Contractor’s Report to the Board

“To the Greatest Extent Possible”: Do-It-Yourselfers and the Recovery of Used Oil and Filters

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Executive Summary

Sources

This report is based on the Board’s statewide survey of do-it-yourself (DIY) oil changers conducted in 2001. In that survey, respondents described in great detail their oil changing and disposal for the year 2000–01. All totals estimated directly from the survey data have been projected forward to the number of households in California on January 1, 2004.

Some important quantities, including rates and volumes of oil illegally disposed, were estimated by combining survey estimates and collection data in the Board’s database, which is based on reports by block grantees of oil and filter collection in 2003–04, as compiled, verified, and re-estimated by Used Oil Program staff. Estimates of DIY oil changing and oil and filter collection by county were obtained by projecting survey estimates onto the Census Bureau’s 5 percent sample of 575,134 California households in 2000, projected onto the number of households in January 2004.

Findings and Recommendations about Used Oil and Filters

Findings about Disposal and DIYers

Note: In this report, improper disposal means illegal disposal.

1. Sixty-four percent of the California households where oil is changed by a DIYer disposed of used oil improperly in 2003–04 (Sections 1, 3).

2. Two distinctly different types of DIYers engage in DIY work for different reasons and dispose of very different volumes of oil on average. Most DIYers change oil only for vehicles in their own households, but “shade-tree mechanics” (STM) change oil on vehicles outside their households as well (Sections 1 and 4 especially).

3. California has about 2.1 million DIY households. Of the DIYers in those households, 348,000 are also STMs; 1.76 million are DIYers within the household only. More than 100,000 DIY households, mainly STMs, dispose of 25 gallons or more of used oil per year (Section 1).

4. STMs disposed of more than half of DIY used oil in 2003–04 and accounted for 50–80 percent of the improperly disposed oil. At least among U.S.-born DIYers, STMs are more likely than other DIYers to dispose improperly. On average, STMs disposed of nine times as much oil improperly per year as other DIYers (Section 4).

5. High-volume oil changing and improper disposal, mainly by STMs, is concentrated at younger ages and in households with low and moderate income (Section 8). The motivation for high-volume STM work is economic (Section 4).

6. Large numbers of new immigrants enter California each year. As we showed in the 2002 initial results and confirm in this report, new immigrants have substantially higher rates of improper disposal. They arrive knowing nothing about used oil recycling. This implies a need to conduct continuing outreach to these groups, in their languages and in culturally sensitive and effective ways. (Section 2, 8 and 9)

Findings about Collection of Used Oil

7. In 2003–04, 40 percent of the oil that DIYers drained from their vehicles was collected. (Section 3).
8. There are two main methods of collecting used oil in California: center-based collection—DIYer delivery of used oil to collection centers—and curbside collection. Collection via centers has been more widely implemented and produces much more oil in total, but curbside collection is much more effective at reducing improper disposal (Section 6).

9. Curbside collection of used oil has developed in California almost entirely in the northern and central counties. Localities in most counties, including the most populous counties of southern California, rely entirely or almost entirely on collection through centers to which DIYers take their oil.

10. Curbside collection. Where curbside collection is available to DIYers, it is very effective, reducing estimated improper disposal to zero (Section 6). Its shortcoming at present is that it is typically not available to DIYers who reside in multifamily dwellings and typically not available to younger DIYers (including STMs), who generate most of the improperly disposed used oil (Sections 8, 9).

11. Collection centers. Very convenient centers are somewhat effective, reducing improper disposal to a little under 40 percent. The shortcomings of collection centers are: they are often not convenient for DIYers; and even when they are very convenient, many DIYers still do not recycle their used oil (Section 6). Even very convenient centers fail to collect a substantial fraction of used oil unless more effective ways can be found to change the behavior of improper disposers and increase their commitment to recycle.

12. Possible oil collection efforts are estimated to collect additional used oil that is now illegally disposed:

<table>
<thead>
<tr>
<th>Effort</th>
<th>Millions of Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making collection centers “very convenient” for every DIY household</td>
<td>3.8</td>
</tr>
<tr>
<td>Extending regular curbside collection to 90 percent of California’s DIY households not presently served by it</td>
<td>12.5</td>
</tr>
<tr>
<td>Collecting all DIY used filters and extracting all their oil</td>
<td>2.1</td>
</tr>
<tr>
<td>Collecting all empty new oil containers and extracting all their oil</td>
<td>1.1</td>
</tr>
</tbody>
</table>

13. Information about specific impacts of used oil in the environment helps overcome lack of convenience of collection centers. DIYers who find taking oil to a collection center inconvenient dispose improperly at a lower rate if they have some knowledge of the impact of used oil (Section 7).

Findings and Recommendations about High-Priority Target Groups

14. Younger U.S.-born STMs are by far the highest priority target group for oil collection programs statewide. They are highest on three main criteria: rate of improper disposal, average volume of oil improperly disposed, and total oil improperly disposed (Section 9).

15. STMs pose a special problem. Many of them dispose of very large amounts of oil improperly. They also may wish to remain unknown to government. The potential for conflict between objectives of oil collection and objectives of regulation and taxation is significant (Section 4).

16. Maximizing collection of used oil and filters disposed by STMs should be a top priority. The CIWMB and local programs should develop special approaches to STMs or institute curbside collection that does not require a special approach except avoiding limits on the amount of oil that can be picked up at residences.
Findings and Recommendations about Curbside Vs. Center Collection of Used Oil

17. Because curbside collection has demonstrated that it reduces estimated improper disposal to zero, curbside collection is the method of choice for used oil collection (Sections 6, 10, 13).

18. To support curbside collection, the Board should encourage localities to establish, expand, and improve curbside collection of oil, filters, and empty oil containers; disseminate information about low-cost, effective, secure curbside collection systems; develop model contracts; and encourage the development of markets in which enthusiastic providers of effective recycling services engage in real competition to offer genuinely effective recycling services (Section 6).

19. Although some gains can be achieved via more convenient collection centers, they are likely to be much smaller than the gains from adoption of curbside pickup. Other disadvantages of collection via centers include its complexity and the substantial maintenance required to remain effective over time (Section 13).

20. Programs that ask DIYers to take their used oil to collection centers can estimate the probability of changing an improper disposer’s behavior with outreach campaigns by applying a simple conceptual scheme that will improve program decision-making over time (Section 13).

21. In center-based collection programs, future reductions of improper disposal are likely to be harder and harder to achieve because the easy-to-persuade DIYers already recycle. Continuous outreach will be especially important in localities with high levels of immigration or any kind of in-migration—but necessary in all center-based programs (Sections 6, 13).

Cost Comparisons of Curbside and Center-Based Collection

22. Cost is often cited as a reason for not adopting curbside collection. But the statutory objective is reducing illegal disposal of used oil and recycling it “to the greatest extent possible” (Public Resources Code Section 48600[f]), and curbside collection achieves that objective. Therefore, program costs for any comparison of curbside and center collection should be measured as the long-term cost of achieving near zero improper disposal. Comparisons should take into account the tendency of the collection operations of privately owned certified collection centers to deteriorate quickly over time (Section 6).

23. Cost per gallon of oil presently collected is not a meaningful basis for comparison of curbside and center-based collection. From the point of view of the statutory objective, curbside collection is successful in reducing improper disposal “to the greatest extent possible.” Centers-based collection has not yet shown it can succeed in that respect. Of course it is less expensive to collect less of the available oil (Section 6).

24. Cost is important. We recommend that the Used Oil Program work with local programs to develop best practices for successful, cost-effective curbside collection and, if necessary, to sponsor studies of the comparative long-term costs of driving illegal disposal of used oil to zero under each method (Section 6).

Findings and Recommendation about Disposal and Collection of Used Filters

25. Almost all used filters handled by the DIY public, and their residual oil, were improperly disposed in 2000–2001 because of the lack of filter collection infrastructure statewide and because DIYers are largely unaware that filters can and should be recycled (Section 11).
26. Much more residual oil remains in used filters than previously thought, even after they are 
drained. Residual oil in filters is a significant part of the total used oil stream (Section 11).

27. Collection of used oil filters for recycling should be a major goal of the CIWMB and local 
programs and much more prominent on Web sites and other informational efforts about used 
oil.

**Findings and Recommendations about Survey Research on Used Oil**

28. All surveys underestimate improper disposal of used oil and filters because people refuse to 
participate in surveys or because they conceal illegal or socially undesirable behavior by 
falsifying their responses to key questions. It is important to understand this so that State and 
local used oil programs are not led into false conclusions about rates of improper disposal 
from surveys that have not been adjusted to correct for underreporting (Section 1).

29. Survey estimates can be adjusted to correct for underreporting of improper disposal if data on 
oil collected from the public is available, the survey obtains data on oil disposed by DIYers at 
oil changes, and the methods developed by this project are applied (Section 3).

30. Replicating the statewide survey locally is not likely to be a good use of program resources. 
Limited-purpose surveys in relatively self-contained communities might still be helpful 
(Appendix 13).

31. Experimentation is needed to develop and test survey methods that reach STMs, given the 
very large volumes of used oil they generate (Appendix 13).

32. Surveys alone cannot reliably assess the effects of used oil marketing and collection 
programs. Combining estimates from a survey with data from oil collection programs, and 
applying the survey estimates to Public Use Microdata Sample (PUMS) household data, is 
necessary (Appendix 13).

33. Future statewide or regional surveys that attempt the detailed data collection of the 2001 
statewide survey should get data from a larger sample and ask questions about additional 
topics (Appendix 13).

34. In many situations, local surveys to gauge DIY, STM, total oil generated, and improper 
disposal will not be a good use of resources because of the difficulty of obtaining and 
processing the data to yield accurate estimates of disposal and improper disposal. Instead, the 
methods used in this report to generate updated estimates for counties should be used to 
develop estimates for cities (Section 13).

**Recommendations about Estimates of Key Quantities for Localities**

35. Counties can use the oil and filter disposal and collection estimates derived in this report to 
assess their programs as of 2003–04 and can apply appropriate multipliers to update the 
estimates year by year for the growth in population. The same estimates can be obtained for 
many cities in California, employing the methods developed in this report for counties 
(Section 13).

36. We recommend that the state Used Oil Program develop updated estimates of DIY, STM, and 
oil, oil containers, and filters generated for both counties and cities, where feasible, applying 
the methods developed in this report (Section 13).
**Recommendation about Data on Residential Used Oil Collection**

37. Residential used oil collection programs in California are very diverse. We recommend development of a system of data collection that works like a web-based questionnaire so that block grantees can quickly record the concrete characteristics of their programs (Appendix 13). The Board’s Used Oil Program is to be commended for already planning development of a web-based system.

**State-Level Estimates Provided**

This report provides statewide estimates on oil: consumed overall, consumed between changes, disposed at changes, remaining in and disposed in filters and in empty new oil containers, disposed as drained oil, reused, disposed at work, available and unavailable for collection, collected from the public, improperly disposed, and disposed by mode for eight modes of proper and improper disposal (Sections 3 and 11).

The report also projects the amount of oil potentially recoverable by making collection centers more convenient; by extending regular curbside collection to 90 percent of DIY households (Section 6); by collecting filters and their oil (Section 11); and by collecting empty new oil containers (Section 3).

Data presented includes types of collection centers used by STMs and other DIYers, and in urban and rural areas, and the role of fast lube outfits and other privately owned collection centers in oil collection (Section 3).

Regarding STMs and other DIYers, data includes the number and percent statewide, total and average oil disposed and improperly disposed, very-high-volume oil changing, the motivation for high-volume oil changing, changes per vehicles in household (Section 4); and the urban-rural location of high-volume STM oil changing (Sections 2 and 8).

The probability of improper disposal as a function of the type of collection program is covered in Section 6. Section 10 covers improper disposal as a function of the collection program taking into account many other factors.

Sections 8, 9, 10, 11 include DIY and STM status and improper disposal rates and oil volumes by age, gender, income, rural residence, and immigrant status.

Section 12 covers media use, including the rates of use of radio, television, and newspapers by DIYers, STM status, proper/improper disposal, age, sex, and immigrant status. Implications for reaching DIYers and improper disposers are also found in this section. Media use and improper disposal is covered in Section 10.

**County-Level Estimates Provided**

Section 2 includes the following estimates by county:

- The number and proportion of households in which a DIYer changes oil in household vehicles.
- Number and proportion of DIY households that dispose of 25 or more gallons of oil per year.
- Number and percent of population who are recent immigrants.

Section 5 includes the following estimates by county:

- Oil disposed by STMs and other DIYers.
• Oil collected as percent of oil disposed.

• Oil collected curbside as a percentage of all oil collected from DIYers, a measure of program emphasis.

Oil filters disposed and collected are estimated in Section 11.
1. Introduction: Shade-Tree Mechanics and Other Do-It-Yourselfers

**Main Tasks and Goals of This Project**

Three main tasks were set for phase II of the 2001 statewide used oil survey:

- Conduct additional analysis of the survey data to maximize the effectiveness and efficiency of used oil program outreach.
- Provide information about attitudes, message receptivity and behavior changes of groups in which improper disposal is most common.
- Provide guidance for local agencies and community groups for use in applying these findings and conducting their own surveys of do-it-yourself oil changers (DIYers).

