene (2007).

42 Ruiz (2007).

made with biodegradable additive. Although the Mater-Bi bags made of starch degraded completely within 60 days, the others required a significantly longer time frame.[43]

Biodegradable bags often take months or years to decompose, and, depending on their material composition, only do so in ideal composting environments (i.e., PLA-based plastic bags). Clearly, if a bag begins to decompose too early due to exposure to high temperatures, light, or moisture, its carrying capacity would be compromised.[44] Although the bags may be unstable in extreme conditions, initial studies have indicated that at end-of-life biodegradable bags may decompose slowly if at all. Greene (2007) tested the degradation of a corn starch-based compostable bag compared to a kraft paper bag in a green yard-waste composting environment. After 20 weeks, each bag had degraded between 80% and 90%.[45] Given that PHA-based plastics do not degrade unless in a composting environment, and the compostable bag required 20 weeks for incomplete degradation under ideal conditions, the claim that biodegradable bags will solve the plastic bag litter problem because they will degrade may be somewhat misleading (see Section 3.4.1). As discussed later under biological resources, bits of plastic are ingested by wildlife and can have adverse effects on their health.

Furthermore, although some regions within California have processing facilities that are prepared for biodegradable bags, others may not. For instance, an article in the *Los Angeles Times* (Proctor 2007) pointed out that although biodegradable bags are required in San Francisco, this policy may not be appropriate in Los Angeles due to the lack of processing facilities to handle biodegradable bags.[46] Biodegradable bags that end up in the ocean may not decompose quickly enough to prevent the risks of injury to marine animals.

Additional characteristics of biodegradable bags suggest that they are not an appropriate substitute for HDPE plastic bags. Biodegradable bags cannot be recycled with other plastic bags. If they enter the recycling material stream, they could contaminate the resulting recycled material, making it unusable.[47]

Biodegradable bags made of Mater-Bi provide a convenient example of the manufacturing process. They are manufactured following the steps outlined in the figure below. These bags are approximately the same size and weight as single-use HDPE plastic bags, but are substantially more expensive. They can be purchased in bulk for approximately 12-30 cents per bag.[48]

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43 Mohee et al. (2006).

44 Cadman et al. (2005).

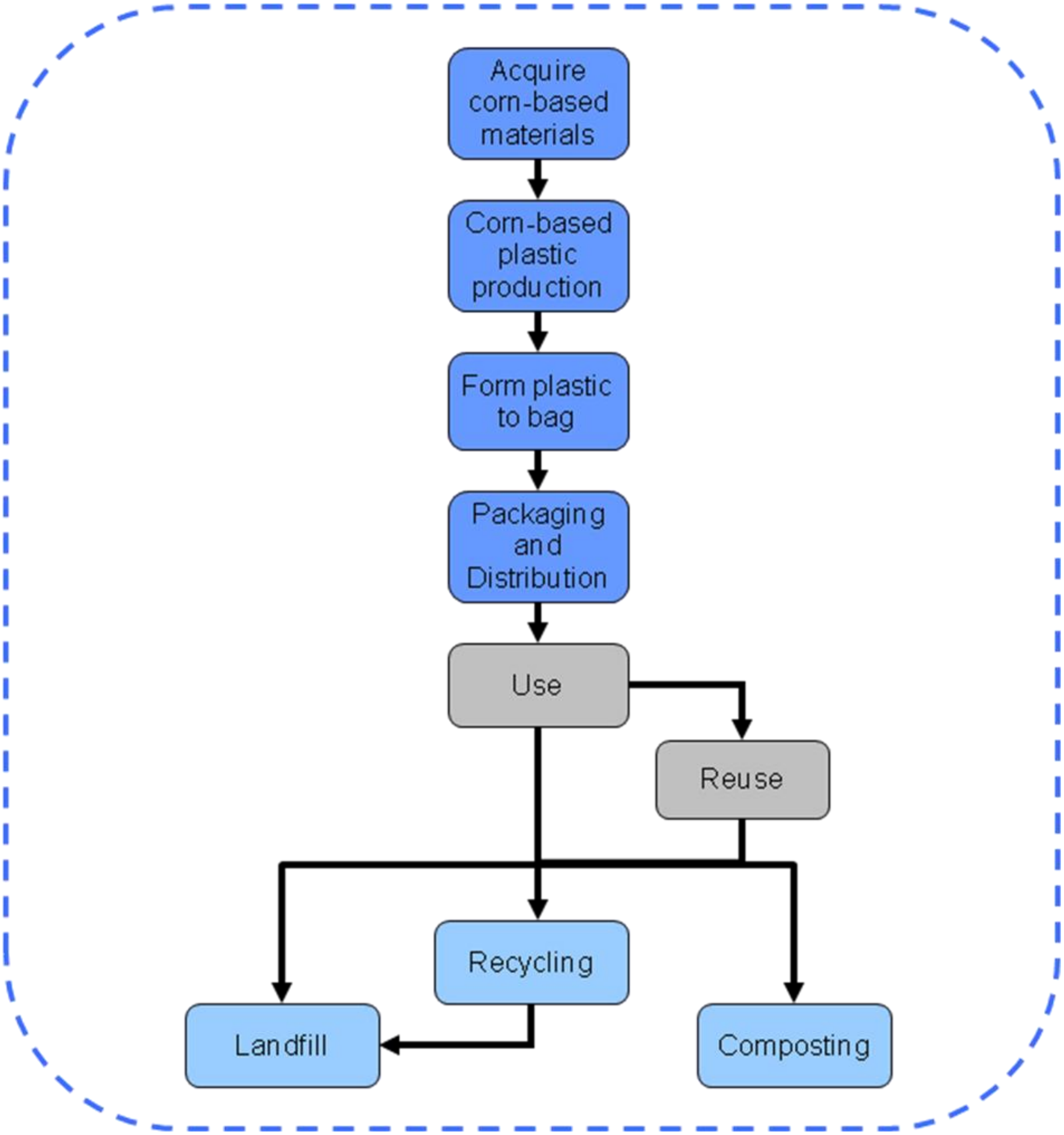
45 Greene (2007).

46 Proctor (2007).

47 Cadman et al. (2005).

48 www.ecoproducts.com

Figure 5: Life Cycle of Mater-Bi and Other Corn-based Biodegradable Bags



3.2.4. Reusable Bags

Reusable bags can be made of various materials including polyethylene (PE) plastic, polypropylene (PP) plastics, multiple types of cloth (cotton canvas, nylon, etc.), and recycled plastic beverage containers (polyethylene terephthalate, or PET), among others. As mentioned in Section 1.2.4, the state of California defines these bags as “a bag with handles that is specifically designed and manufactured for multiple reuse and is either made of cloth or other machine washable fabric, and/or thick, durable plastic (at least 2.25

mils thick)."[49] These bags differ from the single-use bags in their weight and longevity. Built to withstand many uses, they typically cost approximately $1-5 wholesale, weigh at least 10 times an HDPE plastic bag and 2 times a paper bag, and require significantly greater material consumption on a per bag basis than HDPE plastic bags.[50] However, because they can be used hundreds of times, reusable bags can be expected to have a lower environmental impact than plastic bags.

Many types of reusable bags are available today. These include: non-woven polypropylene (100% recyclable) ranging from $1-$2.50 per bag, cotton canvas which is approximately $5.00 per bag, 100% recycled plastic water/soda bottles, which is approximately $6.00 per bag, polyester and vinyl, which is approximately $10.00 per bag, and 100% cotton, which is approximately $10.00 per bag. At the same time, some stores offer reusable bags at substantially less cost in order to reduce the number of single-use bags being used. For example, in early 2010 Whole Foods Markets was selling a small grocery bag made of 80% post-consumer recycled plastic bottles for $0.79. The production stages in reusable bag life cycles depend on the materials used. Once used, these bags are reused until worn out through washing or multiple uses, and then disposed either in the landfill or recycling facility. Due to their weight, they are less likely than plastic bags to blow off a landfill and become litter.

No comprehensive California-specific life-cycle study has been conducted of the reusable bags commonly used in the state. Therefore it is unclear which types of reusable bags have the least environmental impact. However, previous LCAs not focused in California (James and Grant 2005, and Hyder Consulting 2007) suggest that the non-woven plastic durable bag has the greatest environmental benefits overall, based on an analysis of multiple types of reusable bags.

3.3. Regulatory Environment

The following is a general overview of the regulatory requirements that are relevant to grocery bags. This is not intended to be a detailed discussion. Local regulatory environments may vary. Any CEQA document relying on this MEA should consider the environment that is relevant to its situation and include what applies in that situation.

3.3.1. California Statutes

AB 2449

In 2006, California enacted AB 2449 (Chapter 845, Statutes of 2006), which became effective on July 1, 2007. The statute provides that stores that provide plastic carryout bags to customers must provide at least one plastic bag collection bin in an accessible spot to collect used bags for recycling. The store operator must also make reusable bags available to shoppers for purchase. The store is required to keep records describing the collection, transport, and recycling of plastic bags collected for a minimum of three years and make the records available to the state or the local jurisdiction, upon request, to demonstrate compliance with this law. (Public Resources Code Section 42252(d))

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49 City of Palo Alto Website. Bring Your Own Bag News Detail. Available at: http://www.cityofpaloalto.org/

50 ExcelPlas Australia (2004); City of Pasadena (2008).

AB 2449 applies to retail stores of over 10,000 square feet that include a licensed pharmacy and to supermarkets with gross annual sales of $2 million or more which sell dry groceries, canned goods, nonfood items, or perishable goods. Stores are required to maintain records of their AB 2449 compliance and make them available to the CIWMB or local jurisdiction.

AB 2449 requires the manufacturers of plastic carryout bags to develop educational materials to encourage the reduction, reuse, and recycling of plastic carryout bags, and to make the materials available to stores. Manufacturers must also work with stores on their at-store recycling programs to help ensure the proper collection, transportation and recycling of the plastic bags.

AB 2449 restricts the ability of cities (including charter cities) and counties to regulate single-use plastic grocery bags through imposition of a fee. Public Resources Code Section 42254(b) provides as follows:

> “(b) Unless expressly authorized by this chapter, a city, county, or other public agency shall not adopt, implement, or enforce an ordinance, resolution, regulation, or rule to do any of the following:
>
> (1) Require a store that is in compliance with this chapter to collect, transport, or recycle plastic carryout bags.
>
> (2) Impose a plastic carryout bag fee upon a store that is in compliance with this chapter.
>
> (3) Require auditing or reporting requirements that are in addition to what is required by subdivision (d) of Section 42252, upon a store that is in compliance with this chapter.”

AB 2449 expires under its own terms on January 1, 2013, unless extended. There are no other California statutes that directly focus on grocery bags.

