



Project Summary

Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems: A User's Guide

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This User's Guide, summarized here, is the result of a series of research tasks (sponsored by the U.S. Environmental Protection Agency) to develop a procedure to investigate non-stormwater entries into storm drainage systems. Past projects have found that dry-weather flows discharging from storm drainage systems can contribute significant pollutant loadings to receiving waters. These dry-weather flows originate from many sources; the most significant include sanitary wastewater, industrial and commercial pollutant entries, failing septic tank systems, and vehicle maintenance activities. After identification of the outfalls that contain polluted dry-weather flows, additional survey activities are needed to locate and correct the non-stormwater entries into the storm drainage systems. If these loadings are ignored (e.g., by only considering wet-weather stormwater runoff), only limited improvement in receiving water conditions will occur with stormwater pollution control programs.

This User's Guide contains information on designing and conducting local investigations to identify the types and to estimate the magnitudes of these non-stormwater entries.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate User's Guide of the same title (see User's Guide ordering information at back).

Introduction

Current interest in illicit or inappropriate connections to storm drainage systems is an outgrowth of investigations into the larger problem of determining the role of urban stormwater runoff as a contributor to receiving water quality problems. Water discharged from stormwater drainage systems often includes waters from many non-stormwater sources. A 1987 study in Sacramento, CA, found that slightly less than half the water discharged from a stormwater drainage system was not directly attributable to runoff. Illicit and/or inappropriate entries to the storm drainage system are likely sources of this discharge and can account for a significant amount of the pollutants discharged from storm drainage systems.

Common sources of non-stormwater entries include sanitary wastewater, automobile maintenance and operation waste products, laundry washwater, household toxic substances, accident and spill waste streams, runoff from excess irrigation, and industrial sources of cooling waters, rinse water, and other process wastewater. Although these sources can enter the storm drainage system through a variety of ways, they generally result from either direct connections (e.g., wastewater piping either mistakenly or deliberately connected to the storm drains) or indirect connections (e.g., infiltration into the storm drain system or spills collected by drain inlets). Sources can be further divided into those discharging continuously and those discharging intermittently. Table 1 gives a simple overview of typical pollutant sources and their most likely characteristics.



Table 1. Potential Inappropriate Entries into Storm Drainage Systems

Potential Source	Storm Drain Entry ^a		Flow Characteristics		Contamination Category		
	Direct	Indirect	Continuous	Intermittent	Pathogenic/Toxic	Nuisance	Clear
Residential Areas:							
Sanitary Wastewater	X	x	X	x	X	x	
Septic tank effluent		X	X	x	X	x	
Household chemicals	x	X		X	X		
Laundry wastewater	X			X		X	
Excess landscaping watering		X		X	x	x	X
Leaking potable water pipes		X	X				X
Commercial Areas:							
Gasoline filling station	X	x		X	X		
Vehicle maintenance/repair	X	x		X	X		
Laundry wastewater	X		X	x	x	X	
Construction site de-watering		X	X	x		X	
Sanitary wastewater	X	x	X		X		
Industrial Areas:							
Leaking tanks and pipes	x	X	X	x	X		
Miscellaneous process waters	X	x	X	x	X	x	x

X = most likely condition; x = may occur; blank = not very likely
^a = direct, e.g., by piping; indirect, e.g., infiltration and spills

Figure 1 is a simplified flow chart for the detailed methodology contained in the User's Guide. The initial phase of the investigative protocol includes the initial mapping and surveys. These activities require minimal effort and result in little chance of missing a seriously contaminated outfall. The initial activities are followed by more detailed watershed surveys to locate and correct the sources of the contamination in the identified problem areas. After corrective action has been taken, repeated outfall field surveys are required to ensure that the outfalls remain uncontaminated. Receiving water monitoring should also be conducted to analyze water quality improvements. If expected improvements are not noted, then additional contaminant sources are likely present and additional outfall and watershed surveys are needed.