Following are the main goals of this report:

1. Test findings about improper disposal by new immigrants contained in the 2002 CIWMB-published initial results* of the statewide survey against possible confounding factors such as age, education, and income. In the new analysis, findings about new immigrants have not changed, but findings on other issues have.
2. Determine the effect of curbside collection on improper disposal rates of DIYers in localities with curbside programs, and compare curbside collection with programs that rely on certified collection centers.
3. Determine which groups consume the most oil and whether improper disposers consume and dispose of more oil than proper disposers. Estimate amounts of oil disposed by STMs and non-STM DIYers. Estimate how much oil is disposed in various ways.
4. Take into account the volume of oil disposed in oil filters in the analysis of the total volume of oil consumed and disposed.
5. Show patterns of difference or similarity in media use and event attendance between regions and demographic groups, and show the relation of type of outreach to improper disposal.
6. Provide guidance to counties about the rate of DIY oil changing and the number of DIYers in each county, about curbside collection and collection centers, and about total volumes of oil disposed and collected in each county.

**Main Findings**

1. We estimate that 64 percent of DIYers disposed of used oil improperly in 2003–04. Four out of five of this group disposed of all of their used oil improperly.

2. In the 2002 initial results, we had estimated that the improper disposal rate was 19 percent, while acknowledging that that figure was an underestimate. We are able to estimate 64 percent improper disposal now because we developed a mathematical correspondence

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between the survey data on oil disposal and CIWMB block grantee report data on oil collected from DIYers. The method is explained in Section 3 and Appendix 3.

3. **All** surveys underestimate improper disposal of used oil and filters. This occurs because survey respondents try to conceal illegal or socially undesirable behavior by refusing to participate at all, by refusing to answer key questions, or by falsifying their responses to such questions.

4. Knowing that all surveys underestimate improper disposal of used oil and filters is important, for two reasons: (1) so that State and local used oil programs are not led into false conclusions about rates of improper disposal obtained from surveys; and (2) so that programs do not attempt to assess rates of improper disposal via surveys that can not deliver that information.

5. Survey estimates of improper disposal still have important, constructive uses: (1) they can be combined with other kinds of data to produce much more accurate estimates and (2) they can be used to analyze relationships of improper disposal with other factors even though rates of improper disposal are underestimated. This report employs both of these strategies.

6. Two distinctly different types of DIYers engage in DIY work for different reasons and dispose of very different volumes of oil on average. Most DIYers change oil only for vehicles in their own households, but “shade-tree mechanics” (STM) change oil on vehicles outside their household as well.

7. California has about 2.1 million DIY households. Of the DIYers in those households, 348,000 are also STMs; 1,758,000 are DIYers within the household only. An estimated 123,000 DIYers, mainly STMs, dispose of 25 gallons of used oil or more per year.

**Relation of this Report to Initial Results**

This report, like the 2002 initial results, is based on the statewide survey conducted in 2001. Survey respondents described their oil changing and disposal for the year 2000–01. All totals estimated from the survey data have been projected forward to the number of households in California on January 1, 2004. The block grantees’ oil and filter collection data used in this report are taken from their annual reports for 2003–04, compiled, verified, and re-estimated by the Used Oil Program.

This report differs from the 2002 report in the following ways:

- It contains hundreds of findings that are not in initial results, including estimates of amounts of oil disposed in various ways and many county-level estimates.

- It produces findings that are much more reliable than findings published in the 2002 initial results because they have been thoroughly tested against competing claims.

- It develops unique ways of combining the statewide survey data with collection data in order to obtain much more accurate estimates of improper disposal.

- It overcomes as much as possible the underestimation of improper disposal that characterizes all surveys on sensitive subjects.

We have reanalyzed key relationships with used oil disposal, taking into account factors that were not dealt with in the 2002 initial results. Most relationships were unaffected by the new analysis; where there are differences, we point them out. In addition to more accurate estimates of
improper disposal, we are able now to show a clearer and stronger effect of knowledge about environmental impacts of used oil than we were able to show in the initial results.

Who Should Read the Appendices?

The body of the report contains findings intended to be useful to program people. The appendices explain the assumptions and methodology behind the findings and provide analytic detail. Each section has its own appendix except 7 and 12.

Most program people will want to focus on the body of the report rather than the appendices. Researchers and research-oriented program people will want to refer to assumptions and methodology spelled out in the appendices.

Time

The statewide survey was conducted in June and July, 2001. Partly in order to make our many estimates of consumption and disposal of used oil more current and partly to make appropriate use of CIWMB oil and filter collection data, we weighted the survey data for the number of households in California on January 1, 2004. This change affects the total oil consumed and disposed, the total number of DIY and STM households, and so on. It does not affect percentages estimated from the weighted survey data; they remain the same as if we had used population data from 2001. In effect, we have projected the oil disposal and other characteristics of DIYers in 2000–01 onto the California population of January 2004.

We have used CIWMB oil and filter collection data from the annual reports of the block grantees for 2003–04, as refined by Used Oil Program staff to reduce the amount of error in those reports. We carried out additional error correction and reclassification, mainly about details of residential collection programs. We exchanged e-mails and telephone calls and examined websites of dozens of county and city programs to reduce measurement error. We also developed a classification of residential collection programs that was most likely to meet the project goal of evaluating the effects of curbside pickup on improper disposal.

Using Survey Estimates When People Hide the Truth

All surveys underestimate improper disposal of used oil. People try to hide behavior they are ashamed of or that they think is illegal or considered undesirable by others. Some will decline to participate in the survey; others will participate but will not tell the truth. The story below from our experience of screening DIYers to participate in focus groups illustrates the problem.

In spring 2003 a telephone interviewer called a list of people identified as potentially suitable participants in focus groups on DIY oil changing. The script called for the interviewer to ask potential participants what they did with their used oil. In one instance, the interviewer was acquainted with the man she was calling, lived on the same block, and had actually seen him throw oil in the trash.

The interviewer said, “What do you do with your used oil?”

He said, “I take it to a collection center.”

“What do you mean, you take it to the center?” the interviewer said. “I’ve seen you throw it in the trash!”

“Well, yeah, I throw it in the trash, but I’m not going to admit it to you.”

In short, estimates of improper disposal from any survey will be underestimates. They should not be regarded as simply “the data” or as estimates of actual rates of improper disposal.
So what can we do with improper disposal estimates from surveys of DIYers? In spite of the underestimation problem, they have three major uses:

1. **Combine them with other data to create more accurate estimates.** Survey estimates can be combined with other data from the census—such as number of vehicles per household—and from block grantee reports to the CIWMB, such as amounts of oil collected from DIYers. Adjusting survey estimates to fit what we know from these sources generates more accurate and informative estimates of oil disposal and collection. Mathematical correspondences link the survey’s disposal data and the data on collection in the reports.

2. **Analyze relationships.** Survey estimates can be used to discover patterns of relationship with other factors. Even underestimated improper disposal can produce good findings about relationships of improper disposal with age, gender, ethnicity, perceived convenience of recycling, and so on. Even if we are unable to identify all the improper disposers, we are able to identify many of them—enough to find out a great deal about who they are, why they dispose improperly, and why they dispose of large volumes of oil.

3. **Use estimates of items that are not biased.** Many important survey estimates are not biased because they are not about improper disposal; for example, estimates of the rate of DIY oil changing and estimates of the total amount of oil consumed and disposed. There is no reason to suppose that these estimates are distorted by the social desirability bias, and comparisons with aggregate data suggest that these estimates from the 2001 statewide survey are very good.

We employ all of these methods in this report. In Section 3 and Appendix 3, we develop a mathematical correspondence to combine survey and reports data so that we can obtain unbiased estimates of improper disposal and accurately analyze relationships. In particular, we re-estimate the rate of improper disposal—16.6 percent with the (biased) survey data—to be 64.1 percent in actuality.

**The Two Types of DIYers**

DIYers are not an undifferentiated group. They consist of two significantly different types:

- Shade-tree mechanics* (STM), who change oil for others as well as for their own household.
- Other, non-STM DIYers, who change oil only for vehicles belonging to their own household.

Within the STM group, there are two distinct subgroups. At low volumes, STMs are much like other DIYers. They occasionally change oil for one or a few other people, typically relatives or friends. At high volumes, STM work is part-time to full-time employment, with an economic rather than a social motivation. The reasons why high-volume STMs and all other DIYers carry out many oil changes are different. Analyses of high-volume oil disposal must compare high-volume STMs with other DIYers or be carried out separately on the two groups. High-volume STMs have different attitudes and practices and may need to be approached on their own terms if they are to be moved toward proper disposal of used oil and filters.

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*We are indebted to Carlos Garcia, president of Garcia Research Associates in Burbank, for the term “shade-tree mechanic” and for bringing the existence of shade-tree mechanics to our attention. Mr. Garcia participated in the Latino Research Forum we convened to advise us on the 2001 statewide survey and conducted English-language and Spanish-language focus groups for this project in 2003.
How Many DIYers and STMs in California?

Table 1 provides estimates of the numbers of DIY households and STMs in California, including. There are 2.1 million DIY households in California. DIY households make up 19.4 percent of all households with vehicles in 2004, plus or minus 2.2 percent, and 17.6 percent of all households. DIYers include:

- 348,000 STMs—16.6 percent of all DIYers, plus or minus 3.4 percent.
- 1.76 million households with other DIYers—83 percent of all DIY households ± 3.4 percent.

Table 1. Estimated Numbers of DIY Households and STMs in California

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Number in Sample</th>
<th>Estimated in Population</th>
<th>Margin of Sampling Error*</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIY households, including STMs</td>
<td>761</td>
<td>2,106,000</td>
<td>1,983,000</td>
</tr>
<tr>
<td>STMs</td>
<td>111</td>
<td>348,000</td>
<td>274,000</td>
</tr>
<tr>
<td>Other non-STM DIYers</td>
<td>650</td>
<td>1,758,000</td>
<td>1,635,000</td>
</tr>
</tbody>
</table>

* See Glossary of Terms.

Of the approximately 2.1 million DIYers, including STMs, an estimated 123,000 disposed of 25 gallons or more in 2003–04, plus or minus 44,000. While this is not a highly precise estimate—the margin of sampling error is wide—we can be confident that there are tens of thousands of DIYers/STMs in California, between 79,000 and 167,000, who dispose of at least 25 gallons of used oil per year. Some of these, especially STMs, dispose of hundreds of gallons. STMs are very important because, as we show in Section 4 of this report, they dispose of enormously more oil on average than other DIYers.

Implications

It is important to accept that surveys underestimate improper disposal of oil and filters because people tend to hide behavior they know is wrong. Even if the level of improper disposal is underestimated, however, estimates from sufficiently large surveys can be validly used to analyze relationships and identify subgroups that are especially likely to dispose improperly. If non-survey data on used oil collection are available and the additional effort is warranted, the method developed in Section 3 can be applied to yield more accurate estimates of improper disposal.

The two types of DIYers—STMs and DIYers who are not STMs—engage in oil changing for different motivations. A division is present in the STM group as well: those who do a few oil changes a year, often to do a favor or fulfill an obligation, and those who are really operating small businesses that provide income. These groups are different in important ways. Approaches to reduction of improper disposal should take their existence, the different volumes of oil they generate, and their different motivations and problems into account.

* There were about 11,994,000 households in California on January 1, 2004, according to the Department of Finance (Table E-5). Reducing that number by the percentage of households who did not have vehicles on April 1, 2000, according to the census (9.486 percent), about 10,856,000 households had vehicles.
Guide to the Report

Section 2, “Where Are the DIYers?”, shows how the rate of DIY oil changing increases as we go from urban to rural counties, and it presents county-level estimates: the proportion and number of households in each county in which a DIYer changes the oil for household vehicles, the number of high-volume disposers of used oil, and the number of recent immigrants.

Section 3 estimates amounts of oil disposed in eight different ways of proper and improper disposal and shows the use of different kinds of collection centers by DIYers. Appendix 3 develops a method of adjusting survey estimates to correct for the underestimation that is typical in surveys on sensitive topics.

Section 4 estimates the total and average volumes of oil disposed by STMs and non-STM DIYers in California, and the motivations for and amounts of high-volume oil changing by STMs and other DIYers.

Section 5 combines block grantees’ reports of oil collected and survey estimates of oil disposed. It proposes a method for estimating how much DIY/STM oil is disposed in counties and the percentage of DIY/STM oil disposed in each county that is collected in the county. These estimates are then obtained for oil collected curbside: the percentage of DIY/STM oil disposed in counties that is collected by county curbside collection programs. This section also estimates the use of different kinds of collection centers by DIYers.

Section 6 addresses a central question: which collection method reduces the rate of improper disposal the most—curbside collection or collection by the delivery of used oil to collection centers by DIYers?

Section 7 revisits issues of convenience and knowledge and brings out a new finding about the relevance of knowledge for proper disposal of used oil.

Section 8 shows how DIY activity and improper disposal rates and volumes are distributed across age, gender, income, immigrant status, and rural residence, to help programs focus on groups that dispose improperly of the most used oil.

Section 9 looks at age, immigration, STM work, and improper disposal and considers how best to target oil collection programs.

Section 10 tests the findings of Section 6 with a multivariate analysis that shows the effects of collection methods and individual characteristics of DIYers on the probability of improper disposal, net of the effects of other factors. Some earlier findings are confirmed, some are changed.

Section 11 analyzes the disposal and collection of used oil filters, including estimates for each county.

Section 12 looks at patterns of media use and event attendance to identify better ways of reaching DIYers, high-volume STMs, and improper disposers.

Section 13 draws lessons from the findings of this report and suggests how used oil programs can use them to improve used oil collection.
2. Where Are the DIYers?