AB 1972

This statute restricts the labeling of grocery bags as “compostable” or marine degradable” and otherwise prohibits use of the terms "biodegradable," "degradable," or "decomposable" when describing plastic bags. (Public Resources Code Section 42353, et seq.) Public Resources Code Section 42357 provides as follows:

> (a) (1) A person shall not sell a plastic bag in this state that is labeled with the term "compostable" or "marine degradable," unless, at the time of sale, the plastic bag meets the applicable ASTM standard specification, as specified in paragraph (1) of subdivision (b) of Section 42356.
>
> (2) Compliance with only a section or a portion of a section of an applicable ASTM standard specification does not constitute compliance with paragraph (1).
>
> (b) Except as provided in subdivision (a), a person shall not sell a plastic bag in this state that is labeled with the term "biodegradable," "degradable," or "decomposable," or any form of those terms, or in any way imply that the bag will break down, fragment, biodegrade, or decompose in a landfill or other environment.
>
> (c) A manufacturer or supplier, upon the request of a member of the public, shall submit to that member, within 90 days of the request, information and documentation

demonstrating compliance with this chapter, in a format that is easy to understand and scientifically accurate.

AB 258

AB 258 was enacted in 2008 to address the problems associated with releasing "preproduction plastic" (including plastic resin pellets and powdered coloring for plastics) into the environment. It enacted Water Code Section 13367 requiring the State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCBs) to implement a program to control discharges of preproduction plastic from point and nonpoint sources.

Program control measures must, at a minimum, include waste discharge, monitoring, and reporting requirements that target plastic manufacturing, handling, and transportation facilities. The program must, at a minimum, require plastic manufacturing, handling, and transportation facilities to implement best management practices to control discharges of preproduction plastics. This includes containment systems, careful storage of pre-production plastics, and the use of capture devices to collect any spills.

The State Water Resources Control Board reports that it is taking the following actions to comply with Section 13367:

> "State and Regional Water Board staff has conducted and are continuing to conduct compliance inspections of various types and scales of preproduction plastic manufacturing, handling, and transport facilities enrolled under California's Industrial General Permit (IGP) for storm water discharges. Additionally, the Los Angeles Regional Water Quality Control Board has conducted hundreds of inspections of facilities suspected to be "non-filers," or facilities subject to the permit, but have not enrolled. Collectively these inspections will help State and Regional Water Board staff to develop cost-effective regulatory approaches (including compliance-evaluation procedures and appropriate best management practices) for addressing this pollution problem.
>
> "The State Water Board has issued an investigative order to all plastic-related facilities enrolled under the IGP to provide the State Water Board with critical information needed to satisfy the legislative mandates in AB 258 (Krekorian). Facilities subject to this order must complete an online evaluation and assess their points of potential preproduction plastics discharge and means of controlling these discharges. Data gathered as a result of this effort will be used to help the State Board understand the California plastics industry and ultimately develop appropriate regulation of these facilities to ensure compliance with the Clean Water Act."[51]

3.3.2. Trash Control Regulations

Federal, state, and regional water quality standards have resulted in the passage of regional regulations that will eventually prohibit the release of trash to surface waters, including grocery bags that have become litter. Reducing the use of disposable single-use grocery bags is one way of reducing the amount of litter that must be captured before it can enter surface waters. These regulations are described below.

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51 State Water Resources Control Board (2010).

Congress passed the Clean Water Act (CWA) in 1972, which authorized the U.S. Environmental Protection Agency (US EPA) to set federal water quality regulations. The CWA requires completion of Total Maximum Daily Load (TMDL) levels for all pollutant-impaired waters, and requires each state to:

- Identify water bodies that are water quality limited. These water bodies are then placed on the state's "303(d) List" (CWA Section 303 (d)(1) requires each state to identify the waters within its boundaries that do not meet water quality standards).
- Prioritize and target water bodies for TMDL's
- Develop TMDL plans to attain and maintain water quality standards for all water quality limited waters

The TMDL is a number that represents the assimilative capacity of a receiving water (such as a river or creek) to absorb a pollutant. The TMDL is the sum of the wasteload allocations for point sources (specific physical sources, such as a pollution outflow pipe) and nonpoint sources (broad area sources, such as a plowed field or mining waste heap), plus an allotment for natural background sources of pollutants, and a margin of safety. TMDLs can be expressed in terms of mass per time (the traditional approach), or in other ways, such as a percentage reduction or other appropriate measure relating to a state water quality objective. A TMDL is implemented by reallocating the total allowable pollution among the different pollutant sources (through the permitting process or other regulatory means) to ensure that the water quality objectives are achieved.

In short, a TMDL establishes a maximum limit for a specific pollutant that can be discharged into a water body without causing it to become impaired. A given water body may have more than one pollutant that will require the establishment of a TMDL.

TMDLs are enforced through State and Federal discharge permits issued to cities, such as the Municipal Stormwater National Pollutant Discharge Elimination System (NPDES) permit and Publicly Owned Treatment Works (POTWs) permit. Violation of these permits can result in exposure to both civil and criminal liabilities. Upon establishment of TMDLs by the State or US EPA, the State is required to incorporate the TMDLs into the State Water Quality Management Plan.

In California, TMDLs are prepared by the Regional Water Quality Control Boards and adopted by the State Water Resources Control Board as part of each region's Basin Plan. TMDLs are adopted to regulate a variety of pollutants (e.g., bacteria, sediment, heavy metals, pesticides and other toxic pollutants, and nutrients), including trash.

The following adopted trash TMDLs control the release of trash to impaired water bodies.

Los Angeles Regional Water Quality Control Board (RWQCB) Trash TMDLs

In 1996 and 1998, the Los Angeles RWQCB identified more than 160 water body segments that are polluted by various constituents and therefore exceed their water quality standards. In 1998, a coalition of environmental advocacy groups sued the US EPA for failure to ensure timely development of TMDLs for each polluted water in the Los Angeles region. The litigation resulted in a consent decree signed in 1999 (*Heal the Bay, et al. v. Browner*) that established a schedule for completing TMDLs for all the polluted waters within the region.

The Los Angeles River TMDL was adopted by the Los Angeles RWQCB in 2001. The Los Angeles River TMDL required Southern California cities discharging into the river to reduce their trash contribution by 10% each year for a period of 10 years, with the goal of zero trash (i.e., a 100% reduction) in the two waterways by 2015. The Los Angeles River TMDL was subsequently challenged by a variety of affected municipalities, and invalidated by the 4th District Appellate Court in 2006. The Court ruled there was insufficient analysis of the environmental impacts that could be caused by implementation of the Los Angeles River TMDL. In 2007, the Los Angeles RWQCB revised the CEQA documentation and amended the Los Angeles River Trash TMDL. The amended Los Angeles River Trash TMDL became effective in 2008. In December 2009, the Los Angeles RWQCB revised the Municipal Stormwater (MS4) Permit for Los Angeles County and its cities (except for Long Beach) to include the Trash TMDL in the provisions of the permit. This is will improve enforcement of the TMDL.

In addition to the Los Angeles River TMDL, eight other Trash TMDLs exist in the Los Angeles region. All of these TMDLs include the same requirements: for point sources, there must be a 20 percent reduction in trash per year. For non-point sources, a Trash Monitoring and Reporting Plan (TMRP) must be completed and submitted to the RWQCB. Once submitted, monitoring must occur to ensure the TMRP is being properly implemented. (Eric Wu, Unit Chief, Los Angeles RWQCB TMDL Unit). These eight TMDLs and the year they went into effect are listed below:

- Malibu Creek - 2009
- Legg Lake (located on San Gabriel River) - 2008
- Lake Elizabeth, Munz Lake, and Lake Hughes (located on Santa Clara River) - 2008
- Ventura River Estuary - 2008
- Revolon Slough and Beardsley Wash Trash (located on Calleguas Creek) - 2008
- Machado Lake (located on Dominguez Channel) - 2008
- Ballona Creek - 2002
- San Gabriel East Fork (located on San Gabriel River) - 2001

Colorado River Basin RWQCB – New River

The New River is located in the southeastern portion of the Salton Sea Transboundary Watershed. This Watershed consists almost entirely of highly productive farmland irrigated with water imported from the Colorado River. The New River is one of the main tributaries to the Salton Sea, which is California's largest inland surface water.

In 2002, the Colorado River Basin RWQCB listed the New River on the CWA Section 303(d) List because trash and others pollutants violated water quality objectives that protected beneficial uses. The beneficial uses provided by the Colorado River Basin RWQCB include: warm freshwater habitat; wildlife habitat; preservation of rare, threatened, or endangered species; water contact recreation; noncontact water recreation; and freshwater replenishment. As a result, the New River Trash TMDL was adopted by the Colorado River Basin RWQCB in 2006 and approved by the State Water Resources Control Board (SWRCB) and the US EPA in 2007.

The New River TMDL established an interim numeric target of 75% reduction in trash within two years of SWRCB and US EPA approval of the TMDL, and a final numeric target of zero trash (i.e., 100% reduction) within three years of SWRCB and US EPA approval. The Colorado River Basin RWQCB does not currently have any data regarding progress towards achieving the 75% reduction in trash target by 2009, or the 100% reduction in trash target by 2010. The issue will be revisited in 2010, when the Colorado River Basin RWQCB will examine progress on completion of the TMDL implementation plan and determine the percentage of reduction in trash achieved to date. (Nadim Zorzeywar Senior Environmental Science, Colorado River Basin RWQCB).

San Francisco RWQCB – Municipal Regional Stormwater NPDES Permit

Municipal governments in the San Francisco Bay Area, including municipalities and local agencies in Alameda, Contra Costa, San Mateo, and Santa Clara counties, and the cities of Fairfield, Suisun City, and Vallejo (referred to as the permittees), are subject to a recently adopted Municipal Regional Stormwater NPDES Permit (MRP) regulating stormwater discharges in accordance with the Clean Water Act. This MRP was adopted by the San Francisco RWQCB on October 14, 2009.

The MRP states that the permittees must protect the quality of receiving waters through the timely implementation of control measures and other actions to reduce trash loads from municipal separate storm sewer systems (MS4s) by 40% by 2014, 70% by 2017, and 100% by 2022.

As part of the MRP, the permittees must develop and implement a Short-Term Trash Load Reduction Plan, including an implementation schedule. This includes implementation of a mandatory minimum level of trash capture; cleanup and abatement progress on a mandatory minimum number of ‘trash hot spots’ (high trash-impacted locations on State waters); and implementation of other control measures and best management practices, such as trash reduction ordinances, to prevent or remove trash loads from MS4s to attain a 40% reduction in trash loads by July 1, 2014. The permittees must also develop and begin implementation of a Long-Term Trash Load Reduction Plan to attain a 70% reduction in trash loads from their MS4s by 2017 and 100% by 2022.

Smaller municipalities (with a population less than 12,000 and retail/wholesale land less than 40 acres, or a population less than 2000) are exempt from this requirement.

Failure to comply with these requirements can lead to legal enforcement action by the SWRCB against the applicable local agency.