The User's Guide summarized here is designed to provide information and guidance to agencies planning or implementing an investigation of illicit entries to a stormwater or wastewater drainage system. This is achieved by

- 1) Providing a methodology to identify and describe potential sources of non-stormwater pollutant entries into the storm drainage system and

- 2) Describing an investigative procedure that will allow a user first to determine whether significant non-stormwater entries are present in a storm drain, and then to identify the potential type of industrial, residential, or commercial source responsible, as an aid to the ultimate location of the source.

Procedures

The investigation steps described in the User's Guide are:

- Drainage area mapping
- Tracer identification
- Field survey and data collection
- Analyses of data collected
- Categorization of outfalls
- Investigation and remediation
- Pollution prevention program

Mapping

The mapping exercise is carried out as both a desktop operation by using existing information and with field visits to collect further data and to confirm existing information. The maps should provide complete descriptions of the drainage areas including outfall locations, watershed boundaries for each outfall, critical land use areas (mostly commercial and industrial areas), permitted discharges to the storm drainage system, city limits, major

streets, streams, etc. The User's Guide discusses critical land use areas and lists major industries and their potential to be non-stormwater entry sources.

The drainage areas are ranked in the order of their potential to cause problems, which will allow priorities to be set for field investigation of the outfalls. Note that all outfalls will eventually require investigation and the mapping stage is important because the entire investigation is based on it.

Tracer Identification

To detect and identify non-stormwater entries, the dry-weather outfall discharge is analyzed for selected tracers (e.g., ammonia, surfactants) which are found in the potential contaminating sources. The selected tracers should ideally be unique for each potential non-stormwater contaminating source and exhibit the following properties:

- significant difference in concentrations between possible pollutant sources,
- small variations in concentrations within each likely pollutant source category,
- a conservative behavior (i.e., no significant concentration change due to physical, chemical, or biological processes), and
- ease of measurement with adequate detection limits, good sensitivity, and repeatability.

The User's Guide suggests tracers applicable for common pollutant sources (e.g. sanitary wastewater, septic tank effluent, laundry wastewater, and vehicle wash wastewater as well as potable water and "natural waters"). A non-stormwater entry investigation may need to select additional tracers specific to potential pollutant sources, especially industries, in the study area (e.g., major ions, specific heavy metals, etc.). For each selected tracer, the concentration means and standard deviations in all the potential source flows in the drainage area are needed (use of data from other drainage area investigations is not recommended).

Local data collected on tracers will be essential to identify the sources in the outfall discharge. It is important that the tracer data be accurate; guidance is provided on representative sampling and the number of samples required for valid data.

Field Survey

Field investigations are used to locate and record all outfalls including outfalls not previously identified from the mapping exercise. During field investigations, outfalls are physically inspected and