The focus of this section is the rate of DIY oil changing and the number of DIY households in counties. To decide sensibly on outreach strategies, state and local program managers need to know where DIYers are concentrated and the size of the DIY population in their jurisdictions. We also provide information about the location of immigrants, especially recent immigrants, in California, with county-level data; and information about high-volume DIYers. See Appendix 2 for definitions, methodology, and detailed statistics for this section.

Main Findings

1. We can estimate the number and proportion of DIY households and STMs in individual counties by combining survey and census data. Tables of estimated DIY rates and DIY and STM numbers for all counties are given.

2. The estimated percentage of households that engage in DIY oil changing ranges from 4 to 18 percent in the most urban counties, up to 48 percent in mostly rural counties.

3. New immigrants—not immigrants generally—are more likely to dispose of used oil improperly. Many counties experienced a substantial influx of new immigrants in the 10 years before the 2000 census. County-level data on the number of new immigrants and their proportion of the population are provided.

4. The very large number of new immigrants in many counties indicates the value of continuing outreach to these groups, in their languages and with culturally sensitive approaches.

5. High-volume DIYers are mostly STMs except in rural counties, where they still play a substantial role. This suggests that programs, especially in urban counties, must find ways of collecting large amounts of oil from high-volume STMs.

Where Are the DIYers in California?

The DIY Rate Is Higher in Rural Areas but the Same in Northern and Southern California

DIY households are more common in rural than in urban counties. The extent to which a county is rural—its “proportion rural”—is a fair predictor of the rate of DIY oil changing. (Proportion rural is defined by the U.S. Census Bureau; see Appendix 2.) Proportion rural of counties does not explain who is a DIYer very well, but rates of DIY are higher on average in rural areas.

Proportion rural is related to DIY because many of the characteristics of households and individuals that predispose them to change their own oil are more prevalent in rural areas. Only youth, which is associated with higher rates of DIY, is more prevalent in urban areas:

<table>
<thead>
<tr>
<th>Predictor of DIY oil changing</th>
<th>Prevalence of predictor in rural areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-moderate income</td>
<td>MORE low-moderate income households in rural areas</td>
</tr>
<tr>
<td>Youth</td>
<td>LESS prevalent in rural areas</td>
</tr>
<tr>
<td>Number of vehicles in household</td>
<td>MORE vehicles in rural areas</td>
</tr>
</tbody>
</table>
• Age of vehicles GREATER on average in rural areas
  = more DIY
• College grad or less education Slightly MORE prevalent in rural areas
  = more DIY. People with education after graduation from college are less likely to change their own oil.
• Mechanics MORE in rural areas
  = more DIY
• Other tool, machine, and NO DIFFERENCE between urban and rural areas
  vehicle-related occupations = more DIY

After taking all of these individual-level factors into account, however, DIY rates are still higher in rural than in urban counties of California, probably because having routine oil changing done at a garage, fast lube, or service station is less convenient for rural residents.

Table 2 below displays rates of DIY oil changing in categories of percent rural and in southern counties compared to northern and central counties of California. Table 2 shows two things:
1. **North and south are not different in DIY rates.** Rates of DIY oil changing do not differ significantly between the southern counties and the northern and central counties of California. Comparisons of DIY rates for south and north-central counties in the 0–9 percent and 10–29 percent columns of Table 2 show very similar values. (No southern counties are in the 30–100 percent rural range.)

2. **Rates of DIY are higher in more rural counties.**

<table>
<thead>
<tr>
<th>Region</th>
<th>0–9%</th>
<th>10–29%</th>
<th>30–100%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>0.185</td>
<td>0.240</td>
<td>--</td>
<td>0.187</td>
</tr>
<tr>
<td>North &amp; central</td>
<td>0.164</td>
<td>0.241</td>
<td>0.310</td>
<td>0.203</td>
</tr>
<tr>
<td>Total</td>
<td>0.178</td>
<td>0.241</td>
<td>0.310</td>
<td>0.194</td>
</tr>
</tbody>
</table>

Source: estimated from 2001 statewide survey. South = Santa Barbara, Kern, Ventura, Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Imperial counties.

Table 3 estimates the numbers of DIY households in each category of north/south and county percent rural. In the nine southern counties, DIYers are concentrated in the seven most urban counties (Kern and Imperial are the two counties in the 10–29 percent column); in the north and central regions, DIYers are more dispersed across large rural and mountain areas.

Size of county is related to percent or proportion rural, but not perfectly related. At any given level of percent rural, some counties are 5–10 times larger in population size than the smallest ones. Proportion rural is important in its own right and partly independent of size.

Table 4 converts the numbers in Table 3 into the percentage distribution of DIY households over regions and county percent rural. About half of California’s DIY households reside in the seven most urban counties of Southern California (0–9 percent rural column).
Table 3. Estimated Numbers of DIY Households by Region and County Percent Rural

<table>
<thead>
<tr>
<th>Region</th>
<th>0–9%</th>
<th>10–29%</th>
<th>30–100%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>1,062,000</td>
<td>44,000</td>
<td>--</td>
<td>1,105,000</td>
</tr>
<tr>
<td>North &amp; central</td>
<td>499,000</td>
<td>306,000</td>
<td>196,000</td>
<td>1,001,000</td>
</tr>
<tr>
<td>Total</td>
<td>1,561,000</td>
<td>350,000</td>
<td>196,000</td>
<td>2,106,000</td>
</tr>
</tbody>
</table>

Rounded to nearest thousand.

Table 4. Percentage Distribution of DIY Households Over Regions and County Percent Rural

<table>
<thead>
<tr>
<th>Region</th>
<th>0–9%</th>
<th>10–29%</th>
<th>30–100%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>51%</td>
<td>2%</td>
<td>0%</td>
<td>53%</td>
</tr>
<tr>
<td>North &amp; central</td>
<td>24%</td>
<td>14%</td>
<td>9%</td>
<td>47%</td>
</tr>
<tr>
<td>Total</td>
<td>75%</td>
<td>16%</td>
<td>9%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Estimated Rates of DIY Oil Changing by County

We estimated DIY oil changing in each county by applying our analysis of the statewide survey data, which takes county-to-county variations in important factors into account, to the actual population characteristics of each county.

With the statewide survey, we estimated the probability of DIY in households as a function of age of the youngest adults in the household, household income, the number of vehicles in the household, occupations of household members, and the proportion rural of the county of residence. We applied estimated coefficients for these factors from the statewide survey data to the households in the Census Bureau’s 5 percent sample from the 2000 census in California (N = 575,143) and predicted the probability of DIY for each household.

We counted the number of predicted DIY households in each county in 2004, then computed from that the predicted proportion DIY of all county households. Estimated probabilities of DIY for individual households in the 5 percent sample ranged from 0.019 to 0.998. (See Appendix 2 for details of the method.) The estimated proportions DIY of county households are plotted in Figure 1.

The data points in Figure 1 are the estimated proportions of DIY households in counties, given county proportion rural and the other factors. Many of these factors, like income, age, and occupation, are also related to proportion rural. The pattern of the plotted points shows that the DIY rate increases rapidly from the most urban counties (on the left) to about 0.45 rural, on average, then flattens out in counties that are still more rural.

In the most urban counties, the estimated household DIY rate ranges from 0.04 to 0.18. In the most rural counties, the range is 0.37 to 0.48. Thus the factors associated with urban-rural differences are important, but other factors are also at work, producing substantial differences among counties that are similar on the urban-rural dimension.
How Many DIYers in Each County?

The estimated county DIY proportions in Figure 1 and the numbers of households on which they are based—households in which motor oil is changed by a DIYer—are listed for each county in Table 5. County program people can get from the tables an estimate of the size of the target group for their efforts to reduce improper disposal. The method employed here can also be used to obtain these estimates for California cities, provided 5 percent Public Use Microdata Sample (PUMS) data are available for a given city. (See Section 13 and Appendix 13 on this issue.)

The estimated numbers and proportions of DIY households and numbers of STMs provided in Table 5 are listed in order of estimated proportion DIY of all county households. The most urban counties are at the beginning of the table, the most rural counties toward the end.

The actual proportions and numbers in a particular county are likely to be close to the estimates, but it is possible that a given county might have substantially fewer or more DIYers than its estimates indicate. The estimates are subject to sampling error in the coefficients on which they are based (see Appendix 2 for margins of error), and to potential non-sampling error. For example, a mountain county with many vacation homes might have more DIYers part of the year than the number of its census-determined households—defined as the number of occupied dwellings on April 1, 2000—would indicate. In counties that have undergone especially rapid population growth, increased household income, or urbanization since 2000, actual numbers and proportions DIY may be somewhat lower than the estimates in Table 5 and Figure 1.

High-Volume Disposal of Used Oil

Of special interest are “high-volume” DIY households—households that dispose of 25 or more gallons of used oil, combining oil from own-household and non-household (STM) oil changes, if any. High-volume DIY oil changing is relatively uncommon, as a proportion of all DIYers, even less common as a proportion of all households.
Table 5. Estimated DIY and STM Households in 2004, by County (Data Plotted in Figure 1)

<table>
<thead>
<tr>
<th>County</th>
<th>Total Households*</th>
<th>Estimated DIY Households</th>
<th>Estimated STM Households**</th>
<th>County Proportion Rural***</th>
<th>Estimated Proportion DIY of Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>337,621</td>
<td>14,679</td>
<td>2,804</td>
<td>0.000</td>
<td>0.043</td>
</tr>
<tr>
<td>Marin</td>
<td>102,431</td>
<td>7,673</td>
<td>1,157</td>
<td>0.068</td>
<td>0.075</td>
</tr>
<tr>
<td>San Mateo</td>
<td>259,218</td>
<td>26,870</td>
<td>5,081</td>
<td>0.015</td>
<td>0.104</td>
</tr>
<tr>
<td>Alameda</td>
<td>538,081</td>
<td>60,624</td>
<td>10,484</td>
<td>0.005</td>
<td>0.113</td>
</tr>
<tr>
<td>Santa Clara</td>
<td>586,855</td>
<td>71,420</td>
<td>12,549</td>
<td>0.013</td>
<td>0.122</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>360,819</td>
<td>46,057</td>
<td>7,270</td>
<td>0.020</td>
<td>0.128</td>
</tr>
<tr>
<td>Orange</td>
<td>968,063</td>
<td>128,552</td>
<td>24,420</td>
<td>0.003</td>
<td>0.133</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>3,184,446</td>
<td>436,857</td>
<td>81,889</td>
<td>0.008</td>
<td>0.137</td>
</tr>
<tr>
<td>Sacramento</td>
<td>490,856</td>
<td>69,587</td>
<td>10,550</td>
<td>0.023</td>
<td>0.142</td>
</tr>
<tr>
<td>San Diego</td>
<td>1,043,221</td>
<td>168,171</td>
<td>25,841</td>
<td>0.042</td>
<td>0.161</td>
</tr>
<tr>
<td>Santa Barbara</td>
<td>141,393</td>
<td>24,304</td>
<td>4,258</td>
<td>0.055</td>
<td>0.172</td>
</tr>
<tr>
<td>Ventura</td>
<td>255,741</td>
<td>46,015</td>
<td>7,252</td>
<td>0.034</td>
<td>0.180</td>
</tr>
<tr>
<td>Yolo</td>
<td>64,751</td>
<td>12,683</td>
<td>2,125</td>
<td>0.089</td>
<td>0.196</td>
</tr>
<tr>
<td>Solano</td>
<td>138,181</td>
<td>29,112</td>
<td>4,359</td>
<td>0.043</td>
<td>0.211</td>
</tr>
<tr>
<td>Santa Cruz</td>
<td>93,305</td>
<td>20,230</td>
<td>2,470</td>
<td>0.158</td>
<td>0.217</td>
</tr>
<tr>
<td>San Luis Obispo</td>
<td>98,500</td>
<td>22,282</td>
<td>3,534</td>
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* The number of households is the Department of Finance estimate for January 1, 2004; the DOF estimates start with the number of occupied dwellings counted in the census as of April 1, 2000. This count does not include dwellings that were unoccupied on the census date but might be occupied at other times of the year, such as second or vacation homes. Thus for some counties, this number is smaller than the number of households actually living in the county part of the year and, possibly, changing their own motor oil.

** STMs are also DIYers; STMs are included in the estimate of DIY households. Most STMs change only small amounts of oil for others; a few change a great deal. See Section 4.

*** Proportion rural is the proportion of dwellings, occupied or not, that were located outside census-defined urban areas in 2000.

**** Joint Powers Authority.

The high-volume (more than 25 gallons a year) DIY rate as a percentage of all households with vehicles does not vary much in urban and rural areas: 0.6-1.1 percent of households with vehicles in both urban and rural regions dispose of high volumes of DIY/STM used oil, with no clear trend ($p = .7411$). Although the rate of DIY increases in rural areas, fewer of those DIY households are high-volume disposers.

Many of the same factors seem to be involved in high-volume disposal as in DIY and STM oil changing generally, only more so. The DIY rate drops off rapidly with age. The STM rate among DIY households also drops off rapidly by age; so does the rate of high-volume oil disposal among...
DIY households. As with DIY and STM, high-volume disposal appears to be associated also with income—first rising, then falling with income. It is also associated with proportion rural, and with occupations that involve engines, tools, machines, and outdoor work.

Stateside, 80 percent of high-volume DIYers are STMs, but the extent to which high-volume DIYers are STMs varies greatly with percent rural. In urban and semi-rural counties (0–29 percent rural), STMs constitute 83 percent of high-volume DIYers. In very rural counties (30 percent rural or more), STMs make up only 29 percent of high-volume DIYers ($p$ of difference = .0045); the rest are simply non-STM DIYers. The declining role of STMs among high-volume DIYers in rural counties may simply be a consequence of a smaller and more scattered market for STM services in rural areas.