3.4. Potential Environmental Concerns

The MEA is a comprehensive information source on grocery bags. It is not an environmental analysis, per se. The following discussions are intended to highlight the areas of environmental concern that may arise, given a community’s specific circumstances, from consideration of single-use grocery bags. While this information can help agencies assess the significance of proposed regulations of single-use and reusable bags, these discussions should not be viewed as an environmental analysis of the issues, nor a determination of their significance for a particular project. The examination of impacts, conclusions regarding their significance, and feasible mitigation measures are the purview of the lead agencies that may use the MEA as an information source during their CEQA analyses.

3.4.1. Aesthetics

When improperly disposed of (i.e., not recycled or sent to a landfill), grocery bags contribute to the visual effects of litter. In particular, HDPE plastic bags that are not disposed of in a landfill are likely to end up as litter. Even those bags set out for collection as garbage or for recycling or at a landfill may be blown away as litter due to their light weight.[52]

The Los Angeles County Staff Report on Plastic Bags (2007) summarizes several studies conducted on plastic litter. Based on five studies, the report suggests that plastic films, which include plastic bags, account for 7-30% by weight of all litter in the Los Angeles area. HDR Consulting (2008) conducted an audit of San Francisco large litter (items over 4 square inches), and concluded that bags constituted 5.9% of that litter in 2008.[53] Plastic bags account for 73% of the bag litter, while paper accounts for the remaining 27%.[54]

The visual impact of plastic bag litter is a recognized problem, not just in California. In Wales, there is a "high level of disapproval in the eye of the Welsh public" and two thirds of people responding to a Keep Wales Tidy survey described plastic bags as a 'major problem'."[55] According to the 2002 Environment Australia report, plastic bags may remain in the litter stream for five years.

Compared to plastic bags, paper bags pose less of a litter risk because of their biodegradability, weight, and recyclability. In fact, the 2002 Environment Australia report assumes that paper bags only remain in the litter stream for six months.[56] A paper bag weighs significantly more than a plastic bag and is therefore less likely to be carried by the wind as litter. According to the Ecobilan LCA (2004), single-use paper bags are 0.2 times as likely as HDPE plastic bags to become litter.

Reusable bags pose a smaller litter threat than lightweight disposal plastic bags. Cotton calico bags, in particular, remain in the litter stream for 2 years, compared to 5 years for HDPE plastic bags.[57] Heavy, valuable, and intended for multiple uses, reusable bags are produced in smaller quantities than plastic bags, and are purchased by consumers. Because of their durability and monetary value, they are less likely than HDPE plastic bags to be simply discarded after use. In fact, according to the Ecobilan LCA (2004), reusable LDPE plastic bags are 0.4 times as likely as HDPE plastic bags to become litter. Other types of reusable bags may have an even lower likelihood of becoming litter.

The Environment Australia (2002) report suggests that biodegradable bags may remain in the litter stream for only 6 months. However, despite beliefs to the contrary, these bags may pose a more substantial litter risk than plastic bags because consumers are more likely to discard them, believing them to biodegrade readily. Actually, biodegradable bags take at least a few weeks to begin degrading, and depending on their material composition,

52 AEA Technology (2009); County of Los Angeles (2007).

53 HDR (2008).

54 HDR (2008).

55 Keep Wales Tidy. 2006. Plastic Bag Litter Position Paper. July 2006. As reported in AEA Technology (2009).

56 Environment Australia (2002).

57 EuroCommerce (2004).

only degrade in composting conditions with micro-organisms.[58] In fact, AEA Technology (2009) concludes that "lightweight bags of any material are equally as likely to cause problems through littering."[59] And the slow degradation of biodegradable bags in a landfill would have no significant positive impact on landfills; rather, the bags may cause leachate problems and become wind-blown litter.[60] Degradable bags have been presented as alternatives to the single-use plastic bag in part because of the claim that they do not pose a litter problem. AEA Technology (2009) reports that this claim may send the wrong message to consumers, indirectly encouraging them to discard these bags under the assumption that they will eventually break down. Previous LCAs indicate that this mentality could result in even more litter, as people may carelessly dispose of degradable bags in environments not conducive to degradation. Finally, recycling facilities are not currently set up to handle both degradable and HDPE plastic bags. In general, biodegradable bags are not recycled, and mixing them with HDPE plastic bags would result in contamination.[61] This would disrupt the already low level of HDPE plastic bag recycling.

Litter not only negatively affects aesthetics. It also creates adverse effects on marine and land-based wildlife. Section 3.4.4 on biological resources provides a more detailed discussion of these litter impacts.

3.4.2. Agricultural Resources

Previous LCAs do not thoroughly address the potential impacts of various grocery bags on agricultural resources. Consequently, the extent to which the manufacture of corn-based biodegradable bags may affect US corn production is unknown. There has been the suggestion that plastic bags in litter can jam farm machinery, but there is no evidence that this is a common problem.

3.4.3. Air Quality

Greenhouse Gas Emissions

Bag manufacture, transport, and disposal all result in greenhouse gas emissions, atmospheric acidification, and ground level ozone formation. A switch to reusable bags is predicted to result in decreased transport-related emissions due to less bag manufacturing and collection at disposal. However, because HDPE plastic bags have a significantly lower volume than paper or reusable bags, a switch from plastic to paper may result in short-term increase in transportation. Any increase is thought to be insignificant, on the order of one additional truck trip per day per small city.[62]

The Ecobilan study (2004) compares bags using these metrics, and concludes that the paper bag has a significantly larger impact on air quality than single-use plastic bags.[63]

58 Environment Australia (2002).

59 AEA Technology (2009).

60 Environment Australia (2002).

61 Cadman et al. (2005).

62 City of Palo Alto (2009)

63 Ecobilan (2004). Carrefour Bag Study. The results of this report assume that all bags are sent to a landfill at disposal. Because in reality a higher percentage of paper bag are recycled than plastic bags, the results of this LCA must be treated with caution.

Paper bag production, use, and disposal results in 3.3 times the greenhouse gas (GHG) emissions associated with HDPE single-use plastic bags. If only used once, a reusable LDPE bag results in 2.6 times the GHG emissions of a single-use HDPE plastic bag. That said, a reusable bag used 3 times will have fewer GHG emissions per use than a plastic bag. These results match those of an earlier study conducted by Franklin Associates (1990), which concluded that paper bags, compared to HDPE plastic bags, create 90% more GHG emissions.

ExcelPlas Australia (2004) conducted an LCA focusing on disposable and reusable bags as well as degradable plastic bags. The study found that GHG emissions for all bag types are dominated by carbon dioxide through electricity and transport consumption, by methane through the degradation of materials in anaerobic conditions, and nitrous oxide emissions in fertilizer applications on crops.[64] Their results indicated that degradable polymers with starch content have higher impacts upon GHG emissions because of methane emissions during landfill degradation and nitrous oxide emissions from fertilizing crops. This study followed an analysis by Environment Australia (2002), which indicated that the global warming impact of paper bag use is almost twice that of conventional plastic bags.[65]

Further, the Boustead Consulting Study (2007) compared paper, HDPE plastic, and compostable plastic bags, assuming that one paper bag can carry the same quantity of groceries as 1.5 plastic bags. Study results indicate that paper bag production, use, and disposal result in twice the GHG emissions of conventional PE bags.[66] Compostable plastic bag manufacture, use, and disposal, however, result in 4.5 times the GHG emissions of plastic bags.[67] In addition, the Finnish Environment Institute (SYKE) conducted a study of paper, cotton, and recycled plastic biodegradable bags. The authors determined that biodegradable bags are the worst alternative from the point of view of GHG emissions because they contain substances of fossil origin that increase bag durability, but will be released during decomposition in a compost or landfill. These bags are therefore only viable from a GHG emission standpoint if they are burned in a waste-to-energy facility or used in biogas production.[68] In contrast to these results, Murphy (2004) compared the cradle-to-factory-gate GHG emissions of petrochemical polymers and various biodegradable polymers,[69] and found that each of the biodegradable polymers resulted in significant GHG savings. These apparently conflicting results emphasize the particularity of each study and the importance of understanding study boundaries (i.e., distinguishing between the cradle-to-grave and cradle-to-factor-gate analyses).

SYKE (2009) also examined reusable bags and concluded that because of high emissions associated with cotton production and the fact that waste bags would need to be used in addition to the cotton bags, the cotton bag must be used more than 180 times before its climate impact is smaller than the climate impacts of a continuous use of recycled plastic

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64 ExcelPlas Australia (2004).

65 Environment Australia (2002): These results are based on a 6 g plastic bag and 42.6 g paper bag with equal carrying capacity.

66 Boustead Associates (2007).

67 Boustead Associates (2007).

68 SYKE (2009).

69 Biodegradable polymers studied include: 100% thermoplastic starch, thermoplastic starch plus 60% polycaprolactone, and polylactic acid. Murphy (2004).

bags.[70] The authors surmised that if the cotton bag is used enough times in conjunction with small waste bags, then the combination may be better than the conventional plastic bag, but not better than the paper bag or plastic bag made of recycled materials. In short, the study argued that if reusable bags are used, they should be made of other fibers than cotton. An earlier study by Hyder Consulting (2007) suggests that the non-woven polypropylene 'Green Bag' would offer significant GHG savings, on a level of about 6 kilograms (kg) per household per year.[71]

Atmospheric Acidification and Criteria Pollutants

According to Ecobilan (2004), a reusable LDPE plastic bag results in 3 times the atmospheric acidification of HDPE plastic bags. Again, used multiple times, the LDPE reusable bag has a less significant impact than HDPE bags on a per use basis. A paper bag has 1.9 times the impact of HDPE plastic bags on atmospheric acidification. The Franklin Associates (1990) study, reviewed by FRIDGE (2002), suggests that atmospheric emissions for plastic bags are 63-73% less than for paper bags at zero percent recycling. Even assuming 0% plastic bag recycling and 100% paper recycling and a ratio of two plastic bags per paper bag, atmospheric emissions per 10,000 bags are 10.84 kg for plastic bags compared to 14.61 kg for paper bags.[72] Emission categories analyzed include particulates, nitrogen oxides, hydrocarbons, sulfur oxides, carbon monoxide, and odorous sulfur.

Ground-level Ozone

Ozone precursors and particulate matter are emitted into the atmosphere when fuel is burned during the manufacture of plastic and paper bags. Comparison of these emissions from manufacture of various bags indicates the following results, according to Ecobilan (2004): a reusable LDPE plastic bag results in 1.4 times the ground level ozone formation of HDPE plastic bags; when used multiple times, a reusable LDPE plastic bag has a less significant impact than HDPE plastic bags on a per use basis; and a paper bag has 1.3 times the impact of HDPE plastic bags on ground level ozone formation.

3.4.4. Biological Resources

Plastic grocery bags enter the biological environment primarily as litter. This can adversely affect terrestrial animal species, birds, and marine species that ingest the plastic bags (or the residue of plastic bags) or become tangled in the bag. Plastic bags and food containers are a significant portion of the trash in urban surface water runoff in Southern California.[73] The proportion of this trash or litter that is made up of grocery bags is unknown.

