

# CALIFORNIA TOBACCO PRODUCT WASTE ECONOMIC MODEL TOOLKIT



**Estimating the cost of tobacco product waste (TPW) for Cities and Counties**  
**Funded by the California Tobacco Prevention Program, Contract 20-10603**



**SDSU RESEARCH FOUNDATION**



**TPW**  
Environment  
Economics

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# Economic Model Toolkit

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# Introduction to the Toolkit

## What is tobacco product waste?

Tobacco product waste (TPW) consists of the trash and pollution associated with discarded and used tobacco products, including cigarette butts, packaging, chew cans, cigar wraps, snuff pouches, and discarded electronic smoking device (ESD) parts.



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# Introduction to the Toolkit, continued

- **What is this 'toolkit'?**
  - It is a process that communities can use to figure out how much TPW costs in terms of prevention, clean up, disposal, and long-term ecosystem impacts.
- **Who would use this toolkit?**
  - Local tobacco control advocacy organizations
  - City and county public health agencies
  - Academic partners of local public health agencies
- **How would this toolkit be used?**
  - To raise awareness of the economic costs (externalities) of tobacco product waste to governments, taxpayers, businesses, voluntary groups
  - To provide data that could support of economic interventions and policies to reduce tobacco product waste and use
  - Develop new partnerships among environmental and public health groups to address the adverse environmental impacts of tobacco use



# Introduction to the Toolkit, continued

- **What is required to use the toolkit?**

- **Data** from existing sources, mostly. These include:

- The cost of governmental or voluntary group prevention programs for TPW (signage, litter law enforcement for TPW, implementation and enforcement of outdoor smoking bans, etc.)
    - Overall costs of public-funded street cleaning, storm drain maintenance, wastewater maintenance, and specific TPW pickups
    - The number of person-hours provided by voluntary groups to pick up trash and quantification of that trash that is TPW
    - Costs incurred by businesses, schools, or other facilities for specific TPW prevention or cleanup activities

- **People** to commit time and energy to collect and analyze data

- Local government agency leaders and staff
    - Tobacco control coalition members
    - Nonprofit volunteer groups
    - Academic researchers



# Environmental Economics I: Key Terminology

[Click to open Key Terminology](#)

Economic Model – A simplified description of the costs incurred by the use of a commercial product, designed to yield information that can be used for policy development regarding that product.

Negative economic externality - A harmful effect to third parties not directly involved in a transaction, for which they are not compensated.

Cost Center – A unit of an organization or system that consumes resources but does not necessarily contribute to the productivity of that organization or system.

# Basic Elements of Tobacco Product Waste Costs



**Economic burden on government and businesses associated with prevention and abatement.**



**Economic and humanistic burden associated with ingestion, fires, and drinking water contamination.**



**Economic and ecosystem burdens associated with contamination of bodies of water, wetlands, beaches, and soil.**



# Environmental Economics II: Conceptual Basis for TPW Cost Model

There are three general approaches to establishing costs and nine main cost centers from which data may be available or estimated in order to establish an estimate of the community costs of TPW.

[Link to Conceptual Model](#)



# Three Approaches

## To Estimating the Economic Costs of TPW

### 1. Direct Approach

Estimate costs *specifically* incurred for TPW prevention and abatement through reports from public works, parks and recreation departments, other departments, and nongovernmental organizations.



### 2. Proportional Approach

Estimate TPW costs based on the *proportion* of all waste that is attributable to TPW. Assumes that the *total* cost estimates on prevention and abatement of general waste are available, including waste system costs.



### 3. Statistical Approach

Estimate TPW costs based on mathematical formulas incorporating survey data on tobacco use, demographic data, TPW cleanup data, and/or tobacco product sales data in a given community.



# Cost Centers: Five Broad Categories for Sources of TPW Costs

**1**

**Prevention and Enforcement**

**2**

**Surface Abatement:**  
Mechanical, manual,  
automated, private sector

**3**

**System Abatement:**  
Stormwater and  
wastewater systems

**4**

**Disposal:**  
Landfill and hazardous  
waste management

**5**

**Unmitigated Waste**



# 1. Prevention and Enforcement

Municipalities, cities, states, and countries maintain laws, rules, regulations, and programs governing the proper disposal of litter and waste. This costs money!