This is important information. It means that programs must find ways of collecting large amounts of oil from high-volume STMs. This is especially true for counties with substantial urban populations, but even in rural counties STMs are likely to play a major role in high-volume disposal. We deal with more aspects of high-volume oil changing in Section 4.

Where Are the Immigrants?

The location of immigrants in California is important because recent immigrants have a relatively high rate of improper disposal—but not immigrants as a whole.

Most of the total population of California—60 percent, according to the 2000 census—is in the nine southern counties. In 2000, 67 percent of immigrants to the state lived in southern California. Of recent immigrants, entering the U.S. between 1990 and 2000, 64 percent lived in southern California.*

Households in which a DIYer is an immigrant are distributed like the immigrant population as a whole. We estimate from the 2001 statewide survey that 67 percent of immigrant DIY households live in the nine southern counties, 33 percent in northern and central California. DIY households with a U.S.-born DIYer are tilted more toward the northern and central counties: 49 percent live there and 51 percent in the southern tier of counties.

DIY oil changing is more common in rural areas, while immigration is more common in urban areas. The most rural counties are all in northern and central California. Immigrants constitute different fractions of all DIYers in north-central and southern California. Sixteen percent of DIYers in the northern and central counties are immigrants, compared to 29 percent in the southern counties ($p$ = .0006).

We know from the CIWMB 2002 initial results report that recent immigrants, up to 15 years in the U.S., are more likely to dispose improperly than either immigrants of longer residence or U.S.-born DIYers. This is confirmed in this analysis. Among immigrants, improper disposal is concentrated in recent immigrants, who entered the U.S. since 1990—not in the immigrant population as a whole.

The 2000 census counted 3,270,746 immigrants entering California between 1990 and 2000. Figure 2 shows that immigration in that decade was greatest in the most urban counties, though some rural counties also experienced significant immigration 1990–2000.

A second message of Figure 2 is that recent immigrants constitute small parts—less than 5 percent—of the populations of many counties ranging from somewhat rural to very rural. But even among a group of somewhat to mostly rural counties such as Monterey, Imperial, and Colusa, recent immigrants constitute 5–12 percent of total population and 12–16 percent in Santa Clara, San Francisco, and Los Angeles counties. In the large urban counties, these percentages amount to tens and hundreds of thousands of people. In Los Angeles County, recent immigrants comprise 12.6 percent or 1.2 million people—these are large numbers, people who enter California in a continuous stream and who arrive knowing nothing about requirements and opportunities for used oil recycling in California.

**Figure 2. Recent Immigration in California Counties, by Proportion Rural**

Percentages and numbers of recent immigrants are given by county in Table 6. This information will help program managers assess the number of recent immigrants that programs need to reach. The number of households in a county is typically 30–35 percent of the number of persons. The percentage may be smaller in areas or groups with many large households.

**Table 6. Recent Immigration and Proportion Rural by County in 2000 (alphabetical order)**

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Source: U.S. Census, Table GCT-P10.
* Joint Powers Authority.

**Implications**

DIY oil changing declines with age. It increases, then declines with income. DIY oil changing increases with number of vehicles, rural vs. urban residence, and occupations that involve working with motor vehicles, machines, and tools, and working outdoors. These relationships permitted us to estimate the rates and numbers of DIY oil changing households and STM activity in each county. We also described characteristics of DIY and STM households that dispose of very high volumes of used oil. These rates and numbers are of direct use to State and local programs because they indicate the sizes of the most important target groups of DIYers.

Large numbers of new immigrants enter California in a continuing stream. As we showed in the 2002 initial results and confirm in this report, new immigrants have substantially higher rates of improper disposal. They arrive knowing nothing about used oil recycling. This implies a need to conduct continuing outreach to these groups, in their languages, with culturally sensitive and effective approaches through culturally effective channels.
### 3. Disposal and Collection of Oil

**Main Findings**

1. From the statewide survey we estimate that DIYers consumed 31.41 million gallons of motor oil in 2003–04; from purchase data, CIWMB staff had estimated 33 million gallons in 2001.

2. Thirty-one percent of oil consumed by DIYers was not potentially available to California’s ways of collecting drained used oil from DIYers. It was lost during driving, remained in used oil filters and new oil containers, was reused, or was taken to a workplace for disposal.

3. About 40 percent of the available drained oil was collected from DIYers in 2003–04. This estimate is based on the CIWMB’s oil collection database and is supported by the survey data. This is a measure of the collection effectiveness of the present collection system.

4. 13.8 million gallons of potentially recoverable drained liquid oil were improperly disposed and not collected in 2003–04.

5. Other major components of the DIY oil stream are:
   - Unrecoverable: 5.9 million gallons of oil lost in use.
   - Potentially recoverable: 3.3 million gallons.
   - 1.1 million gallons left in new oil containers.
   - 2.2 million gallons that remains in filters even after draining.

6. By combining survey and oil collection data from block grantees’ annual reports, we can overcome most of the underestimation of improper disposal in surveys. We can produce much more accurate estimates of oil disposed in various proper and improper ways and the rates and volumes of improper disposal by important groups such as STMs, immigrants, and younger and older DIYers.

7. Survey estimates of percentages of oil properly disposed in three main categories statewide closely follow the oil collection data for the same categories from block grantees’ annual reports, which bolsters our confidence in both sets of data.

8. More than one-half of DIY used oil—nearly 13 million gallons—was thrown in the trash in 2003–04. More than 1 million gallons of oil were disposed on the ground, by burying, or by pouring it into drains or gutters.

9. Auto parts stores are the collection center of choice for three-fifths of DIYers who take their oil to centers. Statewide, public recycling facilities and service or repair shops play significant but smaller roles.

10. Fast lube outfits are an insignificant factor statewide in the collection of used oil. Only 3.48 percent of DIYers who take their oil to a collection place take it to fast lube outfits, and they account for only 1.94 percent of total properly disposed oil statewide. In rural counties, however, they account for 6.1 percent.

11. STMs and high-volume disposers who take their oil to collection facilities tend to use service stations or auto repair shops more, auto parts stores and public recycling facilities less, than other DIYers, but auto parts stores are still an important drop-off location for this group.

12. DIYers in rural counties are much more likely to depend on public recycling facilities and less on auto parts stores and service or repair shops than DIYers in urban counties.
13. The fact that fast lubes that are certified collection centers are paid the recycling incentive fee for the large volumes of oil they install as well as for the small amounts they collect from DIYers suggests that these funds are not being applied effectively to enhance recycling.

14. Other oil installers such as dealer service departments, repair shops, and service stations are also paid the recycling incentive fee for oil they install as well as oil they collect. Even though they collect much more DIY oil, these funds might still be much more effectively applied to the establishment of no-limit curbside collection programs. Payments might be justified in particular cases where curbside collection is not feasible and the center is demonstrably productive in collecting DIY oil.

15. In the Board’s formulas for converting the weight of used oil to volume, a conversion factor of 8.5 pounds per gallon is used. A better figure is 7.5 pounds per gallon (see footnote † below).

**Amounts of Oil Consumed and Disposed**

**Consumed Oil**

We estimated consumed oil as the sum of oil added between changes and oil put in the vehicle when the oil is changed. See Appendix 3 for estimation details. We estimate that DIYers consumed 31.41 million gallons of oil in 2003–04. Table 7 shows the estimates of use and loss from this total consumption figure and the amount of oil disposed as drained oil, the amount collected by programs of collection from the public, and the amount not collected and presumed improperly disposed.

**Oil Removed from the System by Remaining in Containers and Filters**

The use of motor oil involves significant losses along the way to used oil that can be collected as drained, liquid oil. Fractions of oil left in containers—new oil that remains in the bottles in which it is purchased and used oil that remains in used filters when they are discarded—are largely recoverable, if the containers are collected.

**Oil left in new oil containers.** We know of no research on the volume of oil left in new oil containers sold to the public. A commonly cited assumption is that 1–2 ounces of oil are discarded in new oil containers, typically quarts though larger sizes are sold, too. The average weight of new oil varies somewhat but is approximately 29 oz. per quart. If 1 oz. remains from a full 1-quart container, 1/29 = 0.03448 or 3.448 percent of the oil remains in the container. If the amount is 2 oz., 0.07896 or 7.896 percent remains in the container. We decided on 1 oz. per quart.

* Given the difficulty of accurate recall of complex and repeated behavior in surveys, the estimated 31.41 million gallons is very close to the 33 million gallons estimated purchased by the DIY public in 2000–01. California Integrated Waste Management Board, *Used Oil Annual Recycling Report 2000*, www.ciwmb.ca.gov/UsedOil/RateInfo/Annual.htm [October 21, 2001].

† This has implications for the CIWMB’s evaluations of volume of used oil from weight of oil. Form 303 and other directions to grantees instruct them to use 8.5 pounds per gallon to translate from weight to volume, but 7.5 pounds is the correct conversion factor. “I checked the density of engine oil from a variety of manufacturers. New engine oil has a specific gravity in the range of 0.86–0.88. That translates to 7.16 to 7.33 lbs/USG. Using 7.5 lbs/USG [for used oil] would allow for some contamination (e.g. water, fuel, etc.).” E-mail from Dennis L. Bachelder, American Petroleum Institute, May 21, 2005. For used oil, 7.5 lbs/USG is equivalent to 30 oz/US qt. For new oil, we take the midpoint of 7.16 and 7.33, 7.25 lbs/USG ÷ 4 qts/USG × 16 oz/lb = 29 oz/US qt.
of oil consumed on average, reasoning that oil sold in larger containers would remain in them in smaller amounts per quart of oil because the surface area of a conventional container shape increases more slowly than volume.

An estimated 1.08 million gallons of new oil was left in new oil containers in 2003–04 by DIYers. This equals 3.448 percent of 31.41 million gallons of oil consumed by DIYers, including STMs.

### Table 7. Oil Consumed, Disposed, and Collected from California DIYers, 2003–04

<table>
<thead>
<tr>
<th>Process</th>
<th>Column 1</th>
<th>Column 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume (Millions of Gallons)</td>
<td>Percent of Oil Consumed</td>
</tr>
<tr>
<td>1. Total oil consumed (2 + 3)</td>
<td>31.41</td>
<td>100.0%</td>
</tr>
<tr>
<td>2. Added—consumed between oil changes (survey est.)</td>
<td>-1.75</td>
<td>5.6</td>
</tr>
<tr>
<td>3. Replaced—consumed at oil changes (survey est.)</td>
<td>29.66</td>
<td>94.4</td>
</tr>
<tr>
<td>4. Lost in driving, left in new oil bottles (research est.)</td>
<td>-5.22</td>
<td>16.6</td>
</tr>
<tr>
<td>5. Disposed at changes (3–4)*</td>
<td>24.44</td>
<td>77.8</td>
</tr>
<tr>
<td>6. Remaining in and disposed with filters (survey est.)**</td>
<td>-2.22</td>
<td>7.1</td>
</tr>
<tr>
<td>7. Total oil lost in driving and changing (2 + 4 + 6)</td>
<td>-9.19</td>
<td>29.2</td>
</tr>
<tr>
<td>8. Disposed as drained liquid oil (1–7)</td>
<td>22.22</td>
<td>70.8</td>
</tr>
<tr>
<td>9. Reused (survey est.)</td>
<td>-0.18</td>
<td>0.6</td>
</tr>
<tr>
<td>10. Disposed of at work and recycled (survey est.)</td>
<td>-0.36</td>
<td>1.1</td>
</tr>
<tr>
<td>11. Total not available for collection (7 + 9 + 10)</td>
<td>-9.73</td>
<td>31.0</td>
</tr>
<tr>
<td>12. Available for collection (1–11)</td>
<td>21.68</td>
<td>69.0</td>
</tr>
<tr>
<td>13. Collected from public (grantees’ reports)</td>
<td>-7.85</td>
<td>25.0</td>
</tr>
<tr>
<td>14. Not collected: improperly disposed (12–13)</td>
<td>13.84</td>
<td>44.1</td>
</tr>
</tbody>
</table>

Note: carrying out the subtractions and additions in this table will result in minor rounding-error differences between those operations and the presented results because the latter were obtained using full precision.

* "Disposed" means whatever is done with the oil, proper or improper.

** Survey estimate plus a research-based assumption about the average amount of oil remaining in filters; see Section 11 and Appendix 11.

** ** Oil left in used oil filters. ** In Section 11 and Appendix 11 we review research on the amount of oil left in filters even after draining. That research led us to adopt an average 8.4 percent of the volume of oil placed in engines at oil changes as a plausible estimate of the proportion of oil remaining in filters. In Section 11 we estimate 2.176 million gallons remaining in filters.

Total oil in new oil bottles and used filters is 3.256 million gallons, most of which is potentially recoverable.

** Oil Removed by Loss During Use **

Calculating oil lost in use involves two quantities. First, the volume of oil that is added between oil changes is a measure of oil lost in use because it roughly equals oil that has actually been lost. From the survey responses, as noted, we estimated that DIYers added 1.75 million gallons of oil between changes, which was 5.6 percent of total oil consumed. (We assume STMs do not add
appreciable oil between changes to their customers’ vehicles; therefore, this part of oil lost to recovery applies only to the vehicles of DIY households. It is not an estimate of the amount of oil lost to recovery between changes in individually and household-owned vehicles in the state.)