Over 260 species of wildlife, including invertebrates, turtles, fish, seabirds and mammals, have been reported to ingest or become entangled in plastic debris. The results include

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70 SYKE (2009).

71 Hyder Consulting (2007): This study is particular to Australia, with transport distances and end-of-life assumptions that may not be representative of California bags.

72 Franklin Associates (1990), as reported in FRIDGE (2002).

73 Trash TMDL for the Los Angeles River Watershed, (September 19, 2001):17.

impaired movement and feeding, reduced reproductivity, lacerations, ulcers, and death.[74] Ingested plastic bags impact wildlife by clogging animal throats and causing choking, filling animal stomachs so that they cannot consume real food, infecting animals with toxins from the plastic, and entangling animals in the plastic. ExcelPlas Australia (2004) reports that sea turtles sometimes mistake plastic bags for jellyfish, one of their primary food sources. Many have been found bloated with plastic bags in their digestive tract and gut.[75] According to the International Coastal Clean-up Report (2005), 2.2% of all animals found dead during the 2004 survey had been entangled in plastic bags.[76] The proportion of these bags that were grocery bags is unknown.

Less directly, the small plastic pellets that are eventually manufactured into bags often end up in storm drains.[77] Mistaken for fish eggs, they are consumed by marine life. A study conducted by Tokyo University geochemist Hideshige Takada found that the toxic chemicals in plastic pellets accumulate in birds at levels of up to one million times the normal level in seawater.[78]

According to the ExcelPlas Australia (2004) study, material density is more important than degradability in determining the risk of harmful impacts to marine wildlife. Biodegradable plastic bags may have a similar impact, because they only biodegrade at a relatively fast rate when in a composting facility in the presence of microorganisms. In oceans they can take more than five months to partially decompose, leaving a substantial time period during which they may affect wildlife.[79] In a study of early Mater-Bi material composed of thermoplastic starch and polycaprolactone, McClure (1996) concluded that starch-based plastics are likely to be a lower risk to marine animals than conventional HDPE plastics.[80] However, Herrera et al (2008) points out that while partially degraded smaller pieces of plastic are less likely to be consumed by large marine animals, they may be mistaken as food for smaller animals.[81] It is still uncertain whether or not these smaller pieces pose a significant risk, as they may continue to degrade in the smaller animals' digestive tracts.[82]

Paper grocery bags are also released into the environment as litter. They generally have less impact on wildlife because they are not as resistant to breakdown as is plastic, therefore running less risk of entanglement, and while probably not as healthy a food source as natural foods, if ingested they can be chewed effectively and may be digested by many animals. The literature on the biological effects of paper grocery bag litter is practically non-existent. Less directly, as with plastic bags, the manufacture of paper bags also has adverse effects on wildlife.

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74 Laist (1997), Derraik and Gregory (2009).

75 ExcelPlas Australia (2004).

76 International Coastal Clean-up, 2005. The International Coastal Clean Up 2005 Report. Ocean Conservancy. As reported in AEA Technology 2009.

77 State Water Resources Control Board 2010

78 FEE 2007, as reported in Herrera et al (2008).

79 McClure (1996).

80 McClure (1996).

81 Nolan-ITU 2003 as reported in Herrera et al (2008).

82 Cadman et al. (2005).

Although no reviewed studies comprehensively reviewed the impacts of reusable bags on biological resources, it is believed that these bags will not have a significant impact on marine life. Due to the weight and sturdiness of these bags made for multiple uses, reusable bags are unlikely to be littered or carried from landfills by the wind as litter. Therefore, they are less likely to enter the oceans as waste. However, additional research is needed to identify other potential biological resource hazards associated with various types of reusable bags.

3.4.5. Cultural Resources

The LCA literature does not discuss the impacts of various bags on cultural resources. Any impacts would probably be associated with litter.

3.4.6. Geology and Soils

The LCA literature does not discuss in detail the impacts of various bags on geology and soils. There is some concern that biodegradable plastic bags may release leachates into the soil of landfills. However, additional research is needed to understand the significance of this impact area.

3.4.7. Hazardous Materials

The LCA literature does not discuss the impacts of various bags as hazardous materials. However, some of the raw materials used in the process of manufacturing bags are hazardous materials.

In their completed form, paper bags do not qualify as hazardous materials. However, as mentioned above, the raw materials and the process of manufacturing bags can involve hazardous materials. In addition, for both biodegradable and reusable bags, the raw materials and the process of manufacturing bags can involve hazardous materials.

3.4.8. Hydrology and Water Quality

Hydrology

Grocery bag disposal can adversely affect local hydrology. For instance, plastic bag litter can block waterways (primarily storm drains) resulting in contamination and changes in waterflow to surrounding areas. Eliminating this problem is one basis for the trash TMDL regulations discussed above. Plastic bag litter is a significant contributor to this type of impact, but is not the sole source.

Water Consumption

Bag manufacture uses substantial amounts of water. The Ecobilan report (2004) indicates that water consumption over a paper bag's life cycle is 4 times that of an HDPE plastic bag.[83] A reusable LDPE plastic bag results in 2.6 times the consumption of water of an HDPE plastic bag when compared on a per bag basis.[84] As noted above, reuse of the

[83] Ecobilan (2004).

[84] Ecobilan (2004).

LDPE plastic bag three times is sufficient for per-use water consumption impacts to be less than for HDPE plastic bags. The Australian study conducted by Hyder Consulting (2007) corroborates this finding, suggesting that compared to the conventional plastic bag, the non-woven polypropylene 'Green Bag' would offer water consumption savings of 7 liters per household per year.[85] The Boustead Consulting Study (2007) compared paper, HDPE plastic, and compostable plastic bags, assuming that one paper bag can carry the same quantity of groceries as 1.5 plastic bags. Study results indicate that water use for both paper and compostable plastic bags is more than 16 times the use for HDPE plastic bags.[86] Water used in manufacturing is an indirect effect of bag use and may not result in a direct impact to a community, unless it is home to a bag manufacturer.

Water Quality

The release of bags into the environment can adversely affect water quality. Federal law, as administered by the State Water Resources Control Board and the Regional Water Quality Control Boards, requires the maintenance of water quality. This can include eliminating the volume of trash that enters surface waters. This was discussed previously in Section 3.3. In addition, release of bags may contaminate the water (in the sense of contributing to trash) creating negative health impacts for freshwater and marine organisms, as discussed in Section 3.4.4.

Furthermore, according to the Ecobilan study (2004), paper bags have 14 times the impact of HDPE plastic bags on eutrophication (e.g., nitrate and phosphate emissions into water that stimulate excessive growth of algae and other aquatic life) as a result of their manufacturing process. Reusable LDPE bags have 2.8 times the impact when used only once. The Franklin Associates (1990) study suggests that paper bags generate 12 times the level of eutrophication as HDPE plastic bags during manufacture. This assessment covered dissolved solids, biological oxygen demand (BOD), suspended solids, and acids. According to ExcelPlas Australia (2004), as the use of renewable resources for polymer production increases, so does the impact on eutrophication due to the application of fertilizers to the land and runoff of nutrients into waterways. This assessment suggests that the manufacture of degradable bags may be especially harmful in this impact area. Again, this is an indirect effect of bag use. More directly, degradation of biodegradable bags into a wide range of products and residues after their use, some of which may be toxic unless the bag is compostable, could contribute to the biological oxygen demand (BOD) and chemical oxygen demand (COD) of aquatic regions with unknown consequences.[87]

3.4.9. Land Use and Planning

The literature does not provide a detailed discussion of the impacts of various bags on land use and planning. However, a shift to plant-based resource consumption rather than nonrenewable mineral resources could affect agricultural land use. This is an indirect effect of bag use. This impact area needs to be examined more carefully with attention to the specific region affected in order to draw reasonable conclusions.

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85 Hyder Consulting (2007): This study is particular to Australia, with transport distances and end-of-life assumptions that may not be representative of California bags.

86 Boustead Associates (2007).

87 Environment Australia (2002).

3.4.10. Mineral Resources

Fossil fuel use is significant in the production of bags. According to Hyder Consulting (2007), single-use plastic bags, and single-reusable non-woven plastic polypropylene bags are produced through a by-product of gas or oil refining. In contrast, kraft paper bags, cotton bags, and starch-based biodegradable bags are manufactured from renewable resources.[88] Even so, significant fossil fuel use is required for the manufacture of these types of bags. Manufacturing one billion super-thin plastic bags per day for one year requires 37 million barrels of oil.[89] Approximately 10% of US oil and gas productions and imports are used in synthetic plastic production.[90] According to the cradle-to-grave Boustead Consulting study (2007), fossil fuel use in the manufacture of 1000 paper bags composed of at least 30% recycled fiber is 23.2 kg, whereas it is 14.9 kg for 1500 PE plastic bags and 41.5 kg for 1500 compostable plastic bags.[91] However, ExcelPlas Australia (2004) suggests that one of the main benefits of biodegradable bags is the potential for lower consumption of non-renewable resources due to a greater dependence on renewable resources such as crops.[92]

3.4.11. Noise

No significant noise concerns are associated with any types of single-use or reusable bags. However, any minor noise impacts associated with bag manufacturing and transportation are region-specific, and therefore not addressed in this MEA.

3.4.12. Population and Housing

A shift in bag use would have no impact on population and housing.

3.4.13. Public Services

As mentioned above, disposable grocery bags contribute to litter and can contaminate composting and recycling efforts. In addition, cleaning up litter caused by improper disposal of bags generally results in substantial costs for communities. Here are some examples of costs in several jurisdictions – local costs may vary. Because single-use conventional plastic and biodegradable bags are more likely than other bag types to persist as litter, it is assumed that they would be responsible for the majority of bag litter cleanup costs.

Herrera et al. (2008), a report prepared for the City of Seattle, compared cleanup costs associated with both paper and plastic grocery bags in San Francisco and Seattle, as shown below.[93] The second Seattle column represents costs for plastic bags.

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88 Hyder Consulting (2007).

89 This statistic is based on a survey by the China Plastics Processing Industry Association, according to Zaleski 2008, as reported in Chan et al (2009).

90 DiGregorio (2009).

91 Boustead Associates (2007) assumes that 1500 plastic bags have an equivalent carrying capacity of 1000 paper bags.

92 ExcelPlas Australia (2004).

93 Herrera et al. (2008).

Table 2: Comparison of Solid Waste System Costs Associated with Paper and Plastic Bags – Seattle and San Francisco (Herrera et al. 2008)

Cost	San Francisco (paper and plastic – 2.0% of waste stream)	Seattle (paper and plastic – 1.7% of waste stream)	Seattle (plastic only – 0.82% of waste stream)
Processing Contamination Costs	$694,000	$561,837	$561,837
Composting Contamination Costs	$400,000	$312,000	$312,000
Collection and Disposal Costs	$3,600,000	$2,477,264	$1,075,384
City Street Cleaning Costs	$2,600,000	$503,567	$503,567
Future Landfill Liability Costs	$1,200,000	$173,491	$0
Total	**$8,494,000**	**$4,028,160**	**$2,452,788**
Total per bag	**$0.17**	**$.011**	**$.008**
Street Cleaning Budget	$26,000,000	$3,767,892	$3,767,892
Litter Control Budget	——-	$4,371,643	$4,371,643

Reproduced from Herrera et al. (2008). Note that the per bag costs in San Francisco are overestimated because the total costs are divided by only 50,000,000 bags, instead of the larger total number of bags distributed in the city.

