CONDUCTING RAPID TRASH ASSESSMENTS
July 2009

Erick Burres
Citizen Monitoring Coordinator
SWRCB-Clean Water Team
eburres@waterboards.ca.gov
(213) 576-6788

INTRODUCTION

Rapid Trash Assessment is a useful survey for monitoring trash. This document has been prepared to educate, encourage and assist Citizen Monitors, Watershed Stewardship Organizations and the general public to conduct Rapid Trash Assessments.

Within this document you will find:

- Information on trash as a pollutant and its impacts on California's waters.
- The mechanics of conducting a Rapid Trash Assessment.
- A pictorial overview of a Rapid Trash Assessment.
- References and informational resources on litter, trash and marine debris.

Material has been organized so that sections from this document can be used for educational activities and/or for training as handouts or PowerPoint type presentations.

SWAMP
Surface Water Ambient Monitoring Program

Background

Trash is a water pollutant that has a large range of characteristics of concern.

Not all litter and debris delivered to streams are of equal concern to water quality. Besides the obvious negative aesthetic effects, most of the harm of trash in surface waters is imparted to aquatic life in the form of ingestion or entanglement. Some elements of trash exhibit significant threats to human health, such as discarded medical waste, human or pet waste, or even broken glass. Also, some household and industrial wastes may contain toxic substances of concern to human health and wildlife, such as batteries, pesticide containers, and fluorescent light bulbs that contain mercury. Larger trash such as discarded appliances can present physical barriers to natural stream flow, causing physical impacts such as bank erosion.

From a management perspective, persistence and accumulation of trash in a waterbody are of particular concern, and signify a priority area for prevention of trash discharges. Also of concern are trash "hotspots" where illegal dumping, littering, or accumulation of trash occurs.

The removal and prevention of trash from entering our waters will restore and enhance the uses of these waters.

SWAMP
Surface Water Ambient Monitoring Program

What Is Trash?

Trash (as man-made litter);
as defined in **California Government Code Section 68055.1(g)**:

“Litter means all improperly discarded waste material, including, but not limited to, convenience food, beverage, and other product packages or containers constructed of steel, aluminum, glass, paper, plastic, and other natural and synthetic materials, thrown or deposited on the lands and waters of the state, but not including the properly discarded waste of the primary processing of agriculture, mining, logging, sawmilling or manufacturing [….]."

SWAMP
Surface Water
Ambient Monitoring
Program

Discerning Anthropomorphic And Natural Debris

http://www.longfellowcreek.org/help/athome_01.htm

Leaf litter is trash when there is evidence of dumping. Leaves and pine needles in streams provide a natural source of food for organisms, but excessive levels of leaves, due to human influence, can cause nutrient imbalance and oxygen depletion in streams, to the detriment of the aquatic ecosystem. Clumps of leaf litter and yard waste from trash bags should be treated as trash in the water quality assessment, and not confused with natural inputs of leaves to streams. If there is a question in the field, check the type of leaf to confirm it comes from a nearby riparian tree. In some instances, leaf litter may be trash if it originates from dense ornamental stands of nearby human planted trees that are overloading the stream's assimilative capacity for leaf inputs. Other biodegradable trash, such as food waste, also exerts a demand on dissolved oxygen, but aquatic life is unlikely to be adversely affected unless the dumping of food waste is substantial and persistent at a given location.

SWAMP
Surface Water Ambient Monitoring Program

Trash Characteristics Of Concern: Aquatic Life

Salp with plastic filtered from seawater while feeding.

Leatherback turtle washed ashore with a plastic bag lodged in its throat.

Dead bird with plastics in gut.

For aquatic life, buoyant (floatable) elements tend to be more harmful than settle-able elements, due to their ability to be transported throughout the waterbody and ultimately to the marine environment. Persistent elements such as plastics, synthetic rubber and synthetic cloth tend to be more harmful than degradable elements such as paper, which can rip and biodegrade relatively quickly. Glass, foamed plastic and metal are less persistent, even though they are not biodegradable, because wave action and rusting can cause them to break into smaller pieces. Natural rubber and cloth can degrade but not as quickly as paper (U.S. EPA, 2002). Smaller elements such as plastic resin pellets (a by-product of plastic manufacturing) and cigarette butts are often more harmful to aquatic life than larger elements, since they can be ingested by a larger number of smaller organisms which can then suffer malnutrition or internal injuries. Larger plastic elements such as plastic grocery bags are also harmful to larger aquatic life such as sea turtles, which can mistake the trash for floating prey and ingest it, leading to starvation or suffocation. Floating debris that is not trapped and removed will eventually end up on the beaches, wetlands, lakes, estuaries or in the open ocean, repelling visitors and residents from the beaches and degrading coastal waters. Trash may also accumulate and act as barriers to wildlife.

Turtle with plastic ring around its body.

SWAMP Surface Water Ambient Monitoring Program

All images on this page from Algalita Marine Foundation.

Trash Characteristics Of Concern:
Human Health

Trash in water bodies can threaten the health of people that use them for activities such as wading, swimming or fishing. Of particular concern are the bacteria and viruses associated with diapers, medical waste (e.g., used hypodermic needles and pipettes), and human or pet waste. Additionally, broken glass or sharp metal fragments in streams can cause puncture or laceration injuries. Such injuries can then expose a person's bloodstream to microbes in the stream's water that may cause illness. Some trash items such as containers or tires can pond water and support mosquito production and associated risks of diseases like encephalitis and the West Nile virus.

Glass Beach at Benicia, California.

http://www.deq.louisiana.gov/portal/tabid/2060/Default.aspx

Mosquito Habitat. www.rci.rutgers.edu/~insects/habitat.htm

SWAMP Surface Water Ambient Monitoring Program

TMDLs: Trash

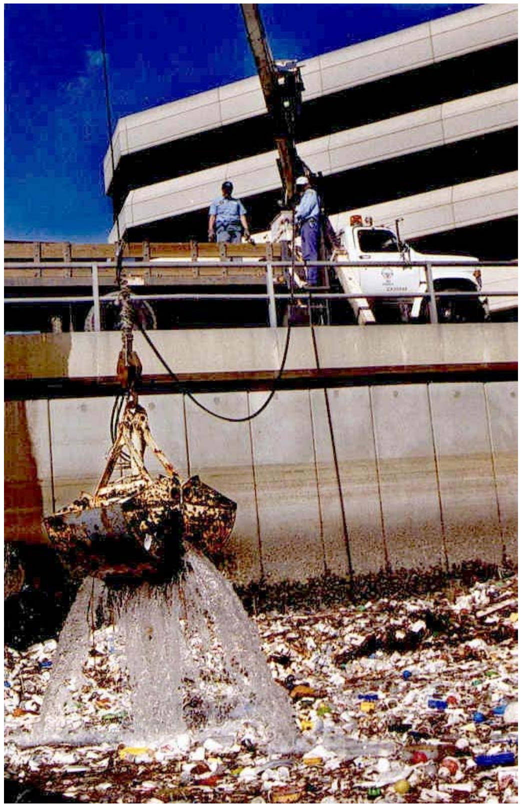
Section 303 (d)(1)(A) of the Clean Water Act (CWA) mandates biennial assessment of the nation's water resources, and these water quality assessments are used to identify and list impaired waters. The resulting list is referred to as the 303(d) list.

The CWA also requires states to establish a priority ranking for impaired waters and to develop and implement Total Maximum Daily Loads (**TMDL**s).

A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet **water quality standards**, and allocates pollutant loadings to point and non-point sources.

Water quality standards include designated **beneficial uses**, numeric and narrative **water quality objectives**, and the state's **antidegradation policy** as specified in the State's Basin Plans.

The United States Environmental Protection Agency has oversight authority for the 303 (d) program and must approve or disapprove the state's 303 (d) lists and each Preliminary Technical Draft and specific TMDL. USEPA is ultimately responsible for issuing a TMDL, if the state fails to do so in a timely manner.



LA RIVER MOUTH AT GOLDEN SHORE IN LONG BEACH February 17, 2000. Photograph was taken by Lisa Billings. Originally published in the Long Beach Press Telegram

SWAMP
Surface Water Ambient Monitoring Program

Water Quality Objectives: Trash

Water quality standards consist of a combination of beneficial uses, water quality objectives and the State's Antidegradation Policy*.

Examples of a narrative water quality objectives applicable to trash are:

- **floating materials**: *"Waters shall not contain floating materials,including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses*"

- **solid, suspended, or settleable materials:** "*Waters shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses*."

*The States' Antidegradation Policy is formally referred to as the *Statement of Policy with Respect to Maintaining High Quality Waters in California* (State Board Resolution No. 68-16).

SWAMP
Surface Water
Ambient Monitoring
Program

Settleable Litter

Sediments which may be addressed in separate TMDLs are natural particulate matters such as silt and sand.

Sediments result from erosion and are deposited at the bottom of a stream.

Sediments do not refer to the decomposition of **settleable litter** into small particulate matters.

Gross Pollutants

Trash consisting of litter and particles of litter that are retained by a 5-mm mesh screen are sometimes referred to as **“gross pollutants”** in European and Australian scientific literature. This definition excludes sediments, and it also excludes oil and grease, and vegetation, except for yard waste that is illegally disposed of in the storm drain system.

SWAMP
Surface Water Ambient Monitoring Program

Preproduction Plastic Pellets "Nurdles"

AB 258, a California bill signed into law October 14, 2007, requires all plastic product manufacturers to use best management practices to prevent pellet spillage.