The second part of oil lost is the extent to which the volume of oil that is drained from an engine is less than the volume of oil in the engine when oil was last added to it because of loss during use. This part of oil lost stems from the likelihood that many DIYers, and the customers of STMs, allow the oil level to drop a bit before they replace the oil. So far as we know, there is no research on this issue. We assumed that oil in engines is down 15 percent on average from the manufacturer’s recommended replacement volume of oil minus what stays in the containers. This part of oil lost is 13.2 percent of total oil consumed.

Combining the two parts of oil lost in use yields 5.6 + 13.2 = estimated 18.8 percent of total oil consumed or 5.9 million gallons.* This oil is not recoverable.

**Oil Removed by Reuse and Taking to Workplaces**

Still in Table 7, two ways of disposing of used oil take it out of the state’s collection system but do not constitute improper disposal: reusing oil and disposing of it at a place of work.

**Reuse.** An estimated 2.7 percent of DIYers (including STMs) reuse some of the oil they drain from vehicles. They dispose of an estimated 185,000 gallons in this manner. Most members of this group lubricate their equipment—especially chain saws—with used oil; many are loggers. A few put oil back into the vehicle or into another vehicle after filtering. Such reuse is not improper disposal, but it does remove the oil from the system of collection from the public.

The rate of DIYer oil reuse in urban and semi-rural counties is 2 or 3 percent; in the most rural counties, the rate is 7 percent reuse.

**Take to workplace.** Another 2.6 percent of DIYers (including STMs) dispose of used oil by taking it to their workplace, where it is recycled. Respondents mentioned farms, ranches, construction sites, shops, and factories. DIYers who take oil to work are maximizing the convenience of proper disposal. We estimate that DIYers, including STMs, took 355,000 gallons of drained oil to work for disposal in 2003–04. This is clearly a form of proper disposal, but it is also oil that is not being collected through the publicly operated system.

In the most urban counties (0–5 percent rural), 1.6 percent of DIYers dispose of used oil at work; in the less urban counties, 3–6 percent.† Mechanics (of any kind, but most are automotive) are more likely than DIYers who are not mechanics to dispose of oil at work, 15 percent vs. 2 percent. Mechanics constitute nearly one-fourth of DIYers who dispose of oil at work.

Altogether 5.3 percent of DIYers disposed of used oil by reuse or by taking it to work. They disposed of 540,000 gallons in these ways, or 2.4 percent of the drained oil disposed by DIYers.

---

* This figure—18.8 percent of oil lost in use—will seem low to some, given the historically cited numbers, which tend to range from 35 to 45 percent. Remember we are dealing here not with all vehicles in use but with the vehicles owned and used by households. In addition, we are classifying other ways in which oil is lost to collection systems under different rubrics: oil left in bottles and in used filters. See Appendix 3 for further discussion of oil lost in use.

† The most urban counties are Alameda, Contra Costa, Los Angeles, Orange, Sacramento, San Diego, San Francisco, San Mateo, Santa Clara, Solano, and Ventura.
This left 21.68 million gallons of used drained oil available in 2003–04 for collection from California DIYers, or 69 percent of the 31.41 million gallons they consumed.

The amount of drained liquid oil that might be collectable as such is, then, a little over two-thirds of total oil consumed. This is important guidance for used oil collection program staff because it reveals information about the size of the pool of potentially available oil. The estimated 69 percent of consumed oil available for collection should be viewed as approximate.

In other words, about 31 percent of oil consumed by DIYers is removed from the public collection system during in-vehicle use, as residual oil in used oil filters and new oil containers, in reuses including lubrication and burning, and through disposition of used oil at workplaces.

Oil Stored

DIYers also store oil. They stored an estimated 1.2 million gallons in 2003–04 and still had it in storage when they were interviewed. This figure equals 3.8 percent of oil consumed. Many said they stored oil temporarily prior to taking it to a collection center; a small number accumulate large amounts. For the estimates in this section, we assumed that used oil added to storage and disposed from storage were equal so that stocks of used oil in storage remained constant. We also assumed that DIYers disposed of oil from storage in the same ways they disposed of oil directly. For these reasons, oil stored does not appear as a separate item in these estimates.

Re-Estimation of Improper Disposal Rates and Volumes

In Appendix 3 we use the 13.84 million gallons of oil improperly disposed to reweight the survey data. This includes oil not collected, stored, taken to a workplace, left in filters or containers, lost in driving, or reused. We then re-estimate the overall improper disposal rate and all the improper disposal rates and volumes of oil cited in this report.

Using the original survey data, we had estimated that 16.6 percent of DIYers were improper disposers. We know that improper disposal is underreported in surveys. How much is it underreported? The estimated 13.84 million gallons of improperly disposed oil in Table 7 is 44.1 percent of total oil consumed. That is far more oil than the 16.6 percent of DIYers whom we classify as improper disposers actually disposed. What proportion of DIYers had to dispose improperly to generate 13.84 million gallons of improperly disposed oil in 2003–04? That is the question we answer in Appendix 3.

The fundamental idea is to find the real improper disposal rate, the rate at which DIYers must have disposed improperly in order to produce the estimated volume of improperly disposed oil. That re-estimated rate of improper disposal is 64.1 percent ± 6.2 percent. Then we use this new estimate of the improper disposal rate to reweight the survey data. Finally, we use the new weights to estimate all improper disposal rates and volumes for subgroups such as STMs, immigrants, younger and older DIYers, and so on, and to estimate changes in the rate of improper disposal associated with convenience and with curbside collection.

Oil Properly Disposed and Collected

Collection Effectiveness

Of the 21.68 million gallons of oil potentially available for collection, CIWMB-sponsored programs collected 7.85 million gallons from DIYers, or 36.2 percent, according to the annual reports of block grantees for 2003–04.

Because oil taken to work for disposal is oil collected (respondents thought or knew it was), a full accounting should include it. We add the 355,000 gallons disposed by DIYers at workplaces both
to total oil collected and to the oil available for collection. We then recalculate the percentage. The result is that 8.20 million out of 22.04 million gallons = 37.2 percent of the available drained and disposed DIY oil was collected overall. If we rely on oil collection data for proper disposal volumes (Table 10 below), we estimate that 40.5 percent of available oil was collected. This is a measure of the collection effectiveness of the system of collection of used oil from DIYers.

**Modes of Proper Disposal**

Survey and collection data overlap with respect to volumes of oil properly disposed (or collected). In Table 8 we employ our reweighted data to correct for underreporting of improper disposal and overreporting of proper disposal in the survey data. Table 8 gives both the survey and the collection numbers, in gallons and in percentages, for three modes of collection and a residual “other” category. Following are the categories:

- Privately operated certified and noncertified centers, combined.
- Government-run fixed-site programs including oil collection points at landfills, household hazardous waste (HHW) facilities, and antifreeze, batteries, oil, and paint collection sites (ABOPS).
- Curbside collection.
- Other programs that are reporting categories in block grantees’ reports but do not appear in the survey data—mobile collection, collection events, and by-appointment programs for collection at residences. All of these show very small amounts of oil collected.

In the gallons comparisons in columns 1 and 2 of Table 8, the reweighted survey estimates are very close to the reports data, which helps to confirm the validity of both sets of data and the procedures by which they were constructed.

The percentage distributions of oil are also given, to simplify the comparison (right-hand columns of Table 8, in **bold**). The survey reasonably accurately estimates the percentages of oil that block grantees are thought to have collected via the three main collection types. The differences are well within the margins of error of the estimated gallons disposed by each mode.

**Improperly Disposed Oil**

**Total improperly disposed oil.** We estimated in the last row of Table 7 that 13.84 million gallons of oil was improperly disposed. This oil was available for collection but was not collected, stored, taken to a workplace, left in filters or containers, lost in driving, or reused. Therefore, it was improperly disposed.

**Improperly disposed oil by mode of disposal.** Combining survey estimates of improper disposal by mode with the 13.84 million gallons estimated improperly disposed oil, we obtain estimates of gallons of oil disposed in each of the three improper disposal modes in Table 9. We estimate that about 638,000 gallons were buried or poured on the ground, while 434,000 were drained or poured into a drain or gutter—1.072 million gallons altogether. An estimated 12.765 million gallons were thrown in the trash.
Table 8. Oil Properly Disposed and Collected—Comparison of Survey and Reports Data

<table>
<thead>
<tr>
<th>Mode of Proper Disposal or Collection</th>
<th>Used Oil Properly Disposed (Survey) and Collected (Reports)***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gallons</td>
</tr>
<tr>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>Collection center*</td>
<td>5,653,000</td>
</tr>
<tr>
<td>Landfill, HHW, ABOPS</td>
<td>910,000</td>
</tr>
<tr>
<td>Curbside collection</td>
<td>717,000</td>
</tr>
<tr>
<td>Other modes**</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>7,280,000</td>
</tr>
</tbody>
</table>

* Certified and noncertified. See Appendix 3 for detailed methodology.
** Mobile events, special oil collection events, and by-appointment pickup. A few survey respondents referred to these modes of disposal, but numbers were too small for valid estimation. To report the grantees’ reports data in the same categories as the survey data, amounts reported collected by “Other modes” are omitted from the percentage calculations. If included, amounts collected by “Other modes” are 4.5 percent of total oil collected in 2003–04.
*** The reports data are for 2003–04; the survey data have been weighted to reflect the number of households in California on January 1, 2004.

We know that survey respondents tend to deny improper disposal. Given that, are the estimates in Table 9 accurate? Perhaps—but it is more likely that respondents would deny the most blatant forms of improper disposal—on the ground or into a drain—than would deny throwing oil in the trash. We are unable to correct for possible bias in responses on particular modes of improper disposal. Therefore, oil disposed on the ground and into a drain is probably underestimated; oil thrown in the trash is probably overestimated. We have no way of knowing how much.

Table 9. Improperly Disposed Oil, by Mode

<table>
<thead>
<tr>
<th>Improper Disposal Mode</th>
<th>Estimated Oil Disposed (Gallons)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bury or pour on ground</td>
<td>638,000</td>
<td>4.6%</td>
</tr>
<tr>
<td>Pour or let drain to drain or gutter</td>
<td>434,000</td>
<td>3.1%</td>
</tr>
<tr>
<td>Throw in trash</td>
<td>12,765,000</td>
<td>92.3%</td>
</tr>
<tr>
<td>Total</td>
<td>13,837,000</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Distribution of Oil over All Modes of Disposal**

With the estimates of the disposition of oil by mode from the two previous tables we can display the estimated breakdown of oil disposed by DIYers by all the major modes of disposal together (Table 10). The overall picture of oil disposal is dominated by oil thrown in the trash, which accounts for more than one-half of disposed used oil, and oil taken to collection centers, accounting for 31 percent. All the other modes together account for 13.7 percent of disposed drained oil, qualified by the likelihood that oil buried or poured on the ground and oil poured or drained into a gutter or drain are underestimated.

Table 10 leads to an estimate that 40.5 percent of all disposed drained oil is properly disposed, including reuse and taking to work. This estimate uses proper disposal volumes from collection reports rather than from survey data, and it includes both oil that is reused and oil taken to work;
it is higher than the 37.2 percent proper disposal estimated above on the basis of survey data alone.

**Table 10. Oil Disposed, by Mode**

<table>
<thead>
<tr>
<th>Disposal Mode</th>
<th>Estimated Oil Disposed (Gallons)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reuse</td>
<td>185,000</td>
<td>0.8%</td>
</tr>
<tr>
<td>Take to work</td>
<td>355,000</td>
<td>1.6</td>
</tr>
<tr>
<td>Bury or pour on ground</td>
<td>638,000</td>
<td>2.9</td>
</tr>
<tr>
<td>Pour or let drain to drain or gutter</td>
<td>434,000</td>
<td>2.0</td>
</tr>
<tr>
<td>Throw in trash</td>
<td>12,765,000</td>
<td>58.4</td>
</tr>
<tr>
<td>Take to collection center</td>
<td>6,000,000</td>
<td>27.4</td>
</tr>
<tr>
<td>Take to landfill, HHW, ABOPS</td>
<td>716,000</td>
<td>3.3</td>
</tr>
<tr>
<td>Curbside collection</td>
<td>776,000</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21,869,000</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Note: oil collected by proper disposal modes is taken from the CIWMB block grantee annual reports database; oil disposed by improper modes was estimated by applying survey proportions to total improperly disposed oil (Table 9). The total in this table falls slightly short of the 22.22 million gallons of oil estimated in Table 7, line 8, “Disposed as drained liquid oil.” The difference is mainly amounts of oil that were unclassifiable in the survey data but were collected by “Other modes” (Table 8).

**Disposition of Oil Consumed by DIYers**

We can rearrange the data in the preceding pages to show graphically what happened to all the oil consumed and/or disposed by DIYers. Figure 3 displays the overall disposition of DIY oil, estimated from the statewide survey, block grantee reports, and the research literature. Of the oil DIYers disposed as drained liquid, they disposed improperly of substantially more (44 percent) than they disposed of properly (collected from the DIY public, 25 percent).

**Figure 3. Disposition of Oil Consumed by DIYers**

Nearly 30 percent of oil consumed by DIYers is presently lost in driving or during oil changing; Of that amount, Figure 4 indicates that most is lost in driving; about one-third is recoverable if used oil filters and empty new oil containers are collected and processed.
Figure 4. Oil Lost in Driving and Changing

- Lost in driving: 24%
- Remaining in filters: 12%
- Left in new oil bottles: 64%

Figure 5 shows that oil thrown in the trash vastly exceeds the volume of oil disposed in other illegal ways, estimated from the statewide survey.