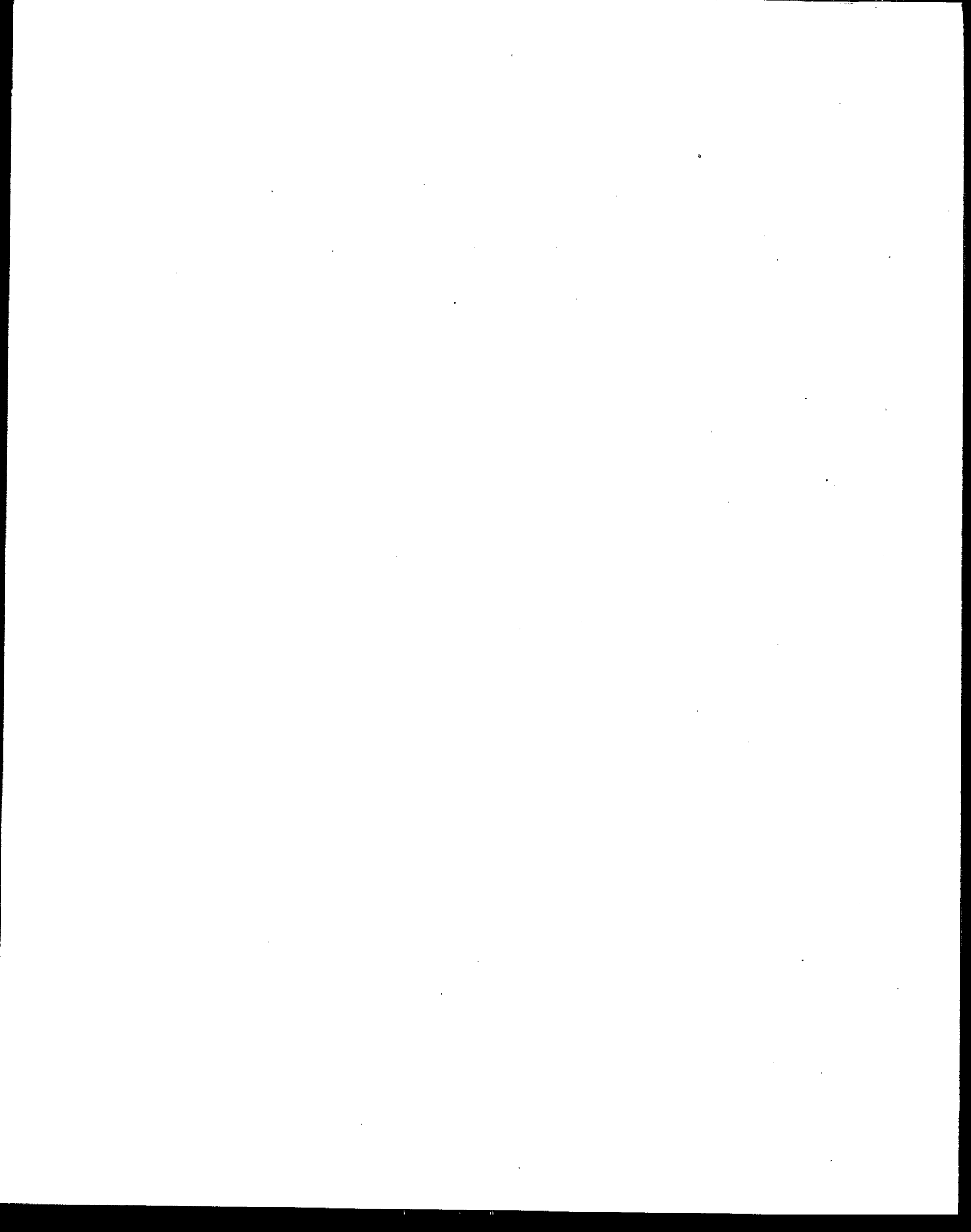


New Report Available

Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems: A Users Guide

You recently received a Project Summary (EPA/600/SR-92/238) with the title shown above. An important source for the full report was omitted from the ordering information on the back page. Copies of the full report entitled, "Investigation of Inappropriate Pollutant Entries Into Storm Drainage Systems: A Users Guide" (EPA/600/R-92/238, January 1993), are available free of charge as long as the supply lasts. These copies can be ordered from:

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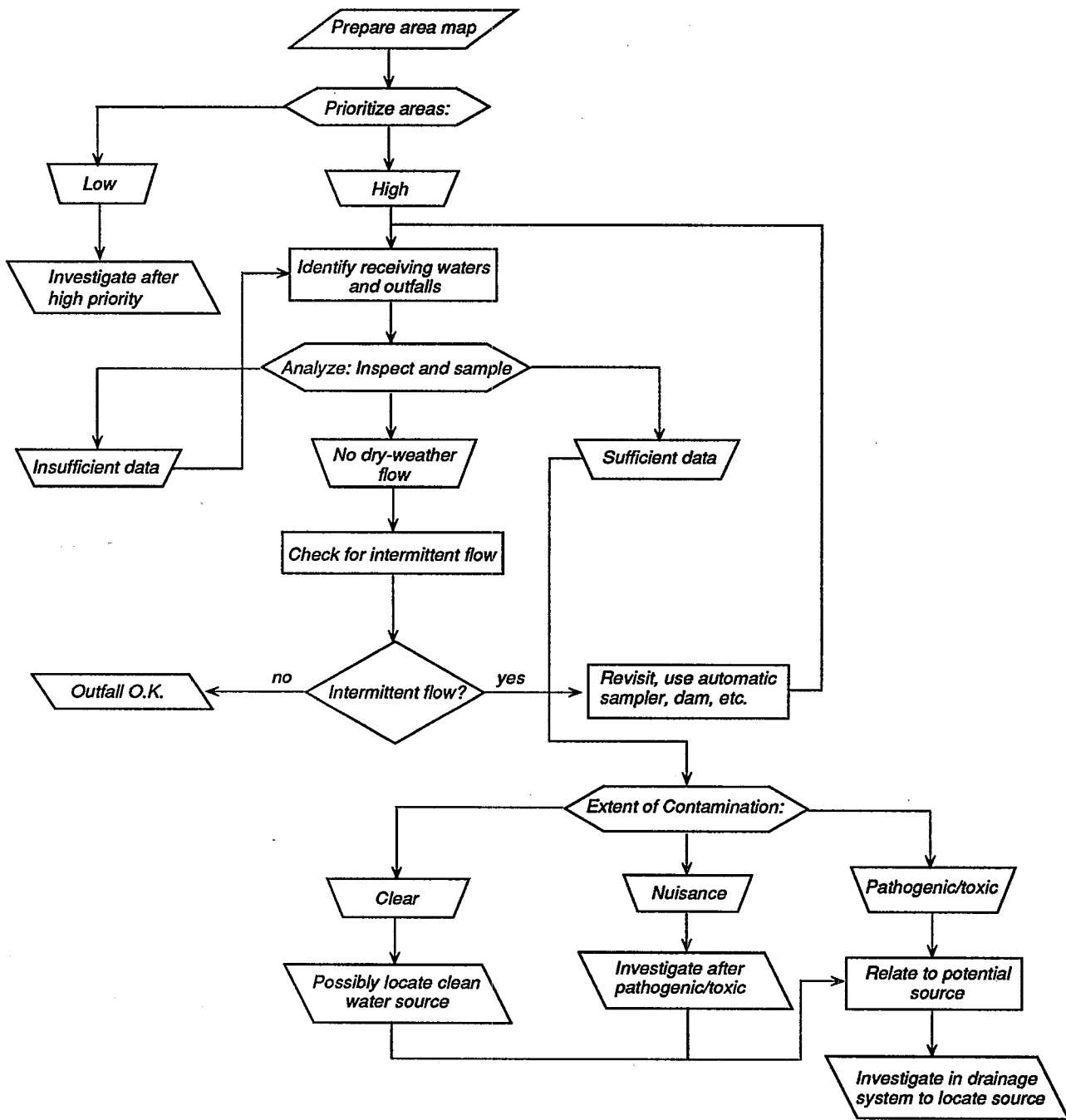


Figure 1. Flow chart for investigation procedures.

samples taken of any dry-weather flow for analyses.

The field survey should, as a minimum, include

- accurately locating outfalls and assigning ID numbers;
- photographing outfalls;
- estimating outfall discharge flowrate (or identifying likely intermittent discharge);
- physically inspecting and recording outfall characteristics including discharge odor, color, turbidity, floatable matter (solids, oil sheen, etc.), temperature, deposits, stains, vegetation affected by pollutants, and damage to outfall structure; and
- collecting dry-weather discharge samples for tracer analyses of specific conductivity (can be field measured with temperature), fluorides, hardness, ammonia, potassium, surfactants, fluorescence, and pH, (plus others, depending on industrial activities).