## PREVENTION COSTS



**Direct government administration and enforcement of any laws and regulations aimed at unlawful waste disposal.**



**Administration of anti-litter and anti-dumping information and education programs alongside enforcement efforts.**



**Communications and rules imposed by private entities designed to prevent or inhibit littering on or near private property.**



## 2. Surface Abatement

Surface abatement involves cleaning and physical removal of wastes.  
A certain proportion of this is TPW.

### Mechanical Street Sweeping

Regularly scheduled across most sectors of a city or municipality. Designed for larger areas that would be difficult to clean using manual methods.



### Manual Area Cleanup

Clean up using basic tools such as brooms, mops, and other handheld tools designed to pick up trash. Target areas include: public areas, parks, beaches, and bodies of water. Services can be carried out by government or private entities.



### Automated and Manual Cleaning

Designed for smaller areas: narrower roads, sidewalks, and parking areas. A mix of small, mechanized machines operated by humans and basic tools such as pressure washing with water or sweeping with dustpan and broom.



# 3. Systems Abatement

Management and removal of waste from stormwater collection and wastewater management systems. A certain proportion of this is TPW.



TPW accumulates in **stormwater** and **wastewater management systems**. Stormwater collection systems, including conduits, storm drains, and full capture devices, can capture TPW discarded on public areas and streets. Wastewater collection and treatment systems show contamination with TPW chemicals that may create costs for mitigation.



# 4. Disposal

TPW collected through proper means (e.g., cigarette butt receptacles, household waste) still results in costs.



After TPW is collected in quantity, toxic chemicals may qualify it as **hazardous waste**, which may invoke specialized handling rules. Especially relevant for the **nicotine** contained in discarded e-cigarettes and e-cigarette pods.



TPW disposed of in landfills have a cost. Landfill costs are **based on weight**, rather than volume, so landfill fees attributable to TPW would be **small but non-trivial**.

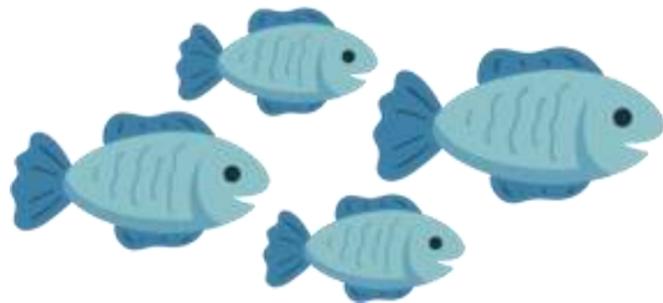


**Chemical leachates** from landfills can **contaminate** nearby soil, bodies of water, and groundwater (this becomes **unmitigated waste**).



# 5. Unmitigated Litter and Waste

This cost is unknown but non-trivial, with potentially significant, yet unknown, human health impacts.



Embedded/disbursed TPW can **harm ecosystem services**. Leached chemical **toxins and microplastics** may contaminate soil, water bodies, groundwater, potable water sources, and food sources, bringing harm to plant, animal, and human life over the **long term**.



Adverse impacts on ecosystems may result in **quality-of-life changes** and costs to health care systems as well as to businesses that depend on healthy ecosystems, such as **tourism, fisheries, and farming**.



# Public Costs: To Communities and Taxpayers

## Prevention

- Anti-litter signage
- Anti-litter campaigns
- Litter law enforcement
- Smoking ban signs and enforcement

## Waste Management

- Mechanical street sweeping
- Manual street & sidewalk cleaning
- Manual area clean up (parks, beaches, etc.)
- Management of hazardous waste
- Schoolyard cleanup costs and management of confiscated vapes
- Landfill yearly costs

## Stormwater Systems

- Structural unit costs
- Maintenance costs per year

## Wastewater Prevention

- Maintenance costs per year

# Private Costs: To Voluntary Groups, Businesses, Citizens

## Prevention

- Anti-litter campaigns
- Waste receptacles
- Signage
- Litter law enforcement
- Outdoor smoking ban enforcement

## Waste Management Costs

- Voluntary group manual cleanups in person-hours: parks, beaches, communities, schools
- Manual business cleanups in person-hours: restaurants, bars, medical facilities, convenience stores



# Data Sources to Estimate TPW Costs

- Data from **city/county sources** on total Waste Management, Stormwater Protection, Wastewater Management, Landfills, and TPW Prevention Costs
  - **Proportion** of total waste management, stormwater protection, wastewater management, and landfill systems that is TPW (See next slide)
- Data from **non-governmental organizations** on TPW-specific prevention and clean up costs (e.g., Surfrider, Sierra Club, etc.)
- Data from **businesses** on specific TPW prevention and clean up data (bars, restaurants, parking lots, etc.)