The City of Pasadena, California, spent approximately $47,400 on clean-up of catch basins in 2008. In addition, the City spends approximately $1.5 million annually for street sweeping. Approximately 12% of Pasadena's and the state's litter stream is plastic bags and other plastic films.[94] Consequently, a reduction in plastic bag litter would result in significant cost savings to the city.

94 City of Los Angeles Staff Report (2009).

Clean-up costs are region-specific. Therefore, the costs detailed above cannot be generalized across California. However, according to the City of Los Angeles Staff Report (2009), litter collection for beaches, state highways, cities, and counties cost California over $300 million each year. Furthermore, the data demonstrate the substance of these costs for both plastic and paper bags. The comparison of Seattle's costs for paper and plastic and only plastic illustrate that, at least in that situation, plastic bags are responsible for the processing and composting contamination costs, whereas paper bags are responsible for the landfill liability costs.

3.4.14. Recreation

Beach litter and contamination of other recreational sites can negatively impact recreational experiences. Plastic debris accounts for a significant portion of beach litter and debris. The Ocean Conservancy documented results of the International Coastal Cleanup indicate that plastic bags are one of the top three items most frequently collected; the other two items are cigarette butts and food wrappers/containers.[95] In addition, the visual impact of bag litter detracts from people's perceptions of recreational water quality.[96] The combination of physical contamination of beach area and the perceived lower quality of coastal waters may negatively impact beach use and recreation.

Negative impacts on the beaches and other aspects of California's environment could impact tourism. As mentioned above, the State Water Resources Control Board (2010) suggests that the pre-production plastic discharges pose a threat to California's environment, which is an important part of California's $46-billion dollar ocean dependent, tourism economy.

3.4.15. Transportation/Traffic

Transport of materials and bags adds to the total GHG emissions associated with the bag life cycle (see the air quality discussion above). However, a shift in bag use is unlikely to have any discernible effect on traffic at a local level. In anticipation of regulating the use of plastic bags within Palo Alto, the city determined that short-term additional truck trips needed to transport more paper bags would be approximately one additional truck trip within the city per day.[97] More research is needed to determine the precise number of additional truck trips that may be generated at a local level as a result of delivering new bags to grocery stores.

3.4.16. Utility, Energy, and Service Systems

This impact area is important from a broad perspective, because the energy associated with production and disposal of each bag type varies substantially. However, because energy needs are dependent on fuel source, material components, technology, and location (including transport), the following discussion of previous LCA results may have little direct local impact.

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95 Ocean Conservancy (2009).

96 UNEP (2009).

97 City of Palo Alto (2009).

Boustead Associates (2007) performed an LCA comparing a conventional polyethylene plastic bag, a compostable plastic bag, and a paper grocery bag made of at least 30% recycled content fibers. Based on a carrying capacity equivalent to 1000 paper bags,[98] the authors determined that conventional plastic bags consumed 763 megajoules (MJ) of energy in manufacture, while paper consumed 2622 MJ, and compostable plastic consumed 2070 MJ.[99] One MJ is the equivalent of approximately 0.278 kilowatts (e.g., 100 MJ equals 27.8 KW).

The Carrefour LCA, conducted by Ecobilan in 2004, compared HDPE plastic bags with reusable LDPE plastic bags and paper bags, assuming that all bags are landfilled at disposal. When used only once, reusable LDPE plastic bags require 2.8 times the nonrenewable primary energy consumption of HDPE plastic bags, while paper bags require 1.1 times the consumption. However, if a reusable LDPE bag is used 4 times, while an HDPE plastic bag is used once, the impact per reusable LDPE bag use is only 0.7 that of an HDPE plastic bag.[100] The Hyder Consulting study conducted in Australia found that annual energy savings per household associated with a shift from single-use to reusable bags could be greater than 190 MJ.[101]

The 1990 study conducted by Franklin Associates also looked at the energy requirements of plastic and paper bags. The study assumed a two-to-one ratio of HDPE plastic bag to paper bag use, and examined varying levels of recycling. At a zero percent recycling rate for both paper and plastic, the energy requirements for HDPE plastic bags were 20-40% less than for paper grocery bags. The energy requirements became equivalent at approximately 0% plastic recycling and 50% paper recycling, or at approximately a 90% recycling rate for both bags. Similarly, Fenton (1991) compared the results of five studies on grocery bags from 1974 to 1990 and determined that reusable bags are less energy-intensive than single-use bags, and that plastic single-use bags are less energy-intensive than paper bags.[102] Due to the age of both the Franklin Associates and Fenton studies, their results may not be relevant today as technology for both manufacture and disposal have changed significantly.

According to DiGregorio (2009), the use of Mirel bioplastic results in more than 95% less nonrenewable energy consumption than the use of petroleum-based plastics.[103] These findings corroborate those of Murphy (2004), which showed that significant energy savings result from the production of biodegradable polymers compared to petrochemical polymers in the cradle-to-factory-gateportion of the life cycle.[104]

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98 Boustead Associates (2007) assumed that 1500 plastic bags would have an equivalent carrying capacity of 1000 paper bags.

99 Boustead Associates (2007).

100 Ecobilan (2004).

101 Hyder Consulting (2007).

102 Fenton (1991).

103 Kim and Dale, 2008, as cited in DiGregorio (2009).

104 Biodegradable polymers studied include: 100% thermoplastic starch, thermoplastic starch plus 60% polycaprolactone, and polylactic acid. Murphy (2004).

3.4.17. Other Impact Areas

Hygiene

Hygiene associated with reusable bag use has been raised as a concern by the plastic bag industry. Part of the appeal of plastic bags is their cleanliness. Once food has contaminated them, they are usually disposed of. Paper bags are not waterproof, so they are less effective at preventing food contamination of surfaces. However, like single-use plastic bags, they are usually disposed of once contaminated. In contrast, food residue on reusable bags may lead to the growth of mold or harbor bacteria, which in turn may come in contact with other foods. This concern is mostly associated with reusable plastic bags; reusable cloth bags – commonly used in California – are more durable and are routinely tossed into the laundry for cleaning.

The Environment and Plastics Industry Council (EPIC), a standing committee of the Canadian Plastics Industry Association, examined the cleanliness of reusable bags in Canada. The study tested 24 reusable plastic bags obtained from shoppers and ranging in age from 1 month to 3 years. Although not explicitly noted, it appears that none of the bags were cloth bags. An open question is whether the results of this study would be repeated if reusable cloth bags were tested. The plastic bags in this study were tested for 'total plate count', total coliforms, *Escherichia coli* (*E. coli*), *Salmonella*, mold, and yeast. Results suggest that a number of the tested bags had become breeding grounds for yeast and mold; 64% showed some level of bacterial contamination; almost 30% had bacterial counts higher than those considered safe for drinking water; mold was present in 6 of the bags; a few bags had an unacceptable total coliform count (these particular bags had been in use for from 1-3 years); but no E. coli or salmonella was present.[105] EPIC notes that although these bags in theory can be cleaned, it is difficult to thoroughly dry them without first encouraging microbial growth. Furthermore, their flimsiness deters scrubbing.

No studies were found that examine the hygiene of reusing single-use plastic bags. Anecdotal evidence indicates that single-use plastic bags are reused as domestic waste basket liners, as lunch bags or similar carrying functions, and as temporary containers for pet wastes collected during outdoor walks (then directly disposed of in the household garbage can). When a plastic bag that originally carried meat or other groceries that can leave residues that may lead to the growth of mold or harbor bacteria is subsequently used to carry food, there may be the potential for hygiene problems. However, the health effects of this use, if any, are unknown.

Solid Waste

Solid waste production from bag manufacture and disposal is generally considered higher for paper bags than for plastic bags. The Ecobilan study (2004) indicates that solid waste production is 2.7 times greater, by weight, for paper bags than for HDPE plastic bags.[106] Similarly, an LDPE plastic bag used only once creates 2.8 times, by weight, the solid waste of an HDPE plastic bag. When used at least twice, reusable bags created less solid waste per use than the single-use plastic, paper and biodegradable bags. However, these results

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105 EPIC (2009).

106 Ecobilan (2004).

must be treated with caution, as the Ecobilan study assumes that all bags are landfilled at disposal. In reality, over 20% of paper bags are recycled (and many bags have significant post-consumer recycled paper content, as discussed earlier), which would reduce solid waste production significantly, while only about 5% of HDPE plastic bags are recycled. In fact, as noted above, some counties in California boast a paper bag recycling rate on the order of 60-80%.[107]

The Boustead Consulting study (2007) assumes that paper bags can hold the same quantity of groceries as 1.5 plastic bags, and suggests that the production of municipal solid waste associated with paper bags is almost 5 times that, by weight, of HDPE plastic bags. It concluded that compostable plastic bags produce almost 3 times the solid waste of HDPE plastic bags.

An earlier study by Franklin Associates (1990) reached similar findings, suggesting that plastic bags contribute 74-80% less solid waste, by weight, than paper grocery bags at zero percent recycling, and the landfill volume occupied by plastic bags is 70-80% less than the volume occupied by paper bags, assuming equivalent uses.[108] In this study, solid waste includes ash from energy generation and incineration and post-consumer solid wastes. Franklin Associates' landfill volume estimates do not reflect the higher rate of recycling paper than plastic bags.

3.4.18. General Bag Comparisons

A few LCAs or studies that reviewed previous LCAs provided comparisons of bags that are more easily summarized by study rather than by impact area.

Patel et al (2003) reviews twenty LCAs using a functional unit of 1 kg of bag material. The report examines non-renewable energy, GHG emissions, ozone precursors, acidification, and eutrophication. The authors conclude that in spite of some uncertainties and information gaps, the LCAs indicate that biodegradable polymers can "make significant contributions to reducing environmental impacts and contribute to sustainability compared to their petrochemical alternatives." When composting is used as the waste management alternative, this is especially true. Starch polymers performed better than other bio-based polymers and natural fibers under available technologies.[109]

Cadman et al (2005) analyzed the impacts of plastic, paper, and reusable bags in Scotland. Results indicated that either switching away from plastic or switching away from both plastic and paper single-use bags would decrease consumption of non-renewable energy, atmospheric acidification, and ground level ozone formation. In addition to these benefits, switching away from both plastic and paper will also result in reduced water consumption, GHG emissions, and water eutrophication.[110]

Novamont performed an LCA based in Switzerland, comparing the environmental impacts of disposable bags made of Mater-Bi with typical disposable paper and HDPE plastic bags.