Intermittent flows will be more difficult, if not virtually impossible, to confirm and sample. Additional field visits, use of automatic samplers, and flow damming techniques may prove successful for obtaining samples of intermittent flows.

Analyses of Data Collected

Simple testing procedures are suggested for analyzing the tracer parameters. Except for temperature and specific conductivity measurements, the analyses should be carried out in a laboratory and not in the field to ensure consistent results. The laboratory need not be sophisticated; it can be a room or trailer set up on a temporary basis.

The recommended analytical procedures for each tracer parameter are based on the following criteria:

- appropriate detection limits,
- freedom from interferences,
- good analytical precision,
- low cost, good equipment durability, and
- reasonable operator training requirements.

Guidance is also given on appropriate levels of analytical detection and precision (repeatability) needed to achieve acceptable results.

Categorize Outfalls

Three levels of outfall discharges are defined: (1) pathogenic or toxic pollution, (2) nuisance and aquatic-life-threatening pollution, and (3) unpolluted.

The pathogenic and toxic pollutants can cause illness upon water contact or consumption and cause significant water treatment problems for downstream consum-

ers, especially if the pollutants are soluble metal and organic toxicants. These pollutants may originate from sanitary, commercial, or industrial wastewater non-stormwater entries. Other residential area activities with a pollution potential include household toxicant disposal, automobile engine degreasing, and excessive use of fertilizers and pesticides.

Nuisance and aquatic-life-threatening pollutants include laundry wastewaters, lawn irrigation runoff, vehicle washwaters, construction-site dewatering, and washing of concrete ready-mix trucks. These pollutants can cause excessive algal growths, tastes, and odors in downstream water supplies, offensive coarse solids and floatables, and noticeably colored, turbid or odorous waters.

Clean water discharged through stormwater outfalls can originate from natural springs feeding urban creeks that have been converted to storm drains, infiltrating groundwater, infiltrating domestic water from waterline leaks, etc.

Comparing the collected dry-weather outfall discharge data with potential source flow data should allow outfalls to be classified. At the very least, outfalls with major pollutant sources should be identified for immediate remediation.

Investigation and Remediation

Drainage area investigations to locate the source(s) of non-stormwater entries can take a number of forms:

- in-depth watershed evaluation (e.g., evaluate whether source is likely to be an individual industry or an areawide problem such as general failure of sanitary wastewater sewers);
- drainage system upstream surveys, (e.g., tracer analyses, visual inspections, smoke and dye tests, and TV surveys to trace the individual source of the pollutant); and
- industrial and commercial site studies (e.g., identify materials/chemicals used and/or produced and whether the sites discharge to a storm drainage system).

Correction of the source, once located, may not be as simple as disconnecting the illicit entry. Widespread and numerous pollutant entries may make a disconnection program impractical, or the existing sanitary wastewater system may not have the capacity to accept more flow. In these cases the storm drainage system may need to be classed as a combined sewer system and have end-of-pipe treatment applied.

Pollution Prevention Program

The goal of eliminating all non-stormwater entries is unlikely to be achieved; however, any action that prevents future entries should be promoted. Typical actions include:

- educating the public (industrial, commercial, residential, and governmental) and
- developing zoning and ordinances.

Discussion

In addition to the above-outlined investigative steps, the User's Guide provides background information in the form of discussions, tables, and checklists to assist the user in identifying contaminated outfall discharges and potential sources, and how to use the tracer data to estimate the proportion of each contaminating source flow in the outfall flow.

Two very simple hypothetical examples illustrate the use of the User's Guide:

Example 1

Use of User's Guide Tables and Check List

A mapping exercise identified the following industries in the stormwater drainage area: vegetable cannery, general food store, fast food restaurant, cheese factory, used car dealer, cardboard box producer, and a wood treatment company.