# Proportional Estimates of TPW for Cost Centers

- TPW proportion of *Storm Drain Cleanout*: 8-32%
  - Source: Keep America Beautiful and others
- TPW proportion of *total surface litter*: 20-34%
  - Source: Undo.org and <https://cte.sdsu.edu/>
- TPW proportion of voluntary cleanups: 12%
  - Source: Surfrider, Int. Coastal Cleanup Reports
- TPW Proportion landfill costs: 1%
  - Source: Just a guess
- TPW proportion of tobacco control program: 2%
  - Source: Local Lead Agency reports



# Example: Data Collection Spreadsheet

This can assist local agencies to provide available data or others searching for government data sources

Estimating total local-level costs of waste prevention, general waste cleanup, storm water protection, and waste water management		
	Total Estimated Cost	Data source
<b>Public Funding Cost Category</b>		
<b>Waste prevention costs</b>		
Anti-litter signage		
Anti-litter campaigns		
Litter law enforcement		
Outdoor smoking bans		
<b>Waste management costs</b>		
Mechanical street sweeping		
Manual street & sidewalk cleaning		
Manual area cleanup (parks, beaches, etc)		
Management of hazardous waste		
Other cleanup costs		
School cleanup costs		
Landfill yearly costs		
<b>Voluntary group cleanups (paid with public funds)</b>		
No. of person-hours per event		
<b>Stormwater systems costs</b>		
Structural BMP unit costs		
Number of BMP units (projected)		
Maintenance costs per year		
<b>Wastewater systems costs</b>		
Maintenance costs per year		



# Statistical Approach (Manual Cleanup Costs)

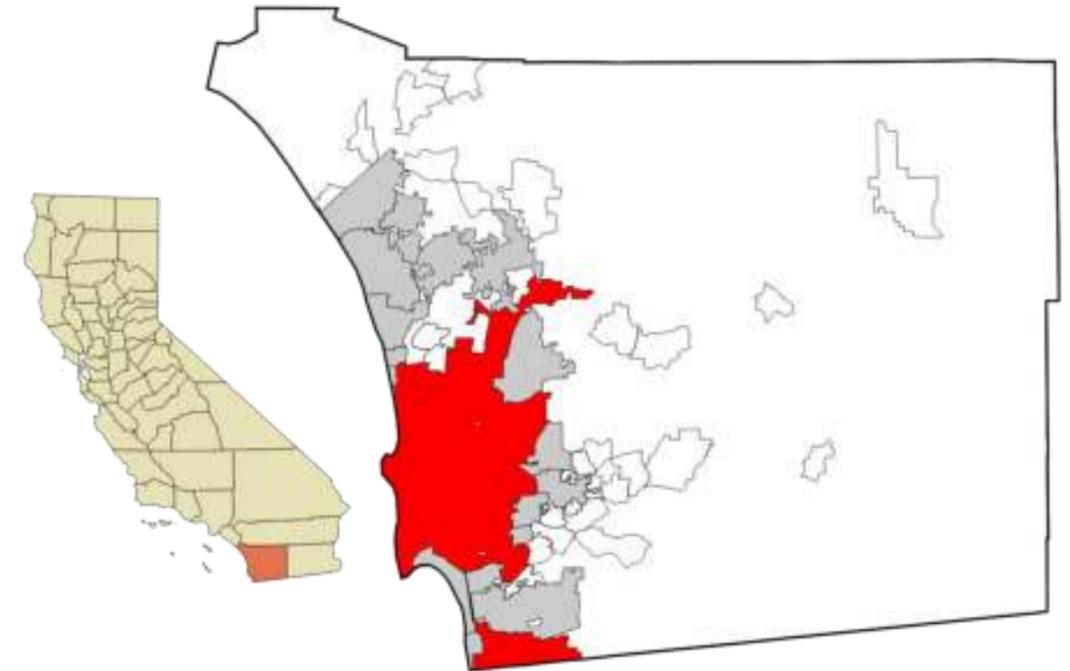
- **General approach:**
  - Research on manual TPW collection in eight cities of San Diego County provides a baseline quantification of all TPW collected in 60 US Census Tracts at a given point in time;
  - Model this TPW total with US Census data on age, sex, race, education, income;
  - Incorporate data on smoking prevalence from CDC or the state and land use;
  - Provides estimate of TPW burden for entire community.
  - Use the clean up effort required (person-time) and average hourly wage for the community to obtain total cost of a theoretical clean up.
- This is a proxy estimate that predicts the costs to manually pick up a city/county jurisdiction's TPW burden.
- ***See next slide to demonstrate statistical model***