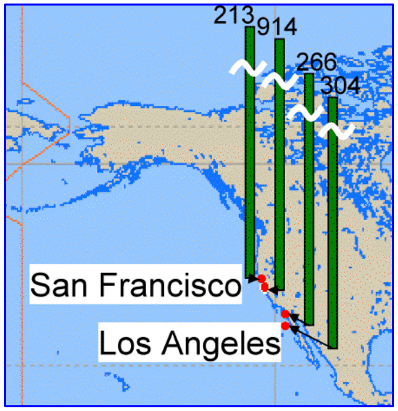
Preproduction plastic pellets (nurdles) are easily released into the environment. This can occur from urban areas during transport, re-packaging, and plastic processing activities. Nurdles eventually migrate to coastal waterways, beaches and the ocean through storm drains.

Nurdles are the size of and look like small fish eggs. Marine life, especially filter feeders, commonly mistake nurdles for food. Ingestion of the plastic pellets can lead to intestinal blockage and starvation.

Nurdles can also carry micro-pollutants. These can be from toxic chemicals within the plastic itself or from pollutants absorbed from the water (see sidebar). These pollutants are attracted to and adhere to the nurdles' surface. These pollutants combined with the nurdles fish egg looks may put marine like to additional risks.

Since plastic does not biodegrade, these nurdles will remain in the marine

In 2005 International Pellet Watch teamed up with Citizen Monitors and the Clean Water Team to investigate Persistent Organic Pollutants with nurdles found on 4 California beaches. The results can be seen in the picture below.



PCB* concentrations (ng/g-pellet)

Beneficial Uses Which Can Be Impacted By Trash Part 1

Municipal and Domestic Supply (MUN)

Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

Agricultural Supply (AGR)

Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Industrial Process Supply (PROC)

Uses of water for industrial activities that depend primarily on water quality.

Industrial Service Supply (IND)

Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

Ground Water Recharge (GWR)

Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Freshwater Replenishment (FRSH)

Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity).

Navigation (NAV)

Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Hydropower Generation (POW)

Uses of water for hydropower generation.

SWAMP
Surface Water Ambient Monitoring Program

Beneficial Uses Which Can Be Impacted By Trash Part 2

Water Contact Recreation (REC-1)

Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2)

Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is

Reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Commercial and Sport Fishing (COMM)

Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Aquaculture (AQUA)

Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic

plants and animals for human consumption or bait purposes.

Warm Freshwater Habitat (WARM)

Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

SWAMP
Surface Water Ambient Monitoring Program

Beneficial Uses Which Can Be Impacted By Trash Part 3

Cold Freshwater Habitat (COLD)

Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Inland Saline Water Habitat (SAL)

Uses of water that support inland saline water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.

Estuarine Habitat (EST) Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Wetland Habitat (WET) Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

Marine Habitat (MAR)

Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Wildlife Habitat (WILD)

Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Preservation of Biological Habitats (BIOL)

Uses of water that support designated areas or habitats, such as

Areas of Special Biological Significance (ASBS), established refuges, parks, sanctuaries, ecological reserves, or other areas where the preservation or enhancement of natural resources requires special protection

SWAMP
Surface Water Ambient Monitoring Program

California’s Trash TMDLs

The State Water Resources Control Board and the California Regional Water Quality Control Boards (often referred to as the “Waterboards”) have developed and are in the process of developing total maximum daily load (TMDL) designations to attain the water quality standards for trash in several waterbodies.

Many waterbodies are listed as impaired by trash on the 303(d) list within the following Regional Water Quality Control Boards:`

- San Francisco Bay
- Los Angeles
- Colorado River Basin
- San Diego

Within the 2006 303(d) List 37 waterbodies were listed as impaired by trash.

SWAMP
Surface Water Ambient Monitoring Program

Types of BMPs: Trash

Best Management Practices (BMPs) are effective, practical, structural or nonstructural methods which prevent or reduce the movement of pollutants (trash, sediment, nutrients, pesticides…) to surface or ground waters.

Catch Basin Inserts

Catch Basin Screen

Posting Storm-drains

Outreach/Education

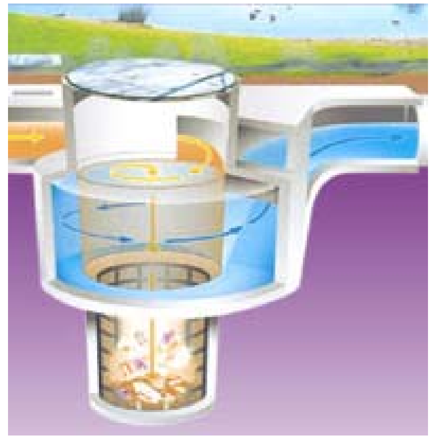
Clean-up Day Events

SWAMP
Surface Water Ambient Monitoring Program

More Types of BMPs: Trash

Nets

Continuous **D**eflective **S**eparators



Publicly Accessible Trash Receptacles

Catch **B**asin **I**nsert

Trash-racks

SWAMP
Surface Water Ambient Monitoring Program

Non-BMP Trash Controls

In-stream trash booms and trash skimmers are not considered Trash BMPs because the litter they address has already entered the waterbody and are polluting it.

SWAMP
Surface Water Ambient Monitoring Program

The Need For Data

Many public and community based organizations host volunteer clean-ups periodically, and document the amount of trash that was removed. The purpose of volunteer clean-ups is to visibly clean the river and its banks, not to quantify debris. As a result, it is likely that some of the debris collected during those events are not recorded. In addition, volunteers traditionally focus on larger, more visible debris to the exclusion of smaller debris which are commonly encountered, such as cigarette butts. The data collected also does not indicate how long the trash had been accumulating

The Regional Boards need data that...

Measure

- TMDL's effectiveness
- Baseline conditions
- Daily generation rates (DGR)

    The DGR is the average amount of litter deposited to land or surface water during a 24-hour period, as measured in a specified drainage area.

Assess

- Best management practices (BMPs)
    - Trash traps (deflectors, mesh bags…)
    - Sweeping (street sweeping, parking lot sweeping…)
    - LIDs (low impact development technologies)
    - Others…

Prioritize

- Hot Zones

SWAMP
Surface Water Ambient Monitoring Program

Enforcement

Many laws address litter/trash

City/County: Illegal dumping, littering, nuisance abatement codes, environmental degradation statutes, street sweeping ordinances…

State: CA Vehicle Code Fish and Game Code, Water Quality Control Plans, State Park Code…

Federal: NPS, NFS, USFWS, NOAA…

International: MARPOL…

SWAMP
Surface Water Ambient Monitoring Program

Litter Abatement Alternatives

Some local jurisdictions have looked at and are initiating alternative ways of preventing waste from becoming pollutants. This has been observed by cities initiating..

- **Recycling**: Curbside programs
- **Green Catering**: Mandating green service-ware use on public properties
- **Composing**: Curbside green waste pick-up
- **Bans**: Plastic Shopping Bags, smoking in public spaces (i.e. beaches), plastics/styrofoam… (All items frequently found in litter.)

SWAMP
Surface Water Ambient Monitoring Program

Social Justice and Litter

Studies have shown that communities that have low levels of education, high poverty, no access to public amenities (no curbside services, no public trash receptacles) and high proportions of minorities suffer from higher levels of litter.

Litter levels should be reduced through the promotion of education, eradicating poverty and the provision of public services.

SWAMP
Surface Water Ambient Monitoring Program

Rapid Trash Assessment:

This trash assessment includes a **visual survey** of the waterbody (e.g., stream bed and banks) and adjacent areas from which trash elements can be carried to the waterbody by wind, water, gravity or human activity.

The delineation of these adjacent areas is **site-specific** and requires some judgment and documentation. The rapid trash assessment worksheet is designed to represent the range of effects that trash has on the physical, biological, and chemical integrity of water bodies, in accordance with the goals of the Clean Water Act and the California Water Code.

The worksheet also provides a record for **evaluation** of the management of trash discharges, by documenting sites that receive **direct discharges** (i.e., dumping or chronic littering) and those that **accumulate** trash from upstream locations.

SWAMP
Surface Water
Ambient Monitoring
Program

Monitoring Design.

The **Rapid Trash Assessment** can be used for a number of purposes:

- Ambient monitoring
- Evaluation of management actions,
- Analyze land uses
- Comparing sites with and without public access
- Identifying possible trash sources
- Assist the State in acquiring other useful data related to trash

Ambient monitoring efforts should provide information at sites distributed throughout a waterbody, and through several seasons to characterize spatial and temporal variability. Additionally, the ambient sampling design should document the effects of episodes that affect trash levels such as storms or even community cleanup events. Pre- and post-project assessments can assist in evaluating the effectiveness of management practices ranging from public outreach to structural controls, or to document the effects of public access on trash levels in waterbodies (e.g.,upstream/downstream). Such evaluations should consider trash levels over time and under different seasonal conditions.

The methodology was developed by the San Francisco Regional Water Quality Control Board for sections of wadeable streams, but can be adapted for assessment of trash along shorelines of lakes, beaches, or estuaries. Ultimately, the monitoring design will strongly affect the usefulness of any rapid trash assessment information

SWAMP
Surface Water
Ambient Monitoring
Program

Site Definition.

Upon arrival at a designated monitoring site, a team of two or more people defines or verifies a 100-foot section of the stream or shoreline to analyze (station).

When a site is first established, it is recommended that the 100-foot distance be accurately measured with a tape measure (or rope of predetermined length). The length should be measured not as a straight line, but as 100 feet of the actual stream or shore length that follows the streams sinuous curves.