A field survey revealed an outfall with constant dry-weather flow, a normal pH (6), and low total dissolved solids concentrations (300 mg/L). Other outfall characteristics included a strong odor of bleach, no distinguishing color, moderate turbidity, sawdust floatables, a small amount of structural corrosion, and normal vegetation.

The significant characteristic in this situation is the sawdust floatables. The industries that could produce sawdust and have dry-weather flow drainage to this pipe are the cardboard box company and the wood treatment company. According to SIC code (from the User's Guide), the cardboard box company would fall under the category of "Paper Products" (SIC# 26) whereas the wood treatment company would be under that of "Lumber and Wood" products (SIC# 24). A comparison of these two industries (by their corresponding SIC group numbers in the User's Guide), indicates that a characteristic of the paper industry is a strong potential for the odor of bleach; wood products do not have any particular smell indicated.

Based on these data, the most likely industrial source of the non-stormwater discharge would be the cardboard box

company. The User's Guide under SIC# 26 indicates that there is a high potential for direct connections in paper industries under the categories of water usage and illicit or inadvertent connections. At this point, further investigations should be conducted at the cardboard box company to confirm the specific source.

Example 2

Use of Flow-Weighted Mixing Calculations

This simplified example is structured on a mass balance basis for just four potential flow sources and four tracers (P1, P2, P3, P4). Table 2 shows the resulting set of mass balance equations which can be applied to each outfall sample.

A1 through A4 represent the fraction of flow contributed from each potential flow source. The "C" terms represent concentrations for each particular tracer (P1 through P4) within each flow source (1 through 4). The "m" terms represent the tracer concentrations actually measured in the outfall sample.

By using tracer concentration data in the potential source flows (C) and in the outfall discharge (m), the matrix can be solved to indicate the fraction of flow contributed from each possible flow source (A1 through A4). More than four potential sources can be included providing there are data on an equal number of suitable tracers.

A similar matrix method can also be used to incorporate uncertainty in source

Table 2. Mass Balance Equation Matrix

Tracer	Potential Flow Sources				Outfall Quality				
	1	2	3	4					
P1:	(A1) (C11)	+	(A2) (C21)	+	(A3) (C31)	+	(A4) (C41)	=	m1
P2:	(A1) (C12)	+	(A2) (C22)	+	(A3) (C32)	+	(A4) (C42)	=	m2
P3:	(A1) (C13)	+	(A2) (C23)	+	(A3) (C33)	+	(A4) (C43)	=	m3
P4:	(A1) (C14)	+	(A2) (C24)	+	(A3) (C34)	+	(A4) (C44)	=	m4

area characteristics. This method results in a range of predicted source flow contributions.

Recommendations

This User's Guide should be used as part of a comprehensive stormwater management plan that addresses all sources of stormwater pollution. Correcting only the most obvious pollutant entries is unlikely to significantly improve the quality of stormwater discharges or receiving waters.

A municipality planning an investigation of inappropriate entries to its storm drainage system needs to base this on local conditions. This User's Guide describes the issues in sufficient depth, with examples, to enable the design of a local investigation.