# Statistical Approach: Estimating TPW Burden In San Diego County

We can predict the amount TPW at different Census blocks as follows:

$$TPW = f(\text{Gender; Age; Population Density; Land Area; Land Use; Ethnicity; Education; Income; Smoking Rate})$$

- TPW was collected from 60 representative US Census blocks (out of 29,000) in San Diego County (Shown in red)
- This allowed us to estimate:
  - The amount of TPW in each Census block, *adjusted* for variables in the model (each Census block represents 1500 people)
  - And then the *person-hours* necessary for a fairly thorough MANUAL cleanup of those Census blocks
  - And thus the estimated costs of MANUAL cleanup of TPW in all San Diego County Census blocks, using the average hourly wage in the County



# Statistical Approach: Manual Cleanup Costs

## 1) Estimating TPW quantities/volume

- a)  $PREV = f(SDEM, X)$
- b)  $TPQ = PREV \times PSPD \times 365$
- c)  $TPQ = TPS$
- d)  $TPW = APW \times TPW\%$
- e)  $TPW = TPQ \times LR\%$
- f)  $TPW = TPS \times LR\%$

## 2) Estimating TPW costs

- a)  $AC(TPW) = AC(APW) \times TPW\%$
- b)  $TC(AMAB) = PHRS \times W$
- c)  $TC(TMAB) = (PHRS \times W) \times TPW\%$
- d)  $TC(TMAB) = TC(AMAB) \times TPW\%$
- e)  $TC(TMAB) = AC(AMAB) \times TPQ \times TPW\%$
- f)  $TC(TMAB) = TC(TMAB)/hour \times PHRS$
- g)  $TC(TPW) = TC(APW) \times TPW\%$
- h)  $TC(TPW) = AC(TPW) \times TPQ$
- i)  $TC(TPW) = TC(TMAB) + ((1 - TMAB\%) \times TC(TMAB))$

Note: **SEE NEXT SLIDE FOR VARIABLE DEFINITIONS**

Each of these “TC(TPW)” equations represent a different pathway to calculating TPW attributable costs.



# Variable definitions– Statistical Approach to Estimating TPW Costs

Variable	Description	Data Sources					
		Literature/ Reports	SDSU Study	Census/ CDC	Nielsen (Sales)	County Survey	NGO Data
$SDEM_i$	Socioeconomic and demographic data	X		X			
$POP_i$	Population data	X		X			
$PREV_i$	Smoking prevalence	X		X			
$TPQ_i$	Tobacco product quantity	X					
$TPS_i$	Tobacco product sales	X			X		
$APW_i$	Volume of all product waste	X					
$TPW_i$	Volume of tobacco product waste	X	X				
$TPW\%_i$	Percent of APW attributable to TPW	X					X
$AC(APW_i)$	Average cost of APW prevention & abatement	X					
$TC(APW_i)$	Total cost of APW prevention & abatement	X				X	
$AC(TPW_i)$	Average cost of TPW prevention & abatement	X					
$TC(TPW_i)$	Total cost of TPW prevention & abatement	X					
$AC(AMAB_i)$	Average cost of manual APW abatement	X					X
$TC(AMAB_i)$	Total cost of APW manual abatement	X				X	X
$AMAB\%$	Proportion of $TC(APW)$ manual abatement						
$AC(TMAB_i)$	Average cost of TPW manual abatement	X	X				X
$TC(TMAB_i)$	Total cost of TPW manual abatement	X					X
$TMAB\%_i$	Proportion of $TC(TPW)$ manual abatement						
$PHRS_i$	Person hours attributable to manual abatement	X	X				X
$W_i$	Median hourly wage for laborer			X			
$PSPD_i$	Tobacco products smoked per day	X					
$LR\%_i$	Percent of TPQ littered	X					X