The starting and ending points of the survey should be easily identified landmarks, such as an oak tree or boulder, fence post, or lifeguard tower and noted on the worksheet ("Upper/Lower Boundaries of Reach"), or documented using global positioning system (GPS), so that each future assessment is made at the same location.

The team should confer and document the upper boundary of the banks or shore to be surveyed, based on evaluation of whether trash can be carried to the water body by wind or water (e.g., an upper terrace in the stream bank).

The team should also document the location of the high water line based on site-specific physical indicators such as location of the low flow channel. Defining these characteristics of the site will facilitate comparing assessments conducted at the same site at different times of the year.

Survey Introduction

The survey should not take more than 20 minutes, and with practice it may take 15 minutes or less to complete.

The team begins the survey at one end of the selected reach. One team member (the “streambank person”) begins walking along the bank (where possible), looking for any trash on the stream (or shore) bank, or above the high water line, and tallies any trash items found on the trash assessment sheet.

The other person (the “streambed person”) walks along the stream bed, or in the water at shorelines, and shouts out any trash items found in the water body for the person on land to tally on the trash assessment sheet.

The person tallying the trash notes on the sheet whether the trash was found in the stream and below the high water line, or above the high water line (i.e., tally lines for below high water line (|), and tally dots or circles (•) for above the high water line). This will help for assigning scores for the worksheet.

A pole or similar lifting tool should be used to help look under bushes, logs, and other plant growth to see if trash has accumulated underneath. The ground or substrate should be carefully inspected to ensure that small items such as cigarette butts and pieces of broken glass or Styrofoam are being included. Because this is a rapid assessment, the tally is not exact, but it is important not to miss items that can affect human health, because such items can strongly affect the total score.

Optional: The person in the stream can carry a garbage bag and collect trash as it is located, making sure to avoid injuries by wearing protective footwear and using gloves. Avoid touching trash with unprotected hands!

SWAMP Surface Water Ambient Monitoring Program

Survey Introduction Continued

At stream sites, when the team has finished the survey of the stream bed and one bank, the “bank person” crosses to the other bank. Continuing the assessment, the team works their way back along the reach, with the bank person surveying the opposite bank and the “bed person” re-examining the stream bed or collecting trash, making sure not to count items twice.

When the surveyors are finished with the tallying, they should fill out the worksheet before leaving the site, while everything is still fresh in the memory. They should discuss each number so that they agree on every score. They should discuss and document the factors affecting trash levels at the site, such as a park, school, or nearby residences or businesses.

The system provides a range of 5 numbers within a given condition category, allowing for the range of conditions expected in the field. For instance, trash located in the water leads to lower scores than trash above the stream bank. Under each of the six trash assessment parameters, the narrative language is provided to assist with choosing a score within the range. Not all specific trash conditions mentioned in the narratives need to be present to fit in a specific condition category (e.g., “site frequently used by people”), nor do the narratives describe all possible conditions. The “Poor” condition category has a range of 6 numbers (0-6), unlike the other 3 condition categories. Scores of “0” should be reserved for the most extreme conditions. Once the scores are assigned for the 6 categories, they should be totaled up and any specific notes on the site should be written in the designated space at the end of the sheet.

A given site should be assessed several times in a given year, during different seasons, to characterize the variability and persistence of trash occurrence for water quality assessment purposes.

SWAMP
Surface Water Ambient Monitoring Program

Trash Assessment Parameters.

The rapid trash assessment includes a range of parameters that capture the breadth of issues associated with trash and water quality.

The first two parameters (1 & 2) focus on **qualitative and quantitative levels of trash**.

The second two parameters (3 & 4) estimate **actual threat to water quality**. (Other parameters can be added that would more specifically address threats of your concern (navigation, water supply, wetland habitat….)

The last two parameters (5 & 6) represent **how trash enters the water body** at a site, through direct dumping or accumulation.

The following pages will present each parameter more fully.

SWAMP
Surface Water Ambient Monitoring Program

1. Level of Trash.

This assessment parameter is intended to reflect a qualitative "first impression" of the site, after observing the entire length of the reach. Sites scoring in the "poor" range are those where trash is one of the first things that is noticeable about the waterbody. No trash should be obviously visible at sites that score in the "optimal" range.

SWAMP
Surface Water Ambient Monitoring Program

2. Actual Number of Trash Items Found.

Based on the tally of trash along the 100-foot stream reach, total the number of items both above and below the high water mark, and choose a score within the appropriate condition category based on the range of items provided. Choose a score among the 5 numbers that is adjusted based on where the tally lies in the provided range. Where more than 50 items have been tallied, assign the following scores: 5: 51-75 items; 4: 76-100 items; 3: 101-150 items; 2: 151-200 items; 1: 201-250 items; 0: over 250 items. Since these tallies do not significantly affect the overall score, it is ok to estimate the tally at sites with more than 100 items, making sure to identify trash items that can affect human health like diapers, pet or human waste, or medical waste.

Sometimes items are broken into many pieces. **Fragments with higher threat to aquatic life such as plastics should be enumerated, while ripped paper and broken glass, with lower threat and/or mobility, should be counted based on the parent item(s). The judgment whether to count all fragments or just one item depends on the potential exposure to downstream fish and wildlife, and waders and swimmers at a given site.** Concrete is trash when it is dumped, but not when it is placed as part of an engineered structure. Consider tallying only those items that would be removed in a restoration or cleanup effort.

3. Threat to Aquatic Life.

As indicated in the technical notes, below, certain characteristics of trash makes it more harmful to aquatic life. If the trash items are persistent in the environment, buoyant (floatable), and relatively small, they can be transported long distances and be mistaken by wildlife as food items. Larger items can cause entanglement. Some discarded debris may contain toxic substances (e.g. batteries, cigarette butts). All of these factors are considered in the narrative descriptions in this assessment parameter.

SWAMP
Surface Water Ambient Monitoring Program

4. Threat to Human Health.

Items that are more dangerous to people that engage in direct and indirect water contact activities (e.g. wading,swimming, fishing) weighted greater in this category of trash assessment. The worst conditions are associated with the potential for presence of dangerous bacteria or viruses, such as medical waste, diapers, and human or pet waste.

Also included in this category are sources of pollutants that could accumulate in fish in the downstream environment, such as mercury.

SWAMP
Surface Water Ambient Monitoring Program

5. Illegal Dumping and Littering.

This assessment category relates to direct placement of trash items at the site, and the "poor" conditions are ascribed to sites that are obviously chronic dumping locations or "trash hotspots."

SWAMP
Surface Water Ambient Monitoring Program

6. Accumulation of Trash.

This assessment category relates to accumulation of trash items from upstream locations.

Accumulated trash is distinguished from dumped trash by indications of age and transport. For instance, faded colors, silt marks, trash wrapped around roots, and signs of decay indicate accumulated trash. Trash accumulation is an indicator that the local drainage system facilitates conveyance of trash to water bodies, in violation of clean water laws and policies.

SWAMP
Surface Water Ambient Monitoring Program

RAPID TRASH ASSESSMENT WORKSHEET

Surface Water Ambient Monitoring Program, San Francisco Bay Regional Water Quality Control Board

WATERSHED/STREAM: ________________________ DATE/TIME: ____________________
MONITORING GROUP, STAFF: __________________ SAMPLE ID NO. ________________
SITE DESCRIPTION (Station Name, No., etc.): ______________________________________

	CONDITION CATEGORY			
Trash Assessment Parameter	**Optimal**	**Sub optimal**	**Marginal**	**Poor**
1. Level of Trash	On first glance, no trash visible; little or no trash evident when streambed and streambanks are closely examined for litter and debris, for instance by looking under leaves.	On first glance, little or no trash visible; after close inspection small levels of trash evident in streambank and streambed.	Trash is evident in low to medium levels on first glance. Stream-bank surfaces and immediate riparian zone contain litter and debris. Evidence of site being used by people: scattered cans, bottles, blankets, and/or clothing.	Trash distracts the eye on first glance. Streambank surfaces and immediate riparian zone contain substantial levels of litter and debris. Evidence of site being used frequently by people: many cans & bottles, food wrappers, manmade shelters, blankets, and/or piles of clothing.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Actual Number of Trash Items Found	0 to 5 trash items based on a rapid survey of a 100-foot stream reach.	6 to 25 trash items based on a rapid survey of a 100-foot stream reach.	26 to 50 trash items based on a rapid survey of a 100-foot stream reach.	Over 50 trash items based on a rapid survey of a 100-foot stream reach.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Threat to Aquatic Life	Trash, if any, is mostly paper or wood products or other biodegradable materials. Note: A large amount of rapidly biodegradable material like food waste creates high oxygen demand, and should not be scored as optimal.	Little or no persistent, buoyant, and small litter or debris. Presence of settleable, degradable, and non-toxic debris such as wood, glass, metal, and degradable plastics such as foamed plastics.	Medium prevalence of persistent (plastic, synthetic rubber or cloth), toxic, buoyant, and small litter such as: plastic bags; pellets; cigarette butts; large deposits of settleable debris such as glass or metal; and any evidence of small clumps of deposited yard waste or leaf litter.	Large amount of persistent (plastic, synthetic rubber or cloth), toxic, buoyant, and small (transportable) trash such as: cigarette butts; plastic bags; plastic pellets; batteries or other toxic substances; and large clumps of yard waste or dumped leaf litter.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Threat to Human Health	Observable trash contains no evidence of bacteria or virus hazards such as medical waste, diapers, pet or human waste, no evidence of toxic substances such as pesticides or batteries, no ponded water for mosquito production & no evidence of puncture or laceration hazards associated with the observed litter or debris.	No medical waste or sources of toxic substances, but any presence of puncture or laceration hazards such as broken glass and metal debris. Or presence of ponded water in trash items such as tires or containers that could facilitate mosquito production.	Presence of **one** of the following: hypodermic needles, pipettes, or other medical waste ; any used diapers or pet waste within the stream channel or where runoff could carry materials to waterbody; any toxic substance such as pesticides, batteries, or fluorescent light bulbs (mercury).	Presence of **more than one** of the following: any hypodermic needles, pipettes, or other medical waste; used diapers or pet waste within the stream channel or where runoff could carry materials to waterbody; any toxic substances such as pesticides, batteries, or fluorescent light bulbs (mercury); ponded water in trash items.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