Figure 5. Disposition of Oil Improperly Disposed by DIYers

- Thrown in trash: 92%
- Buried or poured on ground: 5%
- Drain or gutter: 3%

Figure 6 provides the breakdown of oil collected from the DIY public over the major modes of collection in 2003-04, according to block grantee reports.
Figure 6. Collection of Oil Disposed by DIYers

![Pie chart showing collection methods](chart.png)

What Kinds of Collection Centers Do DIYers Use?

DIYers who claimed they took their oil to a collection center were asked to name the center. We coded the centers named by these DIYers into the categories in Table 11. The total column shows that about three-fifths of DIYers took their oil to auto parts stores in 2003–04. About one-sixth each took oil to service stations or garages and to public recycling facilities. Fast lube operations and workplaces played much smaller roles.

<table>
<thead>
<tr>
<th>Type of Center</th>
<th>Not STM</th>
<th>1–9</th>
<th>10 or More</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto parts store</td>
<td>65%</td>
<td>50%</td>
<td>48%</td>
<td>62%</td>
</tr>
<tr>
<td>Recycling facility*</td>
<td>18</td>
<td>22</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Service or repair shop**</td>
<td>12</td>
<td>19</td>
<td>45</td>
<td>15</td>
</tr>
<tr>
<td>Fast lube outfit</td>
<td>3</td>
<td>8</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Workplace</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

| N                               | 382     | 43   | 24         | 449   |

$p$ of difference = .0083

* Includes recycling centers, transfer stations, refuse and waste management facilities, fire departments, used oil collection facilities at landfills, HHW facilities, harbors, and airports.

** Includes service stations, dealers, tire centers, and auto repair shops.

The Low Productivity of Recycling Incentive Fees to Installers

The very small amount of DIY oil taken to fast lube outfits raises an issue: they claim the State’s recycling fee not only for DIY oil but for all the oil they install as well. Fast lube outfits that are certified collection centers are in effect receiving a large subsidy out of funds that are intended to enhance the recycling of used oil, but they make very little contribution to recycling.
Service or repair shops that are certified collection centers are also receiving subsidies because they are paid for oil they install as well as oil that DIYers drop off. These facilities are slightly more justified in receiving the subsidies because they collect a substantial fraction of DIY oil, including much of the oil disposed by high-volume STMs. Both repair shops and quick lube outfits pay to have the used oil hauled away. However, DIYers probably contribute a larger proportion of the oil collected at the repair shops than at fast lube outfits.

Nevertheless, the subsidy is still substantial. Payments for oil that fast lubes, service stations, and repair centers install does not directly reduce improper disposal. But these payments do give such outfits a substantial incentive to be certified centers. Applying these not-very-productive payments to develop no-limit curbside service would make a much greater contribution to the collection of used oil, filters, and containers. In the absence of curbside collection, in localities with no other good collection center, and where a service station or repair center actually collects a substantial amount of DIY oil, the payments might still be justified in particular cases. The Board and local programs should have the authority to make these kinds of distinctions.

Installers that are certified collection centers receive the recycling incentive fee, but they also charge their customers an “environmental service fee.” This raises further questions about the appropriateness of the subsidy they receive for all the oil they install.

**STM and Other DIYers**

STMs were less likely to dispose of used oil at auto parts stores than were non-STM DIYers (see the Not STM column of Table 11). High-volume STMs (10 or more changes) were much more likely to dispose of their oil at an automotive service or repair shop and much less likely to dispose at a public recycling facility. Anecdotal evidence suggests that many STMs have informal arrangements with service stations or garages to take their oil.

<table>
<thead>
<tr>
<th>Table 12. Type of Collection Center Used, by Percent Rural of County</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Center</strong></td>
</tr>
<tr>
<td>Auto parts store</td>
</tr>
<tr>
<td>Recycling facility</td>
</tr>
<tr>
<td>Service or repair shop</td>
</tr>
<tr>
<td>Fast lube outfit</td>
</tr>
<tr>
<td>Workplace</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>N</strong></td>
</tr>
</tbody>
</table>

*p of difference < .00005

**Rural and Urban Areas**

Rural collection centers have much different patterns of use than those in urban counties (Table 12). Public recycling facilities play a much larger role in the most rural areas, where auto parts stores and service or repair shops are less frequently used for oil disposal than in urban areas.

**Summary**

Survey and block grantees report data can be combined to produce more accurate estimates of oil disposed improperly than would be possible from survey data alone. The method developed here
overcomes much of the underestimation of improper disposal that characterizes any survey on a sensitive topic.

Well over half of the oil consumed by DIYers, including STMs, is potentially available to the system of collection of liquid oil from the public. About 19 percent or 5.9 million gallons is lost during driving and is not recoverable.

Potentially recoverable oil includes 3.448 percent of consumed oil or 1.08 million gallons in new oil containers when they are disposed and 7 percent or 2.176 million gallons that remains in used oil filters. Other used oil is reused (185,000 gallons, or 0.6 percent) or taken to a workplace for disposal (355,000 gallons, or 1.1 percent). DIY oil deposited in workplace tanks is probably collected and recycled. The loss of that oil to the system of collection from the public is a slight gain in the total oil collected from businesses.

Including DIY oil collected from workplaces, 37–40 percent of the drained used oil disposed by DIY households and available for collection was collected from them in 2003–04.

Most DIYers use auto parts store collection facilities. DIYers in rural areas are much more likely to take oil to public recycling facilities than those in urban areas and more likely to use recycling facilities than auto parts stores.

STMs are less likely to take oil to auto parts stores, though about half still do so. High-volume STMs are more likely to take oil to a service or repair shop, less likely to take it to a public recycling facility.
4. STMs, Immigrants, High-Volume Oil Changing, and Improper Disposal

**Main Findings**

**Volume of Used Oil Disposed**

1. On the average, STMs dispose of six times as much oil as other DIYers. About one in six DIYers is an STM, but STMs dispose of more than one-half of used oil.

**Motivation for High-Volume STM Work**

2. The motivation for high-volume STM work is economic: the lower the household income, the more oil changes STMs carry out. Low-volume STM activity is probably undertaken for social or altruistic reasons.

3. Low and middle-income STMs disposed of 95 percent of STM used oil in 2003–04—nearly 8 million gallons.

**High-Volume DIY Activity: Motivation and Patterns**

4. The number of vehicles in the household is the main determinant of high-volume oil changing for DIY households with no STM: the more vehicles, the more changes.

5. Income is positively related to DIY oil activity because the higher the household income, the greater the number of household vehicles on average. Income is also inversely related—regardless of the number of vehicles in households, the DIY rate is lower among households with higher incomes.

6. The rate at which people engage in STM work is about the same in urban and rural areas, but the average number of oil changes and the total number of oil changes by STMs are much greater in urban than in rural areas.

7. A small number of DIYers dispose of large amounts of oil. High-volume DIYers, most of them STMs, account for greatly disproportionate shares of all oil disposed by DIYers.

8. Taking the volume of oil into account greatly increases the importance of collecting oil from STMs.

**Improper Disposal**

9. U.S.-born STMs are more likely to dispose improperly than other U.S.-born DIYers.

10. STMs accounted for as much as 50–80 percent of the improperly disposed used oil in 2003–04. STMs do most of the high-frequency, high-volume improper disposal.

**Total Oil Disposed at Oil Changes by STMs and Other DIYers**

“Shade-tree mechanics” (STM) change oil of vehicles that belong to people outside their households. They are not regularly employed at a garage, service station, or oil-change facility. Seventeen percent of those who the change oil of their own vehicles, called “do-it-yourselfers,” or DIYers, are also STMs.
Table 13 shows average gallons of oil disposed by STMs and other DIYers (that is, DIYers who are not STMs). STMs dispose of about six times as much oil on average per year as other DIYers—37.8 gallons per STM compared to 6.4 gallons for other DIYers (column 1).

Total oil disposed by STMs (column 2) is 54 percent of the 24.4 million gallons of oil disposed by all DIYers (column 3).

<table>
<thead>
<tr>
<th>DIYer Type</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average Oil Disposed (Gallons per Year)*</td>
<td>Total Oil Disposed (Millions of Gallons per Year)*</td>
<td>Share of Total Oil</td>
<td>Margin of Sampling Error of Column 2 (Millions of Gallons)</td>
<td>Sample Size</td>
</tr>
<tr>
<td>STM</td>
<td>37.8</td>
<td>13.2</td>
<td>54%</td>
<td>7.7 to 22.7</td>
<td>111</td>
</tr>
<tr>
<td>Other DIYer</td>
<td>6.4</td>
<td>11.2</td>
<td>46%</td>
<td>10.3 to 12.2</td>
<td>650</td>
</tr>
<tr>
<td>Total</td>
<td>11.6</td>
<td>24.4</td>
<td>100%</td>
<td>17.9 to 33.3</td>
<td>761</td>
</tr>
</tbody>
</table>

Margins of sampling error are large for estimates of average, total, and share of oil for STMs because they are a small subsample with big differences among them in the amounts of oil they dispose of. The main point is not the precise amount of oil disposed by STMs, but the knowledge that the 17 percent of DIYers who are also STMs dispose of a much larger proportion of all DIY oil.

**Very-High-Volume DIY Oil Changing**

Large volumes of DIY oil are disposed by small numbers of very-high-volume DIYers. These high-volume DIYers—mostly STMs—account for very large and highly disproportionate shares of the used oil disposed by DIYers. STMs are more likely to dispose of a great deal of oil than other DIYers, and STMs comprise a very large part of the highest-volume DIY populations. For example:

- The one-fourth of DIYers who dispose of 10 gallons or more per year dispose of almost three-quarters of all DIY oil. STMs comprise two-fifths of these DIYers, and they account for seven-tenths of the oil disposed by this group.

- Less than 6 percent of DIYers dispose of 25 gallons or more per year. They dispose of nearly half of all DIY oil, and four out of five in this group are STMs. STMs account for 93 percent of oil disposed by this group.

High-volume DIYers account for a huge share of the oil disposed by DIYers. STMs dispose of much more oil than other DIYers on average and almost all of the oil disposed by very-high-volume DIYers. Only one out of ten of the very-high-volume DIYers is not an STM.
Who Are STMs? What Are Their Motivations?

Most STMs change oil occasionally for others; 64 percent of STMs carry out fewer than ten STM oil changes per year. This group may not change oil for people outside their household as a form of income, but at some volume, the main motivation for most STM work probably shifts from primarily social or altruistic to economic.

It is easy to see how DIYers who are willing to change oil for other people might achieve large volumes of disposed oil, if they engage in the work on at least a consistent part-time basis. Occupational and other data about the very-high-volume STMs support the conclusion that they engage in part-time work to supplement their incomes. Following are individual characteristics of each STM in the sample who changed oil **50 or more times** for vehicles outside the household:

- Retired, age 74, household income less than $15,000, high school graduate.
- Retired heavy equipment operator, 57, household income $40,000–$70,000, college graduate.
- “Free agent,” 38 years old, household income less than $15,000, some college.
- Retail manager, age 22, household income between $15,000 and $25,000, some high school.
- Floor layer, 35 years old, refused to divulge income, some college.
- Receiver at a market, 19, household income $15,000-$25,000, high school graduate.
- Handyman, 40, refused income, high school graduate.

All of these cases appear to be part-time STMs; the greatest volume of STM oil estimated from respondents’ reports in the sample was 551 gallons during a year, which amounts to 10.6 gallons per week on average. In the population of STMs, there may well be some who work full-time or nearly so, perhaps changing many hundreds of gallons of oil per year. An STM who changes oil for 21 vehicles per week averaging a gallon or more per change will generate more than 1,000 gallons of used oil during a 52-week year ($21 \times 52 = 1,092$).

STM Work and Household Income

The cases suggest that high-volume STM work is a niche economic activity for a relatively small number of people, typically in low-to-moderate-income households. Table 14 supports this proposition, showing that the average number of oil changes carried out by STMs declines rapidly with increasing household income (column 1). STMs in households with less than $25,000 income do more than eight times as many STM oil changes on average as STMs in households with $70,000 or more income.

<table>
<thead>
<tr>
<th>Household Income</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STM Oil Changes (Mean)</td>
<td>Sample N</td>
<td>Estimated Number of STMs</td>
<td>Disposed STM Oil (Millions of Gallons)</td>
<td>Percent of Disposed STM Oil</td>
</tr>
<tr>
<td>Less than $25,000</td>
<td>66.1</td>
<td>13</td>
<td>43,000</td>
<td>2.5</td>
<td>26%</td>
</tr>
<tr>
<td>$25,000 to $69,999</td>
<td>32.1</td>
<td>78</td>
<td>244,000</td>
<td>6.9</td>
<td>70%</td>
</tr>
<tr>
<td>$70,000 or more</td>
<td>7.8</td>
<td>20</td>
<td>63,000</td>
<td>0.4</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>31.9</td>
<td>111</td>
<td>350,000</td>
<td>9.8</td>
<td>100%</td>
</tr>
</tbody>
</table>
Together, lower- and middle-income STMs dispose of 96 percent of all STM used oil (column 5).

The 7.8 mean number of STM changes the high-income group undertook in 2003–04 is within a range that might be purely social or altruistic. However, means can hide a lot of variation: while most STMs in this group reported only one or two oil changes for others, others undertook more, as many as 26. Some households with relatively high household income will have members whose personal income is low or who are unemployed and whose economic motivation for STM work is high.