# Product Sales Data

- **Nielson IQ**

- Commercial source for tobacco product sales at retail level;
- Major market areas in California: San Diego, Bay Area, Sacramento, Los Angeles
- Excludes imports, online, tribal, military, and tobacco specialty shop sales

- Provides estimate of total potential TPW in major market area
- Apply estimated TPW discard rates from previous studies (20-60%)
- Apply estimate of person-time/hourly wage costs required to manually clean up estimated TPW burden based on SDSU study



# Putting It All Together: Direct Costs

- **Manual Cleanup Costs (Public Costs)**
  - Statistical model using San Diego data from 8 cities;
  - Major market area sales data using estimated proportion discarded as needing manual cleanup.
- **Private Sector Cleanup Costs (person-hours)**
  - Reported by voluntary groups;
  - Reported by businesses.
- **System Costs if available**
  - Waste management systems TPW proportion;
  - Landfill TPW proportion;
  - Waste water system TPW proportion;
- **Prevention Costs**
  - Outdoor smoking ban costs;
  - TPW advocacy campaigns;
  - Enforcement costs.



# Secondary Costs

- **Most TPW is not collected and is thus *unmitigated*:**
  - International Coastal Cleanup picks up about 1 million butts each year (out of 5.6 trillion sold);
  - Cellulose acetate filters persist for up to 10 years, and they break down into microplastics;
  - Cigarette butts are the most commonly collected trash item in the world.
- **Likely to be substantial**
  - Ecosystem Services (those things we gain from intact ecosystems—food, outdoor recreation, economic benefits);
  - Chemical pollution: long term contamination by tobacco toxins: carcinogens, metals, etc.;
  - Plastic pollution due to discarded filters;
  - Neighborhood degradation and quality of life.



# Getting Results (Public Entities)

Individuals, communities, and organizations that need to be involved.

- **Success is dependent upon:**

- Commitments from Departments of Public Works, stormwater agencies, public health agencies, and local elected officials

- **Cost data from city/county jurisdictions are needed:**

- Ideal data: specific to tobacco product waste (TPW) cleanup, prevention, and enforcement costs
- Alternatively, total waste management, system maintenance, anti-littering, smokefree policy costs can be used to assess proportion due to TPW

- **Challenge: Identifying individuals from relevant departments and agencies**

- Personnel time to collect data is not an agency priority

- **Recommendations:**

- Directly engage agencies to establish that TPW is relevant to existing programs (e.g., Clean Water Act, Plastics Strategy, Tobacco End Game)
- Involve public health entities and environmental groups as partners and advocates to elevate issue for relevant agencies



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# Getting Results (Private Entities)

Individuals, communities, and organizations that need to be involved.

- **Collaborate:**
  - Voluntary groups, schools, businesses, other organizations that have conducted TPW clean ups
- **Establish a standardized clean up protocol:**
  - Number of volunteers/staff and hours per event
  - Specific TPW items collected (or proportion of all trash picked up)
  - Hourly wage estimate for the community
  - Tools, protective equipment, signage, campaign, or other project costs
  - Multiply person-hours by hourly wage by TPW trash proportion to estimate TPW cost/event.
- **Smartphone app:**
  - Available in 2024 from SDSU research project
  - Quantify, geolocate, and identify collected TPW in specific community



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# Implications for Policy and Practice

- **Direct costs** of cleanup, prevention, and waste systems quantify the burden to communities, governments, taxpayers, businesses, and citizens for TPW;
- **Secondary costs** of ecosystem damages and long-term pollution are also likely to be substantial, especially if human health is impacted;
- **Clean ups, anti-litter laws, anti-litter campaigns** will not substantially reduce TPW
- **Policy options:**
  - Add 'litter fees' to price of tobacco products: reduce consumption and fund programs
  - Prohibit smoking in outdoor public spaces: de-normalize smoking and reduce local TPW burdens
  - Restrict sales of tobacco products:
    - Ban cellulose acetate filter;
    - Ban single use disposable vapes and require hazardous waste law application to e-cigarette components (including package warnings);
    - Reduce distributor density.



# Resources

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