RAPID TRASH ASSESSMENT WORKSHEET SIDE ONE

SWAMP
Surface Water Ambient Monitoring Program

RAPID TRASH ASSESSMENT WORKSHEET

Surface Water Ambient Monitoring Program, San Francisco Bay Regional Water Quality Control Board

	CONDITION CATEGORY			
Trash Assessment Parameter	**Optimal**	**Sub optimal**	**Marginal**	**Poor**
5. Illegal Dumping and Littering	Any observed trash is incidental litter (less than 5 items) or carried downstream from another location. No evidence of illegal dumping.	Some evidence of in-stream or shoreline littering; and/or some evidence of illegal dumping, such as a sign prohibiting dumping along with observed garbage bags of material. Limited vehicular access limits the amount of potential dumping, or material dumped is diffuse paper-based debris (e.g., convenience stores or fast food).	Prevalent in-stream or shoreline littering; and/or the presence of **one** of the following: furniture, appliances, or bags of garbage or yard waste, coupled with vehicular access that facilitates in-and-out dumping of materials to avoid landfill costs.	Significant litter on shoreline or stream banks and streambed; and/or evidence of chronic dumping, with **more than one** of the following items: furniture, appliances, shopping carts, garbage bags, or yard waste. Easy vehicular access for in-and-out dumping of materials to avoid landfill costs.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Accumulation of Trash	There does not appear to be a problem with trash accumulation from downstream transport. Observable trash, if any, appears to have been directly deposited at the stream location.	Some evidence that litter and debris have been transported from upstream areas to the location. Less than 5 trash items have been transported from upstream locations, based on evidence such as silt marks, faded colors or location near high water marks.	5 to 20 items of observable trash are carried to the location from upstream, as evidenced by its location near high water marks and siltation marks on the debris.	Trash appears to have accumulated in substantial quantities at the location based on delivery from upstream areas, and is in various states of degradation based on its persistence in the waterbody. Over 20 items of observable trash have been carried to the location from upstream.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Total Score _______________

SITE DEFINITION:
UPPER/LOWER BOUNDARIES OF REACH: ____
HIGH WATER LINE: ____
UPPER EXTENT OF BANKS OR SHORE: ____
____

NOTES:
____
____
____
____

RAPID TRASH ASSESSMENT WORKSHEET SIDE TWO

SWAMP
Surface Water Ambient Monitoring Program

RAPID TRASH ASSESSMENT WORKSHEET TRASH ITEM TALLY

TRASH ITEM TALLY (Tally with (|) if found below high water line, and (•) if above)

PLASTIC	**METAL**
Plastic Bags	Aluminum Foil
Plastic Bottles	Aluminum or Steel Cans
Plastic Bottle Caps	Bottle Caps
Plastic Cup Lid/Straw	Metal Pipe Segments
Plastic Pipe Segments	Auto Parts (specify below)
Plastic Six-Pack Rings	Wire (barb, chicken wire etc.)
Plastic Wrapper	Metal Object
Soft Plastic Pieces	**LARGE (specify below)**
Hard Plastic Pieces	Appliances
Styrofoam cups pieces	Furniture
Styrofoam Pellets	Garbage Bags of Trash
Fishing Line	Tires
Tarp	Shopping Carts
Other (write-in)	Other (write-in)
BIOHAZARD	**TOXIC**
Human Waste/Diapers	Chemical Containers
Pet Waste	Oil/Surfactant on Water
Syringes or Pipettes	Spray Paint Cans
Dead Animals	Lighters
Other (write-in)	Small Batteries
CONSTRUCTION DEBRIS	Vehicle Batteries Cigarette Butts
Concrete (not placed)	Other (write-in)
Rebar	**BIODEGRADABLE**
Bricks	Paper
Wood Debris	Cardboard
Other (write-in)	Food Waste
MISCELLANEOUS	Yard Waste (incl. trees)
Synthetic Rubber	Leaf Litter Piles
Foam Rubber	Other (write-in)
Balloons	**GLASS**
Ceramic pots/shards	Glass bottles
Hose Pieces	Glass pieces
Golf Balls	**FABRIC AND CLOTH**
Tennis Balls	Synthetic Fabric
Other (write-in)	Natural Fabric (cotton, wool)
Other (write-in)	Other (write-in)

SPECIFIC DESCRIPTION OF ITEMS FOUND (if any):

____
____
____

SWAMP
Surface Water Ambient Monitoring Program

Describe Monitoring Activity:

RAPID TRASH ASSESSMENT WORKSHEET

Surface Water Ambient Monitoring Program, San Francisco Bay Regional Water Quality Control Board

WATERSHED/STREAM: ____________________________ DATE/TIME: ______________________

MONITORING GROUP, STAFF: _____________________ SAMPLE ID NO. _________________

SITE DESCRIPTION (Station Name, No., etc.): ____

SWAMP Surface Water Ambient Monitoring Program

Site Definition:

SITE DEFINITION:
UPPER/LOWER BOUNDARIES OF REACH: ____
HIGH WATER LINE: ____
UPPER EXTENT OF BANKS OR SHORE: ____
____

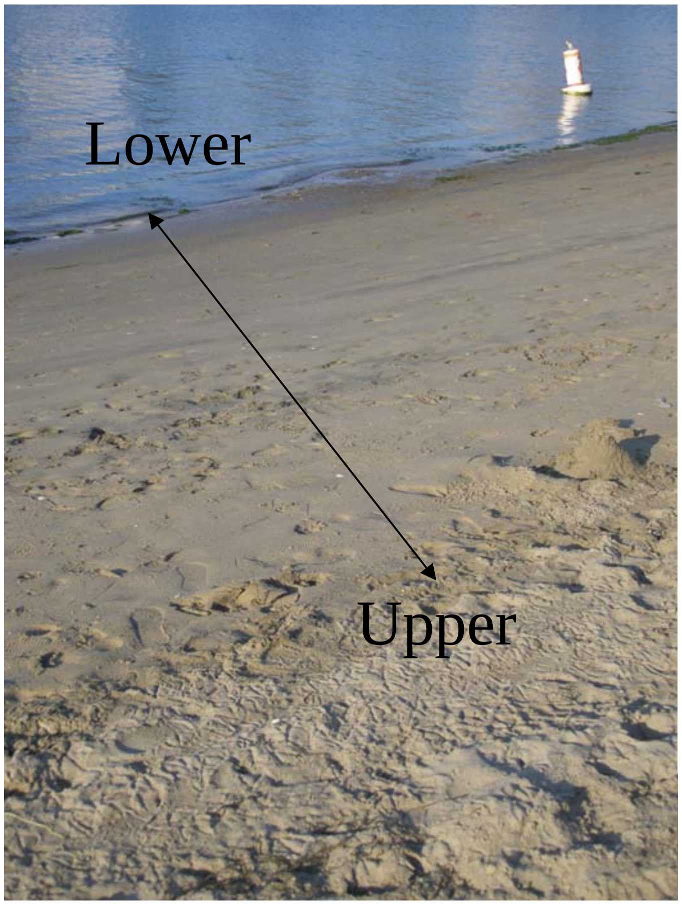
SWAMP
Surface Water Ambient Monitoring Program

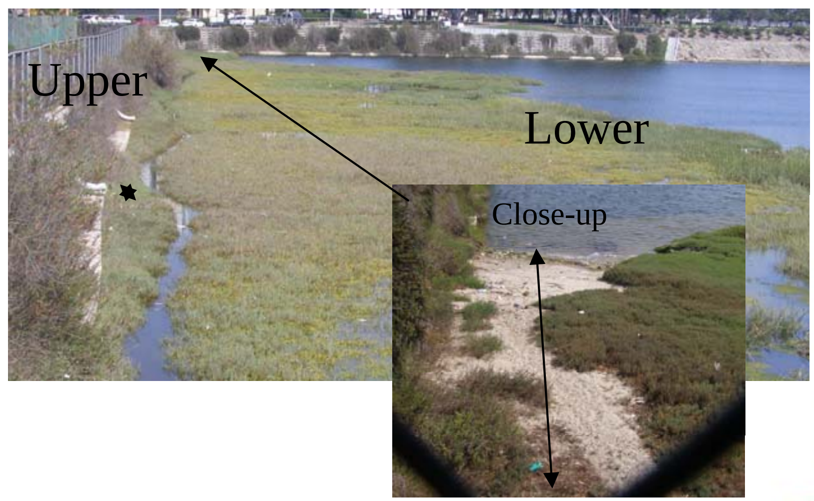
Survey Landmarks

SWAMP
Surface Water
Ambient Monitoring
Program

Waters Edge to High-water (Upper Depositional Area)

TRASH ITEM TALLY (Tally with (|) if found below high water line, and (•) if above)