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107 StopWaste. 2010. Comments on MEA draft.

108 Franklin Associates. 1990. Life Cycle Assessment of Paper and Plastic Bags. As reported in FRIDGE (2002).

109 Patel et al. (2003).

110 Cadman et al. (2005).

Using a functional unit of a single bag, the study concluded that paper bags consume much more energy than corresponding bags made of Mater-Bi or PE because of their greater weight. In addition, when organic waste is composted, the bag containing the waste often is composted with the waste. If non-compostable plastic bags are used in this role, any organic waste stuck to these bags will not be composted. If this impact is considered, Mater-Bi bags are environmentally superior to HDPE plastic bags. Impact categories considered in this full LCA include energy consumption, GHG emissions, acidification, nitrification, ozone formation, toxicity in air and water, salification, and waste production.

Because this LCA is based in Switzerland, it is not directly relevant to bag use in California. In addition, a comparison of bags using a functional unit of one bag can be misleading, as bags made of different materials have different sizes, material use, and carrying capacity.

4. Effects of Policy Options on Bag Consumption

The consumption of grocery bags can be influenced by different policy options, which can take form as economic instruments (e.g., fees, taxes, rebates), regulations (e.g., bans), or social marketing campaigns (e.g., education). These policy options have been implemented in regions throughout the developing and developed world. Educational efforts include informing consumers about the environmental impacts associated with single-use bags, encouraging a switch to reusables through increased availability, and instructing baggers to use fewer bags for a given quantity of groceries. However, Herrera et al. (2008) opines that although education may result in some shifts in consumer behavior, those changes will be minor unless accompanied by a fee or ban.[111]

In California, AB 2449 restricts the ability of municipalities to impose a fee on single-use plastic bags. So, with limited exceptions, a fee is not a feasible option for California cities and counties seeking to limit single-use plastic bags, although placing fees on other single-use bags is an option. Fees have been used in a number of places outside of California, and some of their general experiences are related below.

Any fee placed on the bags must be large enough to influence consumer choices, while remaining politically acceptable. A minimal fee of 0.7 cents per bag in Italy had little or no effect on consumer behavior.[112] At the same time, a survey of Seattle consumers found that 70% of respondents stated that they would be unwilling to pay a fee of more than 10 cents per bag (and thereafter overturned the City's bag fee).[113] Education, though not sufficient by itself, is a necessary component of any economic instrument aimed to reduce bag consumption.[114] Many UK retailers have experimented with varying fees per bag. IKEA found that a 10 pence (~ 15 US cents in 2010) charge on all single-use bags resulted in a

[111] Herrera et al. (2008).

[112] Herrera et al. (2008).

[113] Herrera et al. (2008).

[114] Herrera et al. (2008).

95% drop in consumption, whereas Marks & Spencer realized an 80% drop in consumption after implementing a 5 pence (~ 7 US cents in 2010) charge.[115]

In addition, a number of countries have implemented industry voluntary programs to reduce plastic bag consumption. For instance, the Australian Retailers' Association developed a Code of Practice for the Management of Plastic Bags in 2003, which aimed to reduce plastic bag use by 50% in 2005. This program has been somewhat successful, as Australian plastic bag use dropped 34.2% from 2002 to 2005.[116] Similarly, the UK recently developed its own industry partnership which has successfully reduced the environmental impact of carrier bags by 40% since 2006, as of February 2009.[117] This MEA summarizes the conclusions from existing studies that evaluated the effects of fees and bans on single-use grocery bags.

The underlying principle for reducing the consumption of single-use bags is that doing so will also reduce the negative externalities to society that result from single-use bags. Externalities occur when the market does not consider the impacts of an economic activity on society. In the case of single-use bags, negative externalities include the environmental impacts associated with their manufacturing and end-of-life fate. The use of fees or bans can reduce those environmental impacts by reducing the use of these bags.

Multiple economic and environmental assessments of fees and bans have been published over the years and are useful in the current analysis. However, each study is region- and year- specific. For example, a study conducted ten years ago would likely assume a greater shift from plastic bags to paper bags, whereas a more recent study would likely predict a shift from plastic to some paper but also largely to reusable bags. Similarly, biodegradable bags are more widely available now than in years past. Finally, since consumer education plays a large role in the success of these policy measures, the geographic location of each study is important.

4.1. Economic Instruments

Ideally any discussion of economic instruments, fees being one of them, needs to be evaluated in a local context, since local variables such as income, age, educational attainment, and ethnic background could have a strong effect on how economic instruments affect the consumption of single-use bags.

Studies evaluating the effects of fees on the consumption of single-use bags take either a qualitative or quantitative approach. Qualitative studies focus on the general effectiveness of fees, and sometimes on best practices to set the level of a fee accordingly, the way it should be implemented and marketed, or on the unintended consequences of fees such as increased consumption of other types of bags or equity concerns. Quantitative studies typically rely on the price elasticity of demand, which is the ratio between the percentage change of quantity demanded by the percentage change in price of a given commodity.

115 AEA Technology (2009).

116 Hyder Consulting (2006).

117 AEA Technology (2009).

4.1.1. Republic of Ireland

Ireland introduced a point-of-sale levy on plastic shopping bags in 2002, although the levy does not apply smaller produce bags. Stores were required to charge customers approximately 21 US cents per bag, itemized on the bill. Interestingly, this levy was set much higher than the expected maximum willingness to pay.[118] This "PlasTax" is meant to fund waste management and anti-litter programs, and public education is an important component of this effort.[119] Since the tax's enactment, there has been a greater than 90% reduction in retailer purchases of plastic bags, a substantial increase in the sale of reusable bags, reduced littering and improved landscape effects.[120] Before the tax was implemented, plastic bag litter accounted for 5% of national litter composition. In 2003, that percent fell to 0.32%, and in 2004, it was 0.22%.[121] The use of garbage bags has increased but not on a scale comparable to the decrease in shopping bags. The levy has been embraced by consumers, retailers, and government, and entails minimal administrative costs. In fact, associated costs amount to approximately 3% of revenues.[122] In recent years, use of plastic bags has crept up slowly, as indicated by larger tax receipts (up 46% since 2003). To control the increasing use of plastic bags, the Irish government increased the levy from approximately 21 to 31 US cents.[123] Even with the slight rise in plastic bag usage in 2006, overall use is still far lower than pre-levy (91% below pre-levy levels).[124]

4.1.2. Australia

In Australia, plastic bag usage has been an important issue since 2002. No nationwide system has been adopted, although a number of policies have been proposed. For instance, Victoria proposed a trial 10 cent levy on HDPE bags and South Australia proposed a ban on thin HDPE bags. The trial levy had immediate positive effects, with a 79% reduction in plastic bag use.

4.1.3. Scotland

In Scotland, a bill similar to the Irish PlasTax was introduced in 2005 but eventually withdrawn in 2006. Cadman et al. (2005) conducted an extended impact assessment of the proposed tax, and found that a levy of 10 pence (~15 US cents in 2010) on plastic and paper bags would result in a 90% reduction in plastic bag usage with some shift to paper bags. Without a similar tax on paper bags, there would be a slight increase in waste, assuming a 25% increase in paper bag usage. However, McDonnell and Convery (2008) point out that the assumption of a significant shift from plastic to paper bags is undocumented and seems unreasonable given the Irish experience.[125] Other assumptions about future job losses as a result of reduced plastic bag manufacture run contrary to the

118 McDonnell and Convery (2008).

119 Convery et al. (2006).

120 McDonnell and Convery (2008).

121 McDonnell and Convery (2008).

122 McDonnell and Convery (2008).

123 McDonnell and Convery (2008).

124 McDonnell and Convery (2008).

125 McDonnell and Convery (2008).

Irish experience as well.[126] Friends of the Earth (2006) also disagreed with the results of the Cadman et al (2005) study.[127] They argued that the study did not adequately consider the effect of behavior change that would result in greater reuse of bags. They also pointed to the rate of substitution of paper bags and concluded that in fact a levy would produce a net and quantifiable environmental benefit, similar to the Irish experience.[128] Both McDonnell and Convery (2008) and Friends of the Earth (2006) suggest that the Irish experience should be relied upon more to predict the impacts of a fee in Scotland; in particular, Ireland's result of a limited switch from plastic to paper.[129]

4.1.4. South Africa

South Africa has placed a modest levy on the manufacturers of plastic bags and banned bags below a certain thickness.[130] Revenue is passed to an organization that emphasizes plastic bag recycling. Consumers pay the levy at each purchase, as it is itemized in their bills. In theory, this measure reduces litter while avoiding job loss from reduced plastic bag manufacture.

4.1.5. United States

Seattle, Washington's City Council adopted a 20 cent fee on paper and plastic shopping bags in August, 2008. The purpose of the fee was to reduce use of single-use grocery bags and the associated litter. The fee was subsequently rejected by voters in a referendum in February 2009 and did not take effect.

In addition, the City Council of Washington, D.C. voted unanimously in June, 2009, to ban the use of single-use non-recyclable plastic retail bags and establish a five cent fee for all other single-use bags. The fee and ban went into effect on January 1, 2010.

Within California, many cities and counties have considered implementing fees on single-use bags. San Francisco enacted an ordinance in 2004 requiring a 17 cent fee on each plastic grocery bag provided at supermarket. However, this resolution was nullified by AB 2449. In response, San Francisco banned HDPE plastic bags in 2007. Herrera et al. (2008) noted the fee's benefits of litter reduction, reduced threats to marine life, and significant climate benefits. Cons of the measure include industry opposition from the California Grocers Association and the American Plastics Council, costs are passed on to the consumers, the measure's incompatibility with the existing recycling programs, potential effects on customer convenience, and the possibility of transferring business to surrounding communities.

4.1.6. Lessons for California

Many lessons applicable to California can be taken from these policy measures. Fees can be introduced upstream (to producers, etc), or downstream (to consumers). Although the

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126 McDonnell and Convery (2008).

127 Friends of the Earth (2006).

128 Friends of the Earth (2006).

129 Friends of the Earth (2006).

130 Herrera et al (2008); McDonnell and Convery (2008).

former are easier to implement, they are less effective at reducing plastic bag consumption, as they do not directly address consumer behavior.[131] Rather, consumers should be aware of the additional fees per bag so that they will change their behavior.[132] Fees that are directly passed onto consumers have been effective at altering behavior[133]. However, if these fees apply only to one type of bag, they will likely lead consumers to switch to other disposable bags or more prepackaged goods.[134]

In California, due to AB 2449 no fee can be placed on single-use HDPE plastic grocery bags. Examples of plastic bag fees therefore have limited relevance. However, an agency could legally implement a fee on other single-use bags. Consequently, studies of the efficacy of this economic instrument may still be qualitatively relevant to California.