**STM Work in Urban and Rural Areas**

In Section 2, we estimated the proportion of DIYers in each county who are STMs. This proportion might be lower in rural counties (30–100 percent rural) than in urban counties—about 13 percent in rural area vs. 17 percent in the latter—but this small difference could easily be an artifact of sampling error ($p = .3151$). Because the DIY rate is higher in rural areas, STM work as a proportion of all households with vehicles is 3–4 percent in both rural and urban areas.

The average number of STM oil changes undertaken by STMs, however, is much greater in urban than in rural areas, from 39.4 in urban counties (0–9 percent rural) to 6.9 in the most rural counties (30–100 percent rural), perhaps because of the much larger market for oil-changing services in urban areas.

**Motivations of Other DIYers**

The motivation for do-it-yourself oil changing on the vehicles in one’s own household is also partly economic—obviously a major reason people change their own oil is to save money—but income has both a positive and a negative effect on DIY oil changing.

The positive effect of income on DIY oil changing is a number-of-vehicles effect. On the average, households with higher incomes have more vehicles; the more vehicles, the more likely their oil is changed at home by a DIYer. A DIYer changes motor oil in only 16–17 percent of households with one or two vehicles; in 26–29 percent of households with 3–4 vehicles; and in 36 percent of households with five or more vehicles ($p = .0001$).

The negative effect of income on DIY oil changing is a direct income effect: once we have accounted for the impact of number of vehicles, people are more willing to pay someone else to change their oil, and the direct effect of income on the probability of DIY oil changing is strongly negative. For example, in households with four or more vehicles 80 percent of those with less than $25,000 income change their own oil, but only 21 percent of those with household incomes of $70,000 or more do so ($p = .0198$).

The positive and negative effects of income on DIY oil changing largely cancel each other out. This means the rate of DIY oil changing is pretty much the same at every income level—16–22 percent—except $100,000 and over, where it drops to 12 percent.

As Figure 3 shows, in DIY households the number of oil changes rises steadily with more vehicles, though not quite proportionately. Reading from the graph, households with one vehicle changed oil on average 3.5 times in 2003–04. Households with seven vehicles changed oil on average 14 times: 2.0 changes per vehicle.

In sum, the rate of DIY oil changing and the number of oil changes carried out are both significantly increased by the number of vehicles in use in a household. The greater the number of vehicles, the more likely a DIYer will change the oil, and the more changes they will undertake. But at every number of vehicles, households with higher income are less likely to change their own oil.
Improper Disposal Rates of Immigrant and U.S.-Born STMs and Other DIYers

Table 13 showed that STMs dispose of much more oil overall than other DIYers do. Table 15 compares U.S.-born STMs and other U.S.-born DIYers with respect to their improper disposal rates. The table shows that U.S.-born STMs are considerably more likely to dispose improperly (67 percent) than U.S.-born DIYers who are not STMs (46 percent). The group that generates far more used oil is also more likely to dispose of it improperly. This finding points again to the necessity of collecting used oil from STMs and high-volume STMs in particular if oil is to be collected to the greatest extent possible.

Table 15. U.S.-Born STMs Are More Likely to Dispose Improperly than Other U.S.-Born DIYers

<table>
<thead>
<tr>
<th>Disposal of Used Oil</th>
<th>U.S. Born</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STM</td>
<td>Other DIYer</td>
</tr>
<tr>
<td>Proper</td>
<td>24%</td>
<td>43%</td>
</tr>
<tr>
<td>Improper</td>
<td>76%</td>
<td>57%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>N</td>
<td>97</td>
<td>497</td>
</tr>
</tbody>
</table>

\( p = .0184 \)

We lack sufficient data on non-U.S.-born STMs (N=12) to compare their improper disposal rate with that of other non-U.S.-born DIYers. However, the very fact that so few STMs showed up in the statewide survey is suggestive. The relationship between STM work and recency of immigration suggests that new immigrants are simply less likely to engage in STM work than either immigrants with longer residence (15 or more years) or U.S.-born DIYers (Table 16). The survey data indicate that only 4 percent of recent immigrant DIYers engage in STM work,
increasing to 13 percent for immigrant DIYers who have been in residence in the U.S. longer (15 years or more) and 19 percent for U.S.-born DIYers.

<table>
<thead>
<tr>
<th>DIY/STM Status</th>
<th>Immigrant</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In U.S. &lt; 15 Years</td>
<td>In U.S. 15+ Years</td>
<td>U.S. Born</td>
<td>Total</td>
</tr>
<tr>
<td>STM</td>
<td>4%</td>
<td>13%</td>
<td>19%</td>
<td>17%</td>
</tr>
<tr>
<td>Other DIYer</td>
<td>96%</td>
<td>87%</td>
<td>81%</td>
<td>83%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>N</td>
<td>65</td>
<td>80</td>
<td>593</td>
<td>738</td>
</tr>
</tbody>
</table>

The increasing participation in STM work with years in the U.S. and U.S. birth is clear, substantial, and statistically significant—in spite of this, can we be confident that immigrants, especially new immigrants, are less likely to engage in STM work than U.S.-born DIYers?

Stories told about STMs by acquaintances and researchers and by participants in focus groups held in Burbank in 2003 provide further insight into the circumstances of STM activity, including participation by new immigrants, and into the likelihood that they would be inadequately represented in a telephone survey.

- A young Anglo respondent told us of looking for a reliable, inexpensive mechanic in a seedy area of Los Angeles County where he lived. His landlord had tried every garage in the area and recommended instead an experienced mechanic, an African American, who lived in a trailer in the corner of a supermarket parking lot. This man did not have a telephone, but he hung out in front of a doughnut shop and you could find him there. He would list the materials he needed; you bought them at the auto parts store. He would do oil changes and a wide range of repairs right there in the parking lot, or at your home if you had a driveway. He did what he said he would do, his work was good, and he was cheaper than the garages.

- A semi-skilled worker, Mexican American, in Los Angeles told a focus group of changing oil for friends and relatives for pay. They wanted the work done at low cost, by someone they trusted. He was glad for the extra income. Everyone came out ahead. But to get the materials, then do the work—that was enough. It was too much to also drive ten blocks to a parts store where he could wait in line to leave off the used oil, so he funneled it into the empty new oil containers and put them in the trash.

- A native Spanish speaker inquired about oil changing at garages in the Mission district of San Francisco, where his office was located. At one station, after some conversation, he was told, sure we can change your oil, but if you just want to change your oil, my cousin down the street does that, and it’s cheaper. In immigrant communities, family support networks operate to steer oil changing and minor repairs to relatives, often new immigrants who need work.

These stories don’t prove a case, but they do show how people in a range of circumstances, possibly including recent immigrants, are involved in changing oil and doing repairs on other people’s vehicles. For our purposes it is also important to note that the African-American man in L.A. County and the cousin down the street in San Francisco are not likely to be captured by a telephone survey, so they would not appear in survey data.
We already know that lower income people are less likely to participate in telephone surveys, and STMs are found mainly in lower-to-middle-income households. In addition, probably some STMs, especially new and undocumented immigrants, are more reluctant to participate in surveys, more reluctant to talk about changing oil for other people, and more reluctant to admit improper disposal than other DIYers are.

In spite of interviewing in Spanish and trying to engage Spanish-language respondents in a culturally appropriate conversational way, the survey might have obtained significantly less participation from these groups. Finally, because the survey was carried out only in English and Spanish, recent immigrants who speak mainly other languages are certainly underrepresented.

In short, it may be that newer immigrants really do participate less in STM activity than other DIYers, as Table 16 shows—but it might also be the case that they are harder to reach by telephone and less likely to participate in this survey. This could also explain the pattern of the data in Table 16. The STM participation of newer immigrants needs further research.

**Improper Disposal Volumes of STMs and Other DIYers**

As in Section 3, we combine survey and block grantees’ report data to obtain more accurate estimates of drained oil improperly disposed by STMs and other DIYers. In Section 3 we estimated that 13.84 million gallons of drained oil were improperly disposed in 2003–04. In Table 17 we apportion the 13.84 million gallons among U.S.-born and non-U.S.-born STMs and other DIYers. (We deal only with drained, liquid oil here; improper disposal of residual oil in filters is discussed in Section 11.)

As noted, we have too few interviews with non-U.S.-born STMs (12) for reliable estimates of their improperly disposed oil volume, and we believe that this group is substantially underrepresented in the survey data. Therefore, we have based the following estimates on a hypothesis that the rate of STM work is the same among non-U.S.-born DIYers as it is among U.S.-born DIYers and that non-U.S.-born STMs dispose improperly of the same volume of oil on average as U.S.-born STMs. This hypothesis may not be entirely true, but it is still useful to indicate what volume of oil might be improperly disposed by these groups if it is true.

Table 17 suggests that of these four main groups, U.S.-born STMs dispose improperly of by far the greatest volume of oil: 7.36 million gallons (column 2) or 53.2 percent of all oil improperly disposed by DIYers (column 3). The second-largest total estimated improperly disposed oil (3.36 million gallons, column 2) is for other U.S.-born DIYers, who constitute a large group that generates less used oil on average. The estimated total for non-U.S.-born STMs (2.17 million gallons) is lower than the total for U.S.-born DIYers because even though we have assigned them the average oil improperly disposed of U.S.-born STMs, the size of the group is relatively small.

The data on non-U.S.-born STMs and other DIYers are less reliable than the data on U.S.-born, partly because of smaller numbers and partly because the statewide survey did not include immigrants who speak mainly languages other than English or Spanish. Non-U.S.-born STMs and other DIYers might even be more numerous and dispose of more oil, both properly and improperly, than the data reveal, even though we have made a high assumption about improper disposal by non-U.S.-born STMs.

Combining the two STM percentages in column 3, we estimate that STMs dispose improperly of 68.8 percent of the oil improperly disposed in California, under our assumptions. Allowing for the possibility of substantial error in either data or assumptions, we think it likely that STMs are responsible for 50–80 percent of all the improperly disposed used oil in California, mainly because they generate much more oil on average than other DIYers but also because they dispose improperly at a higher rate.
The data and assumptions suggest that U.S.-born DIYers, including STMs, are responsible for 77.5 percent of improperly disposed oil; non-U.S.-born, 22.5 percent.

Table 17. Drained Oil Improperly Disposed by STMs and Other DIYers, U.S.- and Non-U.S.-Born

<table>
<thead>
<tr>
<th>DIYer Type</th>
<th>Sample N</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Estimated Improperly Disposed Oil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Millions of Gallons</td>
<td>Percent of Total</td>
<td>Average Gallons</td>
<td></td>
</tr>
<tr>
<td>U.S.-Born STM</td>
<td>97</td>
<td>7.36</td>
<td>53.2%</td>
<td>24.42</td>
<td></td>
</tr>
<tr>
<td>Other U.S.-Born DIYer</td>
<td>485</td>
<td>3.36</td>
<td>24.3</td>
<td>2.63</td>
<td></td>
</tr>
<tr>
<td>Non-U.S.-born STM</td>
<td>12</td>
<td>2.17*</td>
<td>15.6*</td>
<td>24.42*</td>
<td></td>
</tr>
<tr>
<td>Other Non-U.S.-born DIYer</td>
<td>134</td>
<td>0.95</td>
<td>6.9</td>
<td>2.53</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>728</td>
<td>13.84</td>
<td>100.0</td>
<td>6.76</td>
<td></td>
</tr>
</tbody>
</table>

* Twelve interviews with non-U.S.-born STMs are too few for reliable estimation. Instead, estimates for non-U.S.-born STMs are based on the assumption that the STM percentage and improper disposal volume among non-U.S.-born are the same as among U.S.-born DIYers. See text above for further discussion and Appendix 4 for methodology.

The difference between STMs and other DIYers in average gallons of oil improperly disposed is huge (column 4). On the average, STMs dispose improperly of more than nine times as much oil as other DIYers; and as we estimated earlier in Table 15, 76 percent of U.S.-born STMs dispose of drained oil improperly.

Implications

The most important message of this section is that STMs are critical to the CIWMB’s efforts to get used motor oil into its collection system. Because STMs dispose improperly of more than nine times as much oil as other DIYers, on average, if you can change the improper disposal behavior of a single STM, you achieve the same reduction in improper disposal as if you changed the behavior of nine other DIYers. STMs who do 10 or more STM oil changes per year dispose improperly of 15–20 times as much oil as other DIYers. Even in total—with their smaller numbers—STMs dispose of more than half of all DIY oil and probably 50–80 percent of improperly disposed oil.

Their motivation is economic, they have a lot of oil to dispose of, and, because they are operating an unregulated small business that generates used oil, they have special incentives to hide their activity. On the other hand, casual observation in lower-income areas of some towns and cities suggests that STMs operate rather openly and freely.
5. Total Oil Disposed and Oil Collected Curbside, by County

This section provides estimates of the volume of used oil disposed and collected by county and the oil collected through curbside collection, in which waste disposal or recycling services pick up oil curbside on neighborhood waste collection days.

This section describes how curbside collection of used oil is estimated and gives estimates by county. We again combine 2001 survey data on the volume of oil disposed by DIYers with census and grantee data to produce estimates of the amount of oil collected from DIYers in relation to the amount of oil disposed by DIYers, by county.

Section 6 of this report considers which methods of collection are most effective at reducing rates of improper disposal. Appendix 5 lays out details of estimation behind the tables in this section and discusses error and error correction in used oil surveys and in block grantees’ oil collection reports.