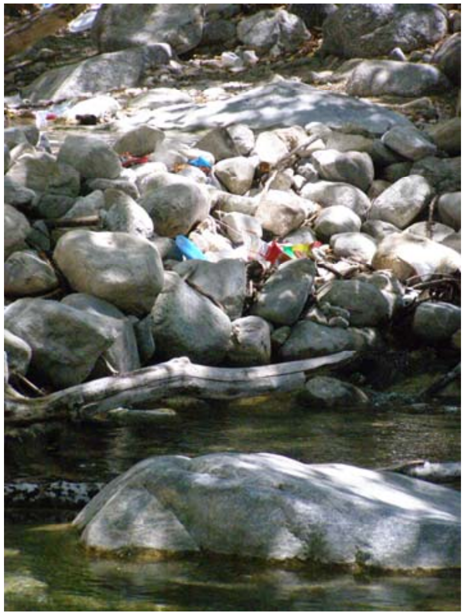


SWAMP
Surface Water Ambient Monitoring Program

Actual Number of Trash Items Found:

2. Actual Number of Trash Items Found	0 to 5 trash items based on a rapid survey of a 100-foot stream reach.	6 to 25 trash items based on a rapid survey of a 100-foot stream reach.	26 to 50 trash items based on a rapid survey of a 100-foot stream reach.	Over 50 trash items based on a rapid survey of a 100-foot stream reach.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Least # of Trash Items



Greater # of Trash Items

Trash Items*:







PLASTIC	**METAL**
Plastic Bags	Aluminum Foil
Plastic Bottles	Aluminum or Steel Cans
Plastic Bottle Caps	Bottle Caps
Plastic Cup Lid/Straw	Metal Pipe Segments
Plastic Pipe Segments	Auto Parts (specify below)
Plastic Six-Pack Rings	Wire (barb, chicken wire etc.)
Plastic Wrapper	Metal Object
Soft Plastic Pieces	**LARGE (specify below)**
Hard Plastic Pieces	Appliances
Styrofoam cups pieces	Furniture
Styrofoam Pellets	Garbage Bags of Trash
Fishing Line	Tires
Tarp	Shopping Carts
Other (write-in)	Other (write-in)
BIOHAZARD	**TOXIC**
Human Waste/Diapers	Chemical Containers
Pet Waste	Oil/Surfactant on Water
Syringes or Pipettes	Spray Paint Cans
Dead Animals	Lighters
Other (write-in)	Small Batteries
CONSTRUCTION DEBRIS	Vehicle Batteries
Concrete (not placed)	Other (write-in)
Rebar	**BIODEGRADABLE**
Bricks	Paper
Wood Debris	Cardboard
Other (write-in)	Food Waste
MISCELLANEOUS	Yard Waste (incl. trees)
Synthetic Rubber	Leaf Litter Piles
Foam Rubber	Other (write-in)
Balloons	**GLASS**
Ceramic pots/shards	Glass bottles
Hose Pieces	Glass pieces
	FABRIC AND CLOTH
Golf Balls	Synthetic Fabric
Tennis Balls	Natural Fabric (cotton, wool)
Other (write-in)	Other (write-in)










SWAMP
Surface Water Ambient Monitoring Program

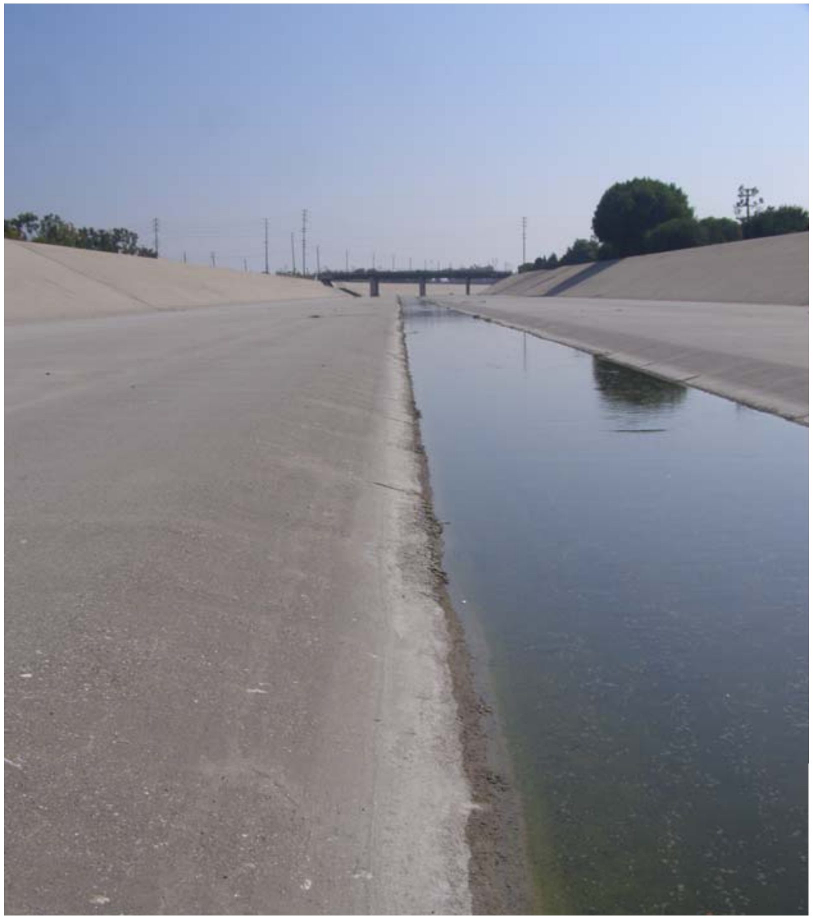
* Proper field identification is critical to minimize variability.

Level of Trash:

Trash Assessment Parameter	Optimal	Sub optimal	Marginal	Poor
1. Level of Trash	On first glance, no trash visible; little or no trash evident when streambed and streambanks are closely examined for litter and debris, for instance by looking under leaves.	On first glance, little or no trash visible; after close inspection small levels of trash evident in streambank and streambed.	Trash is evident in low to medium levels on first glance. Stream-bank surfaces and immediate riparian zone contain litter and debris. Evidence of site being used by people: scattered cans, bottles, blankets, and/or clothing.	Trash distracts the eye on first glance. Streambank surfaces and immediate riparian zone contain substantial levels of litter and debris. Evidence of site being used frequently by people: many cans & bottles, food wrappers, manmade shelters, blankets, and/or piles of clothing.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

SWAMP
Surface Water Ambient Monitoring Program

Level of Trash: Appear Clean



SWAMP
Surface Water
Ambient Monitoring
Program

Level of Trash: Appear Clean, But Have Trash

Bottles and Cinderblocks

Styrofoam, Plastics, Arundo

Styrofoam, Wood, Plastic Film

SWAMP
Surface Water Ambient Monitoring Program

Threat to Aquatic Life:

3. Threat to Aquatic Life	Trash, if any, is mostly paper or wood products or other biodegradable materials. Note: A large amount of rapidly biodegradable material like food waste creates high oxygen demand, and should not be scored as optimal.	Little or no persistent, buoyant, and small litter or debris. Presence of settleable, degradable, and non-toxic debris such as wood, glass, metal, and degradable plastics such as foamed plastics.	Medium prevalence of persistent (plastic, synthetic rubber or cloth), toxic, buoyant, and small litter such as: plastic bags; pellets; cigarette butts; large deposits of settleable debris such as glass or metal; and any evidence of small clumps of deposited yard waste or leaf litter.	Large amount of persistent (plastic, synthetic rubber or cloth), toxic, buoyant, and small (transportable) trash such as: cigarette butts; plastic bags; plastic pellets; batteries or other toxic substances; and large clumps of yard waste or dumped leaf litter.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Trash in San Jose's Coyote Creek. Photo by Larry Johmann

Adjacent to the mouth of the Los Angeles River

SWAMP Surface Water Ambient Monitoring Program

Threat to Human Life:

4. Threat to Human Health	Observable trash contains no evidence of bacteria or virus hazards such as medical waste, diapers, pet or human waste, no evidence of toxic substances such as pesticides or batteries, no ponded water for mosquito production & no evidence of puncture or laceration hazards associated with the observed litter or debris.	No medical waste or sources of toxic substances, but any presence of puncture or laceration hazards such as broken glass and metal debris. Or presence of ponded water in trash items such as tires or containers that could facilitate mosquito production.	Presence of **one** of the following: hypodermic needles, pipettes, or other medical waste ; any used diapers or pet waste within the stream channel or where runoff could carry materials to waterbody; any toxic substance such as pesticides, batteries, or fluorescent light bulbs (mercury).	Presence of **more than one** of the following: any hypodermic needles, pipettes, or other medical waste; used diapers or pet waste within the stream channel or where runoff could carry materials to waterbody; any toxic substances such as pesticides, batteries, or fluorescent light bulbs (mercury); ponded water in trash items.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Bio-hazards must be carefully tallied to allow consistent scoring.