Multiple studies have assessed the value of fees on single-use bags. Herrera et al. (2008) was undertaken for the City of Seattle to examine a range of policy options to reduce disposable grocery bag use, may be the most relevant to California. This study examined the 30-year impact of multiple policy options for reducing disposable shopping bag use, including enhanced education, a combination of education and ban on disposable plastic shopping bags, education and a mandatory advanced recovery fee of approximately 10-25 cents on disposable plastic shopping bags, and education and an advanced recovery fee of approximately 10-25 cents on all disposable shopping bags. The study assumed that education efforts alone would only result in a 5% shift away from plastic bags. A 15 cent fee on plastic bags would result in a shift from 100% plastic bags to 35% plastic bags, 21% paper, and 37% reusable bags, with a 7% reduction in bag use. Finally, a fee on both paper and plastic would shift bag use from 100% plastic to 35% plastic, 0% paper 52% reusable bags, and a 13% reduction in bag use.[135]

The Herrera study suggests that all three regulatory options would result in significant environmental benefits. A ban on plastic would result in more than 60% reductions of impacts to litter aesthetics and marine diversity, and significantly reduced environmental impacts from non-renewable energy, GHG emissions, resource depletion, and shopping bag waste.[136] However, eutrophication would increase slightly. A fee placed on plastic or plastic and paper bags would result in a 50% reduction in impacts of litter aesthetics and marine diversity. Although both scenarios would result in other significant environmental benefits, the fee on both plastic and paper would lead to greater than 50% reductions in non-renewable energy, GHG Emissions, resource depletion, eutrophication, and shopping bag waste generation.

The Herrera study also evaluated the economic impact of these options. A fee on plastic bags would result in costs to consumers and the region, while the City and retailers would experience gains. A fee on all disposable shopping bags would result in slightly lower costs

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131 Herrera et al. (2008); McDonnell and Convery (2008).

132 Herrera et al. (2008).

133 Herrera et al. (2008). ExcelPlas Australia (2004).

134 GHK (2007), as reported in Herrera et al. (2008).

135 Herrera et al. (2008).

136 Herrera et al. (2008).

to consumers due to increased use of reusable bags, significantly higher costs to the region due to decreased paper production, and gains for both the City and retailers.[137]

4.2. Ban Options

Bans, like economic instruments, are ideally evaluated in a local context since local variables such as demographics and economic and social environments could have a strong effect on how consumers respond to bans.

Banning one type of bag may not simply decrease the consumption of that bag type. Rather, consumers will likely switch to other types of bags to carry their groceries. A major consideration of plastic bag bans is that consumers will switch to paper bags, which have a greater environmental impact in multiple areas. Although such a ban would directly reduce the litter problem associated with plastic single-use bags, it could intensify other environmental impacts.

Worldwide, a few countries and regions have implemented various types of bans on single-use grocery bags. For instance, Bangladesh introduced a ban on the manufacture and use of plastic bags in 2002.[138] In Tasmania, the town of Coles Bay has banned the use of plastic bags in all retail outlets, including supermarkets, since 2003, and received widespread support.[139] The government of South Australia recently banned all lightweight checkout plastic bags, in effect as of May, 2009.[140] Perceived impacts of the ban include reduced litter and/or landfill, saved resources, and reduced negative impacts on waterways and marine life.[141]

Many cities within California have already prepared bans on plastic grocery bags. Only three, however, have implemented those bans. The City and County of San Francisco implemented a ban on plastic grocery bags in 2007. No comprehensive studies have been conducted to determine the ban's efficacy, however. In addition, the voters of the Town of Fairfax in Marin County enacted a ballot initiative in May 2009 that bans the use of plastic bags at retail stores and restaurants. And in July 2009, the City of Palo Alto settled out of court by agreeing not to expand their plastic bag ban beyond grocery stores until they have prepared an Environmental Impact Report.

All other bans proposed by cities have resulted in legal challenges over their potential environmental effects and have not been implemented.[142]

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137 Costs were calculated over a 30 year time frame, using a 3% discount rate.

138 HDR Engineering, Inc. (2008).

139 http://plasticbags.planetark.org/case-studies/colesbay.cfm

140 http://www.byobags.com.au/About.mvc/RetailerWhatToDo/82

141 Ehrenberg-Bass (2009).

142 These jurisdictions, in which single-use bag ordinances have been developed but not implemented due to legal challenges or the threat of challenges, include: Berkeley, City of Los Angeles, Los Angeles County, Malibu, Manhattan Beach, Oakland, San Diego, San Jose, Santa Monica, and Santa Clara County.

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Appendix B. CEQA Guidelines MEA Provisions

CEQA Guidelines Section 15169 establishes the broad requirements for the content and preparation of MEAs. The provisions of this section are as follows:

(a) General. A public agency may prepare an MEA, inventory, or database for all, or a portion of, the territory subject to its control in order to provide information which may be used or referenced in EIRs or Negative Declarations. Neither the content, the format, nor the procedures to be used to develop an MEA are prescribed by these Guidelines. The descriptions contained in this section are advisory. An MEA is suggested solely as an approach to identify and organize environmental information for a region or area of the state.

(b) Contents. An MEA may contain an inventory of the physical and biological characteristics of the area for which it is prepared and may contain such additional data and information as the public agency determines is useful or necessary to describe environmental characteristics of the area. It may include identification of existing levels of quality and supply of air and water, capacities and levels of use of existing services and facilities, and generalized incremental effects of different categories of development projects by type, scale, and location.

(c) Preparation

1. An MEA or inventory may be prepared in many possible ways. For example, an MEA may be prepared as a special, comprehensive study of the area involved, as part of the EIR on a general plan, or as a database accumulated by indexing EIRs prepared for individual projects or programs in the area involved;
2. The information contained in an MEA should be reviewed periodically and revised as needed so that it is accurate and current;
3. When advantageous to do so, MEAs may be prepared through a joint exercise of powers agreement with neighboring local agencies or with the assistance of the appropriate Council of Governments.

(d) Uses

1. An MEA can identify the environmental characteristics and constraints of an area. This information can be used to influence the design and location of individual projects;
2. An MEA may provide information agencies can use in initial studies to decide whether certain environmental effects are likely to occur and whether certain effects will be significant;
3. An MEA can provide a central source of current information for use in preparing individual EIRs and Negative Declarations;
4. Relevant portions of an MEA can be referenced and summarized in EIRs and Negative Declarations;

5. An MEA can assist in identifying long range, areawide, and cumulative impacts of individual projects proposed in the area covered by the assessment;

6. An MEA can assist a city or county in formulating a general plan or any element of such a plan by identifying environmental characteristics and constraints that need to be addressed in the general plan;

7. An MEA can serve as a reference document to assist public agencies which review other environmental documents dealing with activities in the area covered by the assessment. The public agency preparing the assessment should forward a completed copy to each agency which will review projects in the area.

Appendix C. Detailed Description of Referenced Life-Cycle Analyses

Franklin and Associates, Ltd. 1990. Resource and Environmental Profile Analysis of Polyethylene and Unbleached Paper Grocery Sacks. Franklin Associates, Prairie Village, Kansas, 1990.

This cradle-to-grave LCA compares the environmental impacts of the production, use, and disposal of plastic and paper bags. Indicators examined include: energy, solid waste emissions, atmospheric emissions, and waterborne wastes. Volume and weight capacity were incorporated into the study (comparing two plastic bags to one paper), as were varying degrees of recycling rates. The bag preference was dependent on rates of recycling of each type of bag. Paper bags create significantly higher waterborne waste and atmospheric waste. Increasing recycling rates of both plastic and paper bags would reduce the energy difference between the production of the two types of bags because the recycling energy savings occur at a greater rate for paper than for polyethylene. Reducing the 2-to-1 ratio of number of plastic bags to number of paper bags used would increase the energy savings for plastic bags."

Functional unit: 10,000 bags

Limitations: The age of this study limits its relevance as technology, alternative types of bags, environmental data, raw material and energy sources, consumer practices and disposal routes have changed significantly.

Fenton, R. 1991. The Winnipeg Packaging Project: Comparison of Grocery Bags. Department of Economics, University of Winnipeg, Manitoba, Canada. 1991.

This report compares five studies on grocery bags between 1974 and 1990, comparing reuse, recycling, and disposal for four different types of bags (permanent, multi-trip, plastic single-use, and paper single-use). The study compares the energy intensity of bags, and concludes that reusing grocery bags is the least energy-intensive alternative: reuse reduces the energy-intensity per trip more than recycling. Among the single-use bags, plastic bags are less energy-intensive than paper bags, as validated by five reports compared in this analysis.

Functional unit: 1 million "bag units" (23,000,000 liters of goods)

Limitations: Similar to the Franklin Associates (1990) study, this LCA has limited relevance due to its age.

Fund for Research into Industrial Development, Growth and Equity (FRIDGE). [2002]. "Socio-Economic Impact of the Proposed Plastic Bag Regulations."

This study compares the Franklin Associates (1990) LCA and an Independent Swedish Environmental Consulting Group 2000 study, and provides a detailed review of the Franklin Associates LCA.

Limitations: This study has limited relevance because of its focus on South Africa, age, and heavy reliance on the Swedish report, which examined paper and plastic animal feed distribution sacks in Europe.

Environment Australia. 2002. Plastic Shopping Bags – Analysis of Levies and Environmental Impacts. Prepared by NOLAN-ITU Pty. Ltd.

This study reviews tax and levy systems in other countries, provides a full streamlined LCA, and conducts a triple bottom line assessment. The analysis examines disposable HDPE shopping bags, disposable 50% recycled HDPE shopping bags, boutique LDPE shopping bags, Coles Calico shopping bags, woven HDPE reusable shopping bags, reusable polypropylene (PP) fiber shopping bags, disposable kraft paper shopping bags, reusable solid PP smart boxes, reusable LDPE shopping bags, biodegradable starch-based shopping bags, and biodegradable PE shopping bags with prodegradant additives. Indicators assessed include: material consumption, litter, GHG emissions, and primary energy use. The study concludes that a shift from disposable plastic to reusable bags would result in the greatest environmental benefits. The reusable heavy duty plastic bags resulted in the largest benefits.

Functional unit: The number of bags necessary for a household to carry approximately 70 grocery items home from a supermarket each week for 52 weeks.

Limitations: The study examines litter caused by disposable plastic bags, but there is no data to discuss other environmental issues such as acidification, eutrophication, ozone, or human toxicity. The results of the study are dependent on the particular reuse and disposal assumptions made within the analysis.

Patel, M., C. Bastioli, K. Marini, E. Wurdinger. 2003. Environmental Assessment of Bio-Based Polymers and Natural Fibres.

This report reviews twenty LCAs and examines various bio-based polymers and natural fibers using the following indicators: non-renewable energy, GHG emissions, ozone precursors, acidification, and eutrophication. The study concludes that use of biodegradable polymers can significantly reduce environmental impacts associated with bag production, use, and disposal, particularly when composting is the disposal option. Starch polymers had the best results in terms of the environmental indicators mentioned above, under current technology.

Functional unit: 1 kg of material

Limitations: Age of the study limits its relevance.