Main Findings

1. The amount of oil disposed by DIYers in each county can be estimated by combining survey and census data. Estimates are reported by county.

2. Total oil collected from DIYers in counties is related to oil disposed by their DIY households, which validates both numbers.

3. We estimate the percentage of DIY oil collected, by county—a measure of the effectiveness of used oil collection programs in counties. There are great differences between counties in the effectiveness of their used oil programs.

4. We measure the emphasis on curbside collection in counties with oil collected curbside as a percentage of all oil collected from DIYers. Emphasis on curbside collection ranges from 0 to 78 percent.

5. Oil collected curbside ranges from 0 to 47 percent of the oil disposed by DIYers.

6. Curbside collection of used oil has developed in California almost entirely in the northern and central counties. Most counties, including the most populous counties of southern California, rely entirely or almost entirely on collection through centers to which DIYers take their oil.

7. These findings rest in significant part on reports by block grantees. The reports specify the amount of oil collected from the public by certified and uncertified collection centers. Some indications of inaccuracy in these reports are noted in Appendix 5. Used Oil Program staff has already made significant progress in developing protocols for verifying and adjusting the block grantee reports, and plans are under way to improve the quality of the grantee reports. CIWMB should continue to strengthen these efforts to produce more accurate information about the effectiveness of local and State used oil recycling program efforts. Specific recommendations about some aspects of data collection and adjustment are presented in Appendix 13.

Introduction

Curbside collection, for the purpose of this report, is the regular collection of DIYers’ used oil at the curb. The collection method is similar to that of trash, yard debris, paper, bottles, and cans. No prior notification by the customer is required. Oil collected curbside is delivered to oil
recyclers. Some programs collect used oil filters as well as oil. The CIWMB report *DIYers and Used Oil Disposal: Initial Results* (January 2002) noted much lower rates of improper disposal in a few counties known to have high curbside recycling coverage.

The initial results report found that proper disposal in general was closely related to perceived convenience. These findings raised the possibility that widespread adoption of curbside collection of used oil—a particularly convenient method of disposal—might significantly reduce improper disposal statewide. This section presents estimates of oil collected curbside and oil collected through collection centers. Section 6 considers whether curbside or center collection is superior in reducing improper disposal of used oil.

**Topics**

1. How much oil is disposed by DIYers in counties?
2. How much oil is collected in California?
3. How much oil is collected curbside in California?
4. Implications

**How Much Oil Is Disposed by DIYers in Counties?**

We combine survey and census data to estimate how much oil is disposed by DIYers, including shade-tree mechanics (STM), in each county. Combining survey and census data, we were able to estimate the number of DIYers overall and the number of STMs in each county (Section 2). We then estimated the oil changes undertaken by each of these groups by county. Finally, we estimated the amount of oil disposed as a result of these oil changes. See Appendix 5 for details.

Estimation of oil by county starts with the estimated number of DIY households in each county that we obtained in Section 2. We estimated the number of STM oil changes as a function of proportion rural of county of residence; age; household income; occupation of mechanic and occupations involving tools, machinery, or outdoor work, all of which help explain why some STMs do more oil changing than others.

We estimated the number of DIY household oil changes with income, age, and number of vehicles in the households. The same method was used to estimate average gallons of oil per oil change.

We then applied the coefficients from these estimations to the very large samples of households in each county or county group provided by the U.S. census. The amount of DIY and STM oil disposed per county was estimated as the sum of oil disposed via DIY and STM oil changes. Estimated disposed amounts of DIY and STM oil ranged from 1,846 gallons in Alpine County to 5,201,883 in Los Angeles County. We present these estimates below in Figure 8 and Table 18 along with amounts of oil collected.
How Much Oil Is Collected in California?

Estimating Oil Disposed by DIYers by County

The total amount of oil generated by and collected from DIYers in a county depends on the number of people and vehicles in the county, the amount the vehicles are driven, and how often their oil is changed. Second, it depends on the rate at which DIYers do the oil changing. In Appendix 5 we check our estimation methods by showing the relationship between estimated oil disposed by DIYers and the estimated number of DIY households, by county. Then below, we show the key performance measure—the amount of oil collected from DIYers, including STMs, as a percentage of oil disposed by DIYers and STMs, by county.

Relation of Oil Collected to Oil Disposed: A Measure of Performance

Statewide, total oil reported collected by block grantees from DIYers in 2003–04 was 7,845,602 gallons.* This is 35.3 percent of the survey-estimated 22.22 million gallons disposed as drained oil at oil changes. The percentage of oil collected varies from county to county. In a given county, oil collected from the DIY public as a percentage of oil disposed by DIYers is a measure of the county’s used oil collection performance.

Figure 8 provides the relationship between oil collected from DIYers, on the vertical axis, and oil disposed by DIYers, on the horizontal. The data are presented on so-called logarithmic scales, where equal intervals correspond to ten-fold increases in the quantities. Logarithmic scales spread out the lower values relative to the higher values of a variable, permitting us to see the relationship for counties at the lower values.

The variation around the best-fitting line reflects real and substantial variation between counties in the amount of oil they collected, given the volume of oil disposed by county residents and characteristics of their populations and used oil programs.

Although the clustering of counties around the line appears to be fairly close, actually the differences between counties in amounts of oil collected are great. For example, Marin and Kings Counties, identified in Figure 8, are fairly close in amount of oil disposed by DIYers, with Marin estimated at 91,296 gallons; Kings, at 115,631.

However, Marin reported 51,852 gallons collected from DIYers, which is 56.8 percent of estimated total oil disposed by DIY households in Marin. Kings County reported 13,420 gallons collected, about one-fourth as much. Kings County reported collecting only 11.6 percent of the estimated oil disposed by county DIY households and STMs. Modest differences on the vertical axis translate into major differences in amounts and percentages of oil collected—that is, in the effectiveness of oil-collection programs in the counties.

County Estimates of Oil Disposed and Collected

The data plotted in Figure 8 are presented for each county in Table 18. Counties are ranked from highest to lowest in total oil collected as a percent of the estimated DIY and STM oil disposed in the county (column 5). This percentage is a key performance measure of the effectiveness of the used oil programs in counties. Oil disposed is estimated for STMs and other DIYers and combined in columns 1–3. Column 4 consists of oil collected volumes reported in block grantee

* Source: CIWMB database, from grantee annual reports. These are reports of oil collected from the public. Oil collected by agricultural collection programs, by airports, and by marinas is excluded for the purposes of this report on DIY oil.
annual reports for 2003–04, with oil collected from airports, marinas, and agricultural programs omitted so as to focus attention as much as possible on DIY-generated oil. The data were verified and corrected by the Used Oil Program and further corrected by the author of this report.

The results are surprising: a great variation in the percent of oil collected in column 5. Counties at the bottom of the range collect 6–20 percent, while counties at the top collect 50–75 percent.

The estimate of oil collected in Sierra County is an unlikely 99.7 percent of oil disposed. Sierra is the second smallest county in the state by population with only 1,562 households. The smallest and most rural counties as a group have a larger margin of sampling error, and Sierra’s improbable value is within the range of the margin of sampling error for a population percentage in the high 70s.

Its value could also have been produced by errors in reporting and estimation of oil collection or by the necessity to disaggregate estimates for larger areas (PUMAs) to individual counties. Estimates of county-level characteristics for small, rural counties are potentially subject to greater sampling error. (See Appendix 2, “Potential Sampling, Prediction, and Non-Sampling Error.”)

Figure 8. Oil Collected from DIYers by Oil Disposed by DIYers in California Counties, 2003–04

Note: Circles are drawn in proportion to the estimated number of DIY households in each county. Best-fitting line drawn by linear regression. Smaller counties are likely to display greater sampling error.
Table 18. Total Oil Disposed by DIYers and Collected from DIYers, by County, 2003–04

<table>
<thead>
<tr>
<th>County</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimated Oil Disposed by Other DIYers (Gallons)</td>
<td>Estimated Oil Disposed by STMs (Gallons)</td>
<td>Estimated Total Oil Disposed by DIYers Including STMs (Col. 3) = (Col. 1) + (Col. 2)</td>
<td>Total DIY/STM Oil Collected in County</td>
<td>Total Oil Collected as Percent of Estimated DIY/STM Oil Disposed in County (Col. 5) = (Col. 4)/ (Col. 3) x 100</td>
</tr>
<tr>
<td>Sierra</td>
<td>3,922</td>
<td>877</td>
<td>4,799</td>
<td>4,785</td>
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<td>109,082</td>
<td>80,308</td>
<td>73.6</td>
</tr>
<tr>
<td>Santa Barbara</td>
<td>162,380</td>
<td>128,596</td>
<td>290,976</td>
<td>190,998</td>
<td>65.6</td>
</tr>
<tr>
<td>Santa Clara</td>
<td>526,429</td>
<td>357,955</td>
<td>884,385</td>
<td>527,822</td>
<td>59.7</td>
</tr>
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<td>Inyo</td>
<td>21,638</td>
<td>5,969</td>
<td>27,608</td>
<td>16,025</td>
<td>58.0</td>
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<td>Marin</td>
<td>54,368</td>
<td>36,928</td>
<td>91,296</td>
<td>51,852</td>
<td>56.8</td>
</tr>
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<td>Santa Cruz</td>
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<td>57,727</td>
<td>191,244</td>
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<td>San Benito</td>
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<td>46,484</td>
<td>23,945</td>
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<td>5,434</td>
<td>25,131</td>
<td>12,551</td>
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<td>145,977</td>
<td>71,957</td>
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<td>1,589,543</td>
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<td>213,382</td>
<td>526,754</td>
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<td>Trinity</td>
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<td>1,815,419</td>
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<tr>
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<td>462,099</td>
<td>161,082</td>
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<td>Orange</td>
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<td>446,657</td>
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<tr>
<td>County</td>
<td>Column 1 Estimated Oil Disposed by Other DIYers (Gallons)</td>
<td>Column 2 Estimated Oil Disposed by STMs (Gallons)</td>
<td>Column 3 Estimated Total Oil Disposed by DIYers Including STMs (Col. 3) = (Col. 1) + (Col. 2)</td>
<td>Column 4 Total DIY/STM Oil Collected in County</td>
<td>Column 5 Total Oil Collected as Percent of Estimated DIY/STM Oil Disposed in County (Col. 5) = (Col. 4)/(Col. 3) x 100</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------</td>
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<td>37,433</td>
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<td>19,930</td>
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<td>2,014,776</td>
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<td>361,030</td>
<td>76,570</td>
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<td>Tehama</td>
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<td>27,016</td>
<td>91,023</td>
<td>16,576</td>
<td>18.2</td>
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<td>6,880</td>
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<tr>
<td>Lake</td>
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<td>15,852</td>
<td>70,030</td>
<td>10,226</td>
<td>14.6</td>
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<td>5,422</td>
<td>31,828</td>
<td>4,500</td>
<td>14.1</td>
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<td>65,887</td>
<td>173,537</td>
<td>21,789</td>
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<td>1,447</td>
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<td>1,846</td>
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<td>11.6</td>
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<td>41,806</td>
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<td>13,420</td>
<td>11.6</td>
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<tr>
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<td>26,225</td>
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</tbody>
</table>

The county-level estimates in Table 18 are subject to possible sampling and data error. Sampling error is likely to be greater for smaller counties, sometimes much greater. Data error might involve erroneous reporting of oil as DIY oil that is actually generated by oil installers. If oil installed by non-DIYers was erroneously included in county reports of oil collected from DIYers, that could easily add 30 or 40 percentage points to the column 5 estimate for a county.
Used Oil Program staff now adjusts the reported oil collection figures from grantees to reduce inclusion of oil generated by installers rather than by DIYers. This is an important effort if the Board and grantees are to have accurate data about program effectiveness. One of the rules applied at present is an allowance of 5 percent of the volume of oil claimed for reimbursement by fast lube outfits (which presently can claim reimbursement for all of their oil, not just DIY oil).

This rule may count fairly large amounts of non-DIY oil as DIY oil. If this is the case, oil collection totals for some counties might be overstated. The real figure for fast lubes might be closer to 1 percent. Fast lube outfits generate so much oil that an error of 1–2 percentage points might add thousands of gallons to a county’s adjusted collection figures.

We do not have direct data on DIY oil as a proportion of all reported fast lube oil. We estimated in Section 3 that 3.48 percent of properly disposing DIYers who take oil to a collection center take it to a fast lube outfit for disposal. However, they dispose of only 2.27 percent of the properly disposed (collected) DIY/STM oil taken to centers: 1.51 percent in urban counties (0–9.9 percent rural), 6.48 percent in the more rural counties. These estimates suggest a possible constraint on the DIY oil volumes counted from fast lube outfits. See especially Appendix 3, “Assumptions, Accuracy of County-Level Estimates, and the Constraint of Reality,” for a possible way of dealing with this. Error issues are also discussed in Appendices 5 and 13.

In any case, we need not claim that county-level estimates in this report are precisely accurate, and we cannot guarantee that they are. Publishing them will help locate errors and bring about improvements in the method. The estimates are approximations; most of them are probably roughly accurate within their margins of sampling error.

**How Much Oil Is Collected Curbside?**

**Definition—Regular Curbside vs. Prior-Notification Programs**

In this report, curbside collection is defined as pickup of used oil at the curbside on a regular recycling day, weekly or biweekly (in one locality, monthly), with no requirement for prior notification. Other residential programs for collection of oil are called curbside programs in some localities and “door-to-door” programs in others. They require a telephone call beforehand, so we call these programs prior-notification programs. Prior-notification