SWAMP
Surface Water Ambient Monitoring Program

Illegal Dumping & Littering:

	CONDITION CATEGORY			
Trash Assessment Parameter	**Optimal**	**Sub optimal**	**Marginal**	**Poor**
5. Illegal Dumping and Littering	Any observed trash is incidental litter (less than 5 items) or carried downstream from another location. No evidence of illegal dumping.	Some evidence of in-stream or shoreline littering; and/or some evidence of illegal dumping, such as a sign prohibiting dumping along with observed garbage bags of material. Limited vehicular access limits the amount of potential dumping, or material dumped is diffuse paper-based debris (e.g., convenience stores or fast food).	Prevalent in-stream or shoreline littering; and/or the presence of **one** of the following: furniture, appliances, or bags of garbage or yard waste, coupled with vehicular access that facilitates in-and-out dumping of materials to avoid landfill costs.	Significant litter on shoreline or stream banks and streambed; and/or evidence of chronic dumping, with **more than one** of the following items: furniture, appliances, shopping carts, garbage bags, or yard waste. Easy vehicular access for in-and-out dumping of materials to avoid landfill costs.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

SWAMP
Surface Water Ambient Monitoring Program

Accumulation of Trash:

6. Accum-ulation of Trash	There does not appear to be a problem with trash accumulation from downstream transport. Observable trash, if any, appears to have been directly deposited at the stream location.	Some evidence that litter and debris have been transported from upstream areas to the location. Less than 5 trash items have been transported from upstream locations, based on evidence such as silt marks, faded colors or location near high water marks.	5 to 20 items of observable trash are carried to the location from upstream, as evidenced by its location near high water marks and siltation marks on the debris.	Trash appears to have accumulated in substantial quantities at the location based on delivery from upstream areas, and is in various states of degradation based on its persistence in the waterbody. Over 20 items of observable trash have been carried to the location from upstream.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Trash Accumulation Over Time:

Look for Signs of:
- Aging
- Decomposition
- Layering
- Dates on trash items

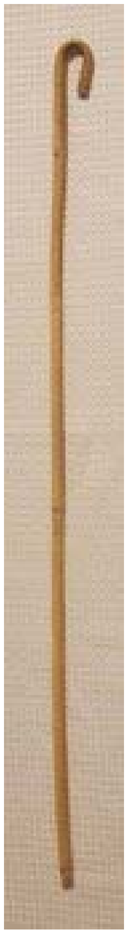
SWAMP
Surface Water Ambient Monitoring Program

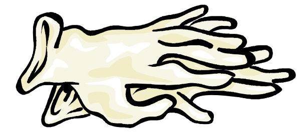
Total Score:

Total Score ________________

Add up all Parameter scores.

Equipment:





- Tape Measure or 100 Ft Rope
- Survey Markers, GPS or Landmarks
- Stick for Lifting Up Vegetation
- Gloves, Litter Grabbers and Trash Bags When Removing Trash
- Optional – GPS, Camera

SWAMP
Surface Water Ambient Monitoring Program

Health and Safety

Conducting Rapid Trash Assessments requires additional health and safety concerns.

- Sharp and or pointed objects many be encountered. These objects might be hidden from view (underwater, covered by sediments, mixed with other litter…).
- Biohazards might be encountered (used hypodermic needles, diapers, feces…).

AVOID: Homeless encampments, clandestine drug labs, or other dangerous areas.

If you encounter the illegal activities such as the disposal of hazardous waste or unidentifiable waste, do not enter the area. Contact the proper authorities ASAP.

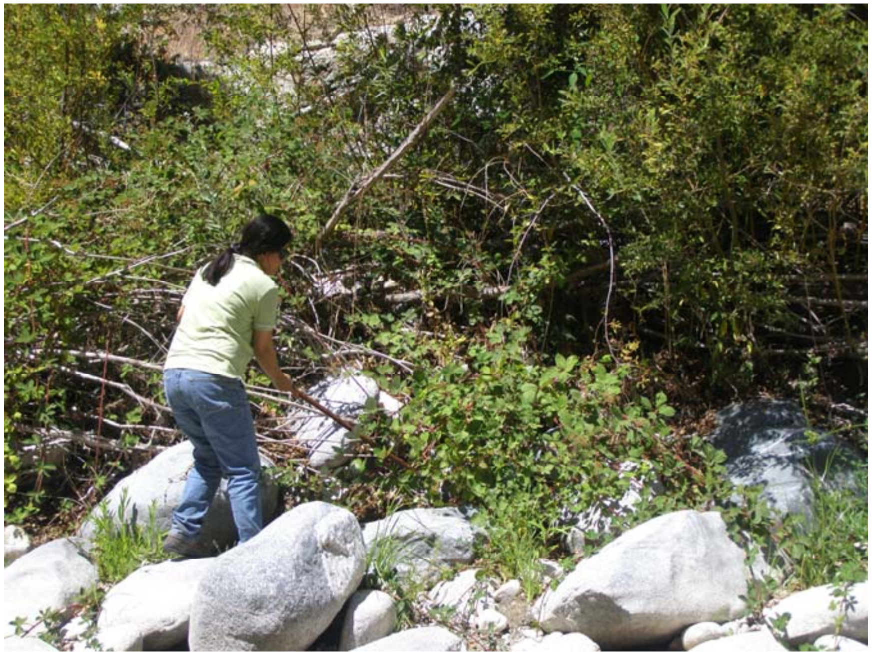
SWAMP
Surface Water Ambient Monitoring Program

Pictorial Overview/Review of a Rapid Trash Assessment

Streambank Person:

One team member begins walking along the bank or in the water (wear waders) at the edge of the stream or shore, looking for trash on the bank up to the upper bank boundary, and above and below the high water line.

This person picks up trash and if there is no recorder, tallies the items on the trash assessment worksheet as either above or below the high water line based on the previously determined boundary.



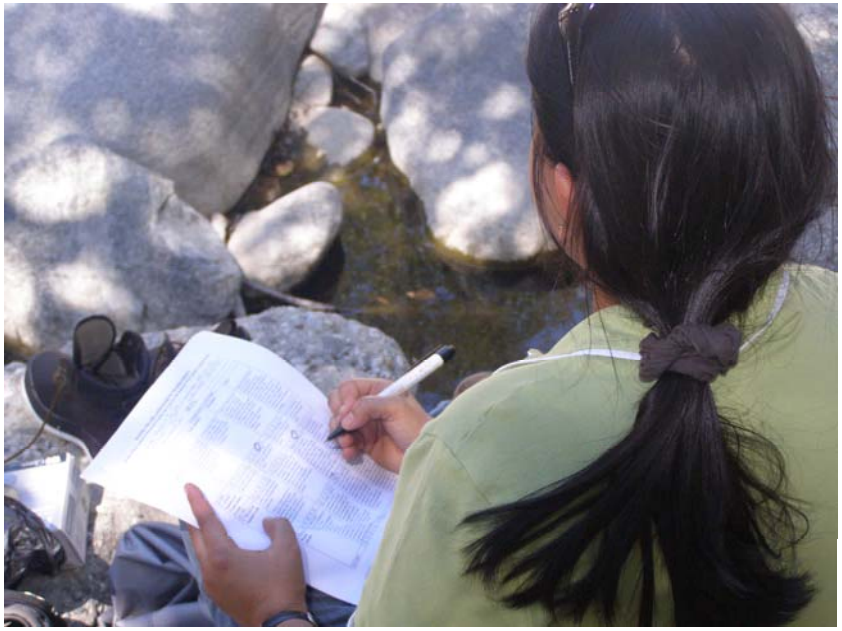
SWAMP
Surface Water
Ambient Monitoring
Program

Streambed Person:

The streambed person person walks in the streambed and up and down the opposite bank, picking up and calling out specific trash items found in the water body and on the opposite bank both above and below the high water line, for the tally person to mark down appropriately on the trash assessment sheet.

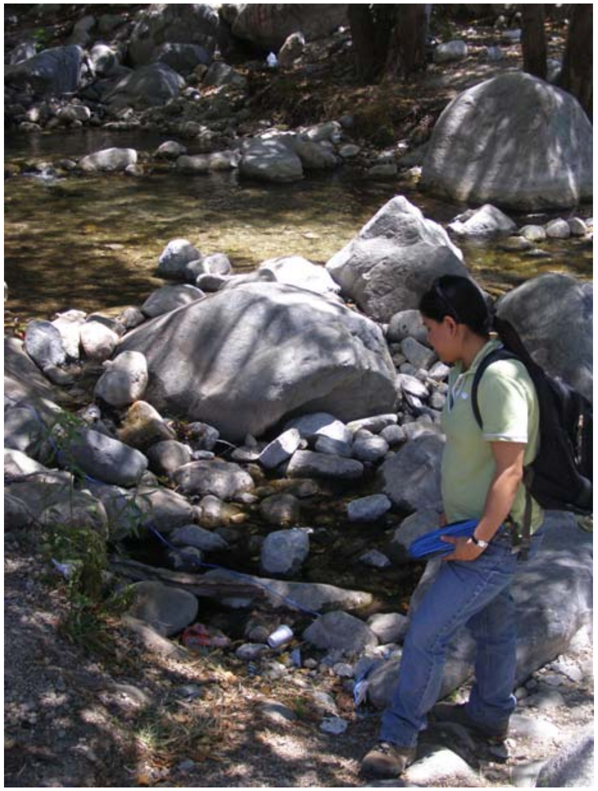
Recorder:

The recorder tallies all information collected by the bank person and the bed person.



Laying Out Transect:

The 100-foot distance be accurately measured. The length should be measured not as a straight line, but as 100 feet of the actual stream or shore length, including sinuous curves.



SWAMP
Surface Water Ambient Monitoring Program

Conducting the Assessment

Follow the steps previously outlined and conduct the assessment.

Record all findings.

Dispose of trash collected.

References:

California Regional Water Quality Control Board, Los Angeles Region. 2001. Trash Total Maximum Daily Loads for the Los Angeles River Watershed

California Regional Water Quality Control Board, San Francisco Bay Region. 2002. Rapid Trash Assessment Version 8 (Visit the RWQCBSFBR SWAMP Webpage for updates.)