ExcelPlas Australia, Centre for Design at RMIT, and NOLAN-ITU. 2004. The Impacts of Degradable Plastic Bags in Australia.

This report expands on the earlier Environment Australia report (2002), placing added emphasis on marine litter impacts. The report concludes that reusable bags have lower environmental impacts than all of the single-use bags. Degradable bags have similar GHG impacts to conventional HDPE bags, and may create much higher eutrophication from farming activity. Conventional HDPE bags result in greater abiotic depletion. Benefits of degradable bags lie in their faster degradation in the litter. However, these rates are still unclear.

Functional unit: The number of bags necessary for a household to carry approximately 70 grocery items home from a supermarket each week for 52 weeks.

Limitations: The results of the study are dependent on the particular reuse and disposal assumptions and bag weight and relative capacity assumptions made within the analysis.

Ecobilan. 2004. Environmental impact assessment of Carrefour bags. Report prepared for Carrefour by Ecobilan, February 2004.

This study focuses on disposable polyethylene shopping bags, disposable paper shopping bags, disposable biodegradable bags, and a reusable PE bag. The report concludes that for all indicators, reusable PE bags are better than single-use bags, if used at least four times. Single-use PE bags are better than other single-use bags in all environmental impact areas except for littering. Paper bags consume about the same amount of energy, create similar amounts of photochemical oxidants, consume three times the amount of water, create 90% more GHG emissions, create 80% more nitrogen oxide and sulfur dioxide emissions, create twelve times the level of eutrophication, and result in 80% more solid waste. However, in the litter category, paper bags performed better than plastic HDPE bags.

Functional unit: 9,000 liters of goods, estimated to be a typical annual purchase volume in France.

Limitations: This study is particular to French stores. Therefore, assumptions about travel distance, fuel type, technology use, bag demand and disposal choices may limit its relevance to California.

EuroCommerce. 2004. The use of LCAs on plastic bags in an IPP context. Prepared by C. Marlet. September 2004.

This report provides a detailed review of Ecobilan (2004), Environment Australia (2002), Ireland Consultancy Study (1999), Mater-Bi Bags LCA (1996), and Franklin Associates (1990). Based on this review, the study concludes that significant environmental benefits can be achieved by switching from single-use plastic bags to more durable reusable bags, particularly those with a long usable life. Little or negative gain would be derived from a switch from plastic single-use bags to biodegradable or paper bags, with “potential litter gains offset by negative resource use, energy and greenhouse outcomes.”

Functional unit: NA.

Limitations: This report’s relevance lies in its comprehensive review of previous studies.

Cadman, J., S. Evans, M. Holland, and R. Boyd. 2005. Proposed Plastic Bag Levy – Extended Impact Assessment Final Report. Prepared for Scottish Executive 2005.

This study provides an LCA to evaluate the impacts of a proposed plastic bag levy in Scotland. Using information from the Ireland 'PlasTax' and the experience in Australia, the report examines four levy scenarios. The analysis concludes that there would be an environmental benefit for some of the indicators depending on consumer choice of plastic bag alternatives. In all scenarios where the levy is applied (just on plastic bags or on both plastic and paper bags), consumption of non-renewable energy, atmospheric acidification and formation of ground level ozone, and the risk of litter would be considerably less than the current situation. Higher environmental benefits are realized when the levy applies to both paper and plastic; in addition there are reduced impacts in terms of consumption of water, emissions of GHGs, and eutrophication of water bodies. A switch to paper bags could result in an increase in solid waste generation.

Functional unit: This report looks at the number of bags required per year, estimating individual bag weight so that each bag has an equal carrying capacity.

Limitations: The results of the study are dependent on the particular reuse and disposal assumptions and bag weight and relative capacity assumptions made within the analysis.

James and Grant. 2005. LCA of compostable plastic bags. Centre for Design, Melbourne Institute of Technology.

This report expands on ExcelPlas (2004), examining the environmental impacts of the various types of degradable bags compared to conventional alternatives. The report presents background information on the types of degradable polymers, and summarizes the results of the ExcelPlas (2004) streamlined LCA that compared degradable polymers and alternative materials such as HDPE, LDPE, kraft paper, and calico. Indicators examined include: material consumption, GHG emissions, abiotic depletion, eutrophication, litter marine biodiversity impacts, and litter aesthetics impacts for twelve different bags. The woven HDPE bag results in the lowest litter marine biodiversity and litter aesthetics impacts, although the non-woven plastic durable bag has the greatest environmental benefits overall.

Functional unit: The number of bags necessary for a household to carry approximately 70 grocery items home from a supermarket each week for 52 weeks.

Limitations: The results of the study are dependent on the particular reuse and disposal assumptions and bag weight and relative capacity assumptions made within the analysis.

The ULS Report. 2007. Review of Life Cycle Data Relating to Disposable Compostable Biodegradable, and Reusable Grocery Bags.

This study reviews three previous LCAs, including, Ecobilan (2004), Boustead (2005), and Life Cycle Inventories for Packaging (1998). The report compares degradable polymers with conventional HDPE bags, paper bags, reusable plastic bags, and calico bags, and concludes that reusable bags have lower environmental impacts than all of the single-use bags. Degradable bags may reduce the visual impact of litter, but could interfere with plastic recycling. In sum, it is important to find ways to reduce the use of both plastic and paper single-use bags.

Functional unit: Not stated.

Limitations: The results of the study are dependent on assumptions based on European manufacturing data, which may not be relevant in California. In addition, limited documentation limits the credibility of the report.

Hyder Consulting. 2007. Comparison of existing life cycle analyses of plastic bag alternatives.

This study includes a streamlined LCA that is based on existing LCA data. It compares the environmental impacts of various shopping bag alternatives in Australia, including single-use plastic, paper and degradable bags, as well as reusable bags made of plastic and cloth. Indicators examined include: material consumption, GHG emissions, energy consumption, water use, litter marine biodiversity, and litter aesthetics. The report concludes that a substantial shift to more durable bags would deliver environmental gains through reductions in GHG emissions, energy and water use, resource depletion, and litter. The reusable, non-woven plastic 'Green Bag' achieves the greatest environmental benefits. No single-use bag is clearly a better environmental choice than any other, as benefits in one area are outweighed by greater impacts in another area. Finally, the end-of-life destination of these bags is important, as greater environmental savings are realized from recycling all bags.

Functional unit: The number of bags necessary for a household to carry approximately 70 grocery items home from a supermarket each week for 52 weeks.

Limitations: The results of the study are dependent on the particular reuse and disposal assumptions and bag weight and relative capacity assumptions made within the analysis.

Boustead Consulting and Associates Ltd. 2007. Life Cycle Assessment for Three Types of Grocery Bags – Recyclable Plastic; Compostable, Biodegradable Plastic; and Recycled, Recyclable Paper. Prepared for the Progressive Bag Alliance.

This LCA examines three types of grocery bags: a traditional grocery bag made from polyethylene, a grocery bag made from compostable plastics (65% EcoFlex, 10% PLA, 25% $CaCO_3$), and a paper grocery bag made using at least 30% recycled fibers. Every step of the manufacturing, distribution, and disposal stages is included in the analysis. The study found that polyethylene grocery bags use less energy in terms of fuels for manufacturing, less oil, and less potable water than paper bags. In addition, PE plastic grocery bags emit fewer GHG and acid rain emissions, and less solid waste. The same trend exists when comparing the typical PE grocery bag to grocery bags made with compostable plastic resins.

Functional unit: The capacity of the grocery bag to carry consumer purchases, assuming both a 1:1 and 1:1.5 paper-to-plastic carrying capacity.

Limitations: The results of the study are dependent on the particular reuse and disposal assumptions and bag weight and relative capacity assumptions made within the analysis. That said, the disposal assumptions are based on 2005 U.S. EPA data, and may closely reflect the situation in California. Assessment of bags on a 1:1 and 1:1.5 paper-to-plastic carrying capacity is questionable, as other studies have assumed that paper can hold many more items than plastic.

Herrera et al. 2008. Alternatives to Disposable Shopping Bags and Food Service Items Volume I and II. Prepared for Seattle Public Utilities. January 2008.

This report provides the city of Seattle with relevant information to inform policies being developed for disposable shopping bags. The report concludes that actions analyzed within the study will likely reduce environmentally adverse and socially undesirable implication of disposable plastics. The report provides a detailed summary of the major LCAs and synthesizes them to analyze the situation for Seattle. Conclusions include:

- Disposable plastic bags are a significant source of litter and affect both terrestrial and marine wildlife;
- Use of reusable bags instead of disposable shopping bags of all kinds provides substantial environmental benefits, and reduces unintended environmental impacts, including litter;
- All education on disposable shopping bag use should emphasize that no bag or an existing reusable bag is the preferred option, followed by a new reusable bag used for as long as possible, and finally recyclable plastic and paper bags reused often and then deposited in curbside or in-store recycling facilities;
- The use of biodegradable shopping bags may not lessen littering (ie, lightweight, disposable), but may degrade faster in the marine environment, lessening impacts. Their shorter persistence in the environment still has the potential to harm the marine ecosystem;
- The presence of biodegradable bags in the recycling stream could potentially jeopardize Seattle's plastic bag recycling program through contamination. Furthermore, any additional presence of petroleum plastic bags in the Cedar Grove composting system could also harm Seattle's composting program; experience and stakeholder input suggests that any strategy implemented for disposable shopping bags should address all disposable shopping bags (of all materials) at all retail outlets that provide them;
- The "free" status of disposable shopping bags provides no incentive for consumers to reduce their use; experience has shown that consumption of disposable bags will be reduced substantially at modest prices paid by the consumer (ACG 2006). A fee on all disposable shopping bags provides the most environmental gains (except for litter), and provides for much higher overall economic gains when compared to all strategies. With a fee on all bags, consumers experience slightly less costs than with a plastic only ARF (due to an anticipated increase in the use of reusable bags), and the region experiences additional economic cost (due to decreased paper production). Again, the City and potentially retailers both benefit from revenue under either a plastic only or all-bag fee.

Functional unit: Various, depending on the LCA reviewed.

Limitations: The results of the study are particular to Seattle. However, these results may be similar to those in California.

AEA Technology. 2009. Single Use Bag Study. Final report prepared for the Welsh Assembly Government August 2009.

This report reviews various reasons put forward for and against taking further action to control single use carrier bags. On balance it is concluded that there is a good logic and evidence for progressing with action to reduce bag use beyond the ambition level set by the existing voluntary agreement in the UK. The study also reviewed measures applied both in the UK and internationally, including outright banning plastic carrier bags, voluntary reduction schemes, public awareness raising. The Irish legislation, introducing a 0.15 pence charge per plastic bag offers a particularly attractive model. Finally, this study reviews previous LCAs and analyzes various environmental impacts of plastic bag use.

Functional unit: Various, depending on the LCA reviewed.

Limitations: This is the most recent LCA study. However, since it is based in the UK, it may have limited relevance to California.

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