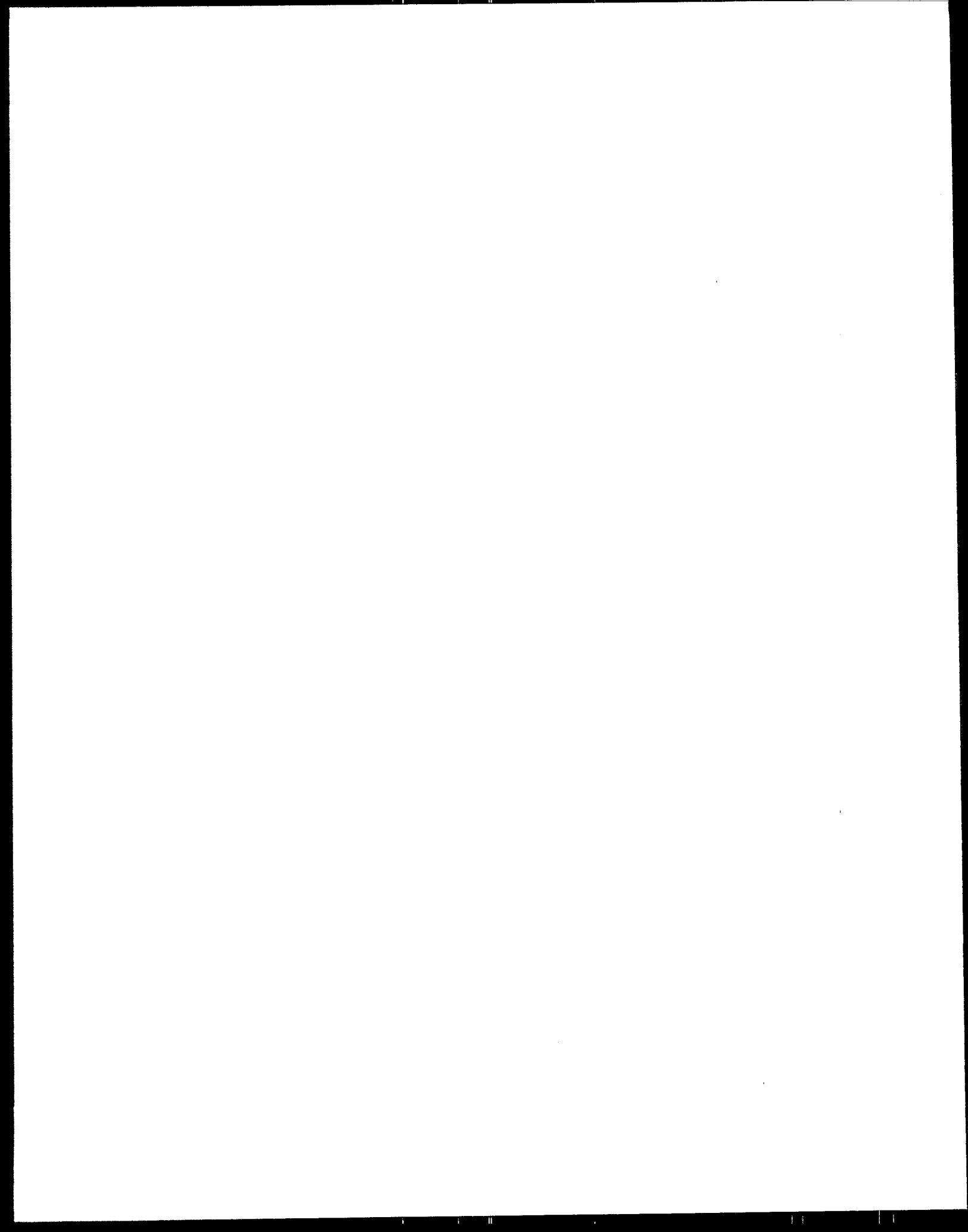
All the applicable procedures described in the User's Guide must be used to successfully identify pollutant sources. For example, attempting to reduce costs by only examining a certain class of outfalls or using inappropriate testing procedures will significantly reduce the utility of the