Moore, Steve (2005) Poster: A Rapid Trash Assessment Method Applied to Waters of the San Francisco Bay Region: Trash Measurement in Streams California Regional Water Quality Control Board San Francisco Bay Region http://www.swrcb.ca.gov/water_issues/programs/swamp/docs/trash_poster.pps

Moore, Steve (2005) Power Point Presentation: A Rapid Trash Assessment Method Applied to Waters of the San Francisco Bay Region: Trash Measurement in Streams California Regional Water Quality Control Board San Francisco Bay Region http://conference.plasticdebris.org/whitepapers/Steven_Moore.pdf

Moore, Steve (2005) Report: A Rapid Trash Assessment Method Applied to Waters of the San Francisco Bay Region: Trash Measurement in Streams California Regional Water Quality Control Board San Francisco Bay Region www.swrcb.ca.gov/rwqcb2/docs/swampthrashreport.pdfS

Surface Water Ambient Monitoring Program California Regional Water Quality Control Board, San Francisco Bay Region. 2003. Evaluation of the Rapid Trash Assessment Methodology.

U.S. Environmental Protection Agency. 2001. Draft: Assessing and Monitoring Floatable Debris.

U.S. Environmental Protection Agency. 2002. The Definition, Characterization and Sources of Marine Debris. Unit 1 of Turning the Tide on Trash, a Learning Guide on Marine Debris.

SWAMP Surface Water Ambient Monitoring Program

Additional Resources

Allison, R.A., Chiew, F.H.S., and McMahon, T.A. (1998**) A Decision-Support-System for Determining Effective Trapping Strategies for Gross Pollutants**. Cooperative Research Centre for Catchment Hydrology. Victoria.

Allison, R.A., Walker, T.A., Chiew, F.H.S., O'Neill, I.C., McMahon, T.A. (1998) From Roads to Rivers, **Gross Pollutant Removal From Urban Waterways**. Cooperative Research Centre for Catchment Hydrology. Victoria.

Allison R.A., T.A. Walker, F.H.S. Chiew, LC. O'Neill and T.A. McMahon. (1998). *From Roads to Rivers,* **- *Gross Pollutant Removal from Urban Waterways* Technical Report** 98/6, Cooperative Research Centre for Catchment Hydrology, 97p.

Barnes, David, K. (2005) "**Remote islands reveal rapid rise of southern ocean debris**," *The Scientific World Journal*, 5, 915-921. DOI.O.1100/ISW.2005.120.

Barnes, David , (2002) "**Biodiversity: Invasions by Marine Life on Plastic Debris**," 41 6 *Nature*, 6883 (April 25, 2002): 808-809.

California Department of Transportation. 1999) **California Department of Transportation District 7 Litter Management Pilot Study.** Sacramento. Caltrans CT-SW-RT-00- 013.

California Department of Transportation. (2000), **Caltrans Litter Management Study (LMPS) Final Report**, Caltrans Doc. No. CT-S W-RT-00-O 1

California Department of Transportation. (2000), **Guidance Manual; Stormwater Protocols (Second Edition)**, Caltrans Doc. No. CTSW-RT-00-005

California Department of Transportation. (2000**),*Guidance for Monitoring Storm Water Litter***, Caltrans Doc. No. CTS W-RT-00-G25

California Department of Transportation Storm Water Program. (2003) **CalTrans Public Education Research Study- Final Report**, June 2003, p.14.

SWAMP
Surface Water Ambient Monitoring Program

Additional Resources 2

California Regional Water Quality Control Board Los Angeles Region. (2001) **Trash Total Maximum Daily Loads for the Ballona Creek and Wetland September 19, 2001**, California Regional Water Quality Control Board Los Angeles Region

California Regional Water Quality Control Board Los Angeles Region. (2001) **Trash Total Maximum Daily Loads for Los Angeles River Watershed September 19, 2001**

California State University Stanislaus Office of Water Programs. (2001) **Results of the Cal Trans Litter Management Pilot Study** http://www.owp.csus.edu/research/papers/papers/ PP020.pdf

http://www.cigwaste.org/preproduction/

City of Los Angeles, Watershed Protection Division, Department of Public Works, Bureau of Sanitation. (2004) **Technical Report: Best Management Practices for Implementing the Trash Total Maximum Daily Loads**

Copello, Sofia and Favio Quintara. (2003) "**Marine debris ingestion by Southern Giant Petrels and its potential relationships with fisheries in the Southern Atlantic Ocean**," *Marine Pollution Bulletin* 4 6 (2003): 1 513-1515

County of Los Angeles Department of Public Works. (2004) **Technical Report on Trash Best Management Practices**

County of Los Angeles Department of Public Works. (2004) **Trash Baseline Monitoring Results for Los Angeles River and Ballona Creek Watersheds** http://ladpw.org/wmd/TrashBaseline/Trash%20Monitoring%20rpt.pdf

Coe, J; D.B, Eds., **Marine Debris: Sources, Impacts and Solutions**, (1997) Springer-Verlag: New York, 4 32.

CDS Technologies. (2001), **Evaluation Protocols for Continuous Deflective Separation Performance (CDS)** April 5, 2001 and Addendum #1 April 20, 2001

Danza, Jim. (1994) **Water Quality and Beneficial Use Investigation of the Los Angeles River: Prospects for Restored Beneficial Uses**. Masters Thesis, California State University Fullerton.

Department of Recreation Management & Tourism, College of Public Programs. "**Exploring Norms and Behaviors Related to Litter & Recycling Among Arizona Residents & Visitors**." http://www.arizonacleanandbeautiful.org/research.html

Derraik, J.G. B. (2002) "**The pollution of the marine environment by plastic debris: a review**" *Marine Pollution Bulletin* 44 (2002): 843

DePoto, Bill. (2005) "**Stormwater Best Management Practices: A Primer**," in *WatershedWise*, 9/1-2, Summer/Fall 2005

SWAMP
Surface Water Ambient Monitoring Program

Additional Resources 3

Durrum, Emmett (1997**) The Control of Floating Debris in an Urban River**. In Marine Debris: Sources, Impacts, and Solutions, Coe, James and Rogers, Donald, Eds. New York: Springer-Verlag, 1997.

Endicott, J., et al, 2002, **Design and Performance of Non-Proprietary Devices for Highway Runoff Litter Removal**, Cal Trans and CSUS Office of Water Programs- presented at the American Society of Civil Engineers 9th International Conference on Urban Drainage.

Gregory, M.R., Ryan, P.G. (1997) "Pelagic plastics and other seaborne persistent synthetic debris: a review of Southern Hemisphere perspectives" in Coe, J.M. Rogers, D.B. (Eds.), MarineDebris—Sources, Impacts and Solutions, Springer-Verlag, New York, pp. 4 9-66.

Gordon, Miriam (2006) **Eliminating Land-based Discharges of Marine Debris in California: A Plan of Action from The Plastic Debris Project.** *Plastic Debris, Rivers to Sea Project*-Algalita Marine Research Foundation & California Coastal Commission

Goldberg, E. D. (1994) "**Diamonds and plastics are forever?**" *Marine Pollution Bulletin* 28 (1994): 4 66.

Goldberg, E. D. (1997) "Plasticizing the seafloor: An overview," *Environmental Technology* 1 8 (1997:195-201.

Gordon, Miriam and Ruth Zamist, **MUNICIPAL BEST MANAGEMENT PRACTICES FOR CONTROLLING TRASH AND DEBRIS IN STORMWATER AND URBAN RUNOFF.** California Coastal Commission Algalita Marine Research Foundation

Gregory, M.R. (1999) "**The hazards of persistent marine pollution: drift plastics and conservation islands**," Journal of the Royal Society of New Zealand 21 (1991): 83-100;

Gregory, M.R. (1999) "**Plastics and the South Pacific island shores: environmental implications**," Ocean and Coastal Management 42: 603-615

HydroQuol (1993), **City-Wide Floatables Study, Field and Laboratory Protocols** Capital project Number WP-112, Contract II

James, Roger B. "**Measurement and BMP Removal of Suspended Material in Storm Water Runoff"**, Water Resources Management 63

Laist, D.W. (1997) **Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records.** pp. 99-140. *In*: J.M. Coe and D.B. Rogers (eds.), Marine Debris: Sources, Impacts, and Solutions. Springer-Verlag. New York, NY.

SWAMP
Surface Water Ambient Monitoring Program

Additional Resources 4

Kanehiro, H and T. Tokai, K. Matuda (1995) "**Marine litter composition and distribution on the seabed of Tokyo Bay**," Fisheries Engineering 31:195-199.

Mato, Y. et al, (2002) "Toxic chemicals contained in plastic resin pellets in the marine environment -spatial difference in pollutant concentrations and the effects of resin type," Kankyo Kagakukaishi 1 5: 41 5-423.

Moore, C.J, et al, (2005) "**Density of Plastic Particles found in Zooplankton Trawls from Coastal Waters of California to the North Pacific Central Gyre," and "Working Our Way Upstream: A Snapshot of Land-Based Contributions of Plastic and Other Trash to Coastal Waters and Beaches of Southern California**," in Proceedings of the Plastic Debris Rivers to Sea Conference, September 2005, www.plasticdebris.org.

Moore, C.J. (Algalita Marine Research Foundation), Moore, S.L., Leecaster, M.K., and Weisberg, S.B.(1999) **Marine Debris in the North Pacific Gyre, 1999, with a Biomass Comparison of Neustonic Plastic and Plankton**.

Moore, Charles and Gwen Lattin, Ann Zellers (2005) "**Density of Plastic Particles found in zooplankton trawls from Coastal Waters of California to the North Pacific Central Gyre**," in Proceedings of the Plastic Debris, Rivers to Sea Conference, 2005. www.plasticdebris.org.

Moore, S. L., D. Gregorio, M. Carreon, S. B. Weisberg, and M. K. Leecaster. (2005) **Composition and distribution of beach debris in Orange County, California**. In: S.B. Southern California Coastal Water Research Project Annual Report 1999-2000**.** Southern California Coastal Water Research Project. Westminster, CA.

Moore, S.L. and Allen, M.J. (2000) **Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of the Southern California Bight**. Marine Pollution Bulletin 40:83-88.

Moore, S et al, 2001, "**Composition and Distribution of Beach Debris in Orange County, California**," Marine Pollution Bulletin, 42:3, 241-245

Moore, Charles; Gwen Lattin, Ann Zellers, "**A Brief Analysis of Organic Pollutants Sorbed to Pre and Post-Production Plastic Particles from the Los Angeles and San Gabriel River Watersheds**," presented at Plastic Debris, Rivers to Sea Conference September 7-9, 2005. www.plasticdebris.org

Moore, Charles; Gwen Lattin, Ann Zellers (2005) "**A Brief Analysis of Organic Pollutants Sorbed to Pre and Post-Production Plastic Particles from the Los Angeles sand San Gabriel River Watersheds**," presented at *Plastic Debris, Rivers to Sea Conference* September 7-9, 2005 In proceedings: www.plasticdebris.org

SWAMP Surface Water Ambient Monitoring Program

Additional Resources 5

Moore, Charles; Gwen Lattin, Ann Zellers (2005) "**Density of Plastic Particles found in Zooplankton Trawls from Coastal Waters of California to the North Pacific Central Gyre**," in Proceedings of the Plastic Debris, Rivers to Sea Conference, 2005 www.plasticdebris.org

Moore, S.L.; Dominic Gregorio, M. Carreon, Steven B. Weisberg, and M. Leecaster (2001) "**Composition and distribution of beach debris in Orange County, California**," *Marine Pollution Bulletin*, 4 2(2001): 241-245.

Nevins, Hannah et al (2005) "**Seabirds as indicators of plastic pollution in the North Pacific,**" presented at the *Plastic Debris, Rivers to Sea Conference* www.plasticdebris.org

Ogata, Yuko and Hideshige Takada, Kaoruko Mizukawa, Hisashi Hirai, Satoru Iwasa, Satoshi Endo, Yukie Mato, Mahua Saha, Keiji Okuda, Arisa Nakashima, Michio Murakami, Nico Zurcher, Ruchaya Booyatumanondo, Mohamad Pauzi Zakaria, Le Quang Dung, Miriam Gordon, Carlos Miguez, Satoru Suzuki, Charles Moore, Hrissi Karapanagioti, Steven Weerts, Tim McClurg, Erick Burres, Wally Smith, Michael Van Velkenburg, Judith Selby Lang, Richard Lang, Duane Laursen, Brenda Danner, Nickol Stewardson, Richard Thompson (2009) **International Pellet Watch : Global monitoring of persistent organic pollutants (POPs) in coastal waters. 1. Initial phase data on PCBs, DDTs, and HCHs.** Marine Pollution Bulletin, in press August 2009.

Ogi, Haruo and Yuri Fukumoto (2000) "**A Sorting Method for Small Plastic Debris Floating on the Sea Surface and Stranded on Sandy Beaches**," Bulletin of the Faculty of Fisheries, Hokkaido University 51(2), 2000, 71-93

Orange County Storm Water Program- Trash and Debris Task Force (2005) **A Review of Current Trash pollution and Mitigation Efforts in Orange County: Final Report**,

Orange County Storm Water Program (2003) **Trash and Debris Best Management PracticeEvaluation** http://www.ocwatersheds.com/Stormwater/PDFs/2003_Appendix_E/2003_Appendix_E2_Trash_Debris_BMP_Eval.pdf

Plastic Debris Rivers to Sea Conference 2005 http://conference.plasticdebris.org/agenda.shtml

Ribic, C.A., Johnson, S.W., and Cole, C.A. (1997) **Distribution, Type Accumulation, and Source of Marine Debris in the United States, 1989-1993**. Pp. 35-47 *in*: Coe, J.M., and Rogers, D.B. (eds.), Marine debris: Sources, impacts, and solutions. Springer-Verlag. New York, NY.

Russell Boudreau (2005) **Debris Nets in the San Gabriel River-Design and Physical Modeling**, Moffat & Nichol, www.plasticdebris.org/WhitePapers/Russell_Boudreau/pdf

SWAMP
Surface Water Ambient Monitoring Program

Additional Resources 6

Seba Sheavly,Seba (2005) **Beach Debris-Characterized through the International Coastal Cleanup & the U.S. National Marine Debris Monitoring Program**, presented at *Plastic Debris, Rivers to Sea Conference,* September 7-9, 2005. www.plasticdebris.org
Slaughter, Ellie (2009) Acute Toxicity of Cigarette Butt Leachate to Marine and Freshwater Fish. San Diego State University School of Public Health

Spiegelman, Helen and & Bill Sheehan (2005) "**Unintended Consequences: Municipal Waste Management and the Throwaway Society**" Product Policy Institute http://www.productpolicy.org/assets/resources/UnintendedConsequences-MSWandEPR.pdf.

Syrek, Daniel B. and Masoud Kayhanian (2003) **A Regression Model to Predict Litter in Urban Freeway Outfalls after Rainstorms**. Presented at: StormCon, Austin Texas, July 2003

Syrek, Daniel and Frank Bernheisel (2000) **Mississippi Litter 2000, A Baseline Survey of Litter at 113 Street and Highway Locations**

Takada,H. et al., Tokyo University of Agriculture and Technology (2005) "**Pellet Watch: Global Monitoring of Persistent Organic Pollutants (POPs) using Beached Plastic Resin Pellets**," Presented at *Plastic Debris, Rivers to Sea Conference* September 7–9, 2005. www.plasticdebris.org

United Nations Environment Programme, GPA Coordination Office. **Marine Litter—Trash that Kills**, www.gpa.unep.org; http://marine-letter.gpa.unep.org/facts/what-where.htm

United States Environmental Protection Agency (US EPA) (1992) **Plastic Pellets in the Aquatic Environment: Sources and Recommendations**. Washington D.C. EPA 842-B-92-010.

United States, August 2002. **Assessing and Monitoring Floatable Debris**, Washington, D.C. p. 2-2; Williams et al.

United States Department of Commerce, National Oceanic and Atmospheric Administration, Office of Public and Constituent Affairs (1995) "**Turning to the Sea: America's Ocean Future**" (1999): 56. See also, UNEP, United Nations Environment Programme (1995) "Global Programme of Action for the Protection of the Marine Environment from Land-based Activities." Note by the secretariat. UNEP (OCA) /LBA/IG.2/7

United States Department of Transportation, Federal Highway Administration. ***Stormwater Best Management Practices an Ultra-Urban Setting: Selection and Monitoring,*** **"Fact Sheet- Street Sweepers**" – www.fhwa.dot.gov/environment/ultraurb/3fs16.htm

SWAMP
Surface Water Ambient Monitoring Program

Additional Resources 7

United States Environmental Protection Agency (1999) **Combined Sewer Overflow Technology Fact Sheet- Floatables Control.** Washington, D.C. EPA 832-F99-088- http://www.epa.gov/owm/mtb/floatctrl.pdf
United States Environmental Protection Agency (1999) **Storm Water Technology Fact Sheet: Hydrodynamic Separators**, Washington, D.C. EPA 832-F-99-017

United States Environmental Protection Agency (2001) **Stormwater Technology Fact Sheet: Baffle Boxes,** Washington, D.C. EPA 832-F-01-004 http://www.epa.gov/owm/mtb/baffle_boxes.pdf

United State Environmental Protection Agency (1992) ***Plastic Pellets in the Aquatic Environment: Sources and Recommendations***.

Walker, T.A., Allison, R.A., Wong, T.H.F., and Wooton, R.M (1999) **Removal of Suspended Solids and Associated Pollutants by a CDS Gross Pollutant Trap**. Cooperative Research Centre for Catchment Hydrology. Victoria.

Walker, T.A., Wong, T.H.F. (1999) **Effectiveness of Street Sweeping for Stormwater Pollution Control, Technical Report, Report 99/8, December 1999**. Cooperative Research Centre for Catchment Hydrology. Victoria.

Wallace, N. (1985) "**Debris entanglement in the marine environment**: A review" (1985) pp. 259-277 in: R.S. Shomura and H.O. Yoshida (eds.), *Proceedings of the Workshop on the Fate and Impact of Marine Debris*, U.S. Department of Commerce, NOAA Technical Memorandum. NMFS, NOAA-TM-NMFS-SWFC-54.

Wang, Thea, (2005) "**Friend's of the L.A. River's Trash Sort**." In "First State of the River Report 2005", FOLAR

Williams, Allan T. and Murray T. Gregory, M, D.T. Tudor, (2005) "**Marine Debris- Onshore, Offshore, Seafloor Litter**," 2005. Encyclopedia of coastal processes, (ed.), M Schwartz, p. 623, Springer.

William McDonough and Michael Braungart (2002) **Cradle to Cradle: Remaking the Way we Make Things.** North Point Press

SWAMP
Surface Water Ambient Monitoring Program