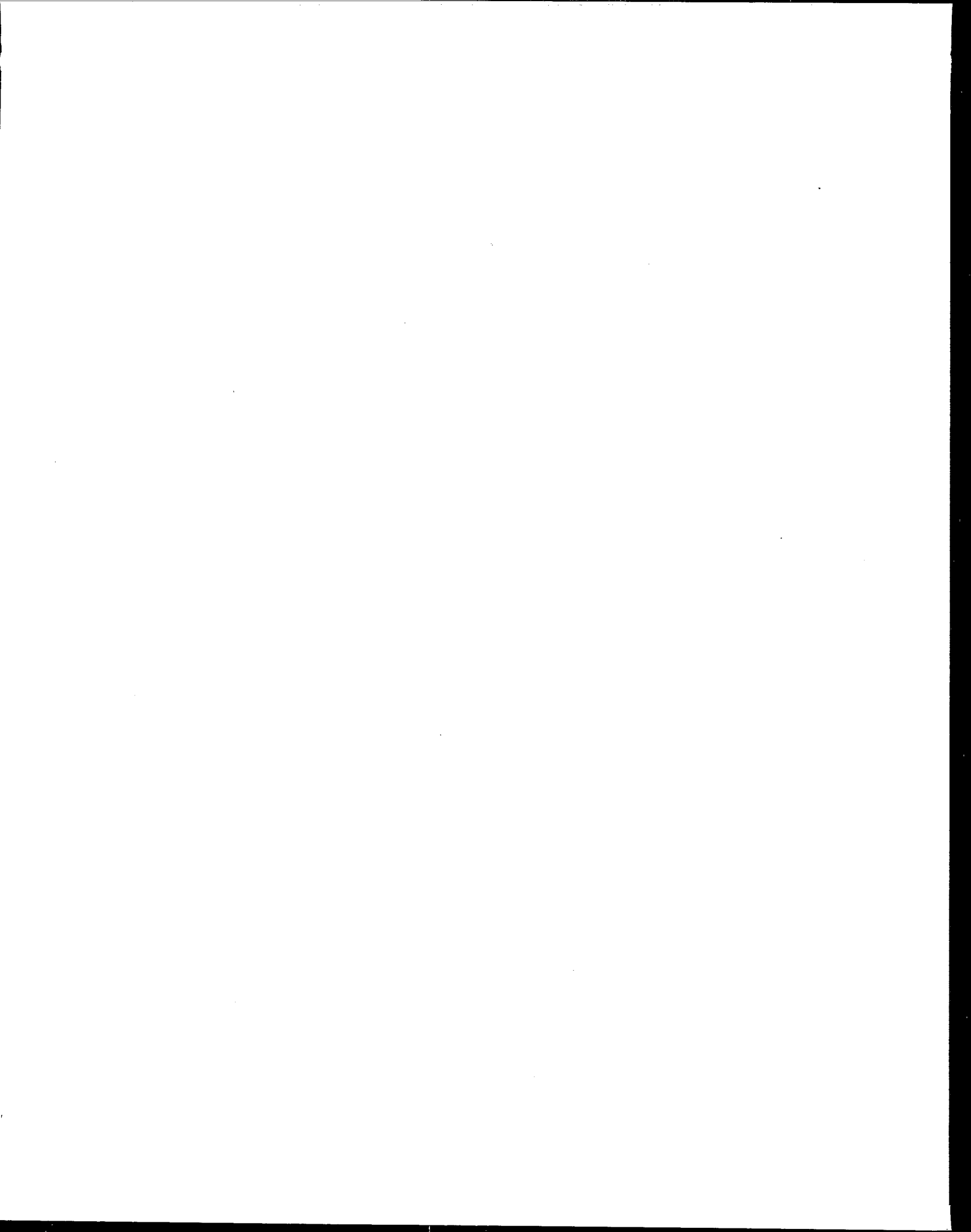
testing program and result in inaccurate data. cursory data analyses are also likely to result in inaccurate conclusions.

At an early stage, the economic and practical advantages of designating the storm drainage system as a combined sewer (and applying end-of-pipe treatment) should be considered. This early review could save further investigation costs.

The methodology (appropriately modified) can also be applied to other types of sewerage systems, such as combined and separate sanitary sewerage systems, to locate inappropriate entries, e.g., untreated or toxic industrial wastewaters/wastes and infiltration/inflow (into sanitary systems).

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The complete report, entitled "Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems: A User's Guide," (Order No. PB93-131472/AS; Cost: \$19.50, subject to change) will be available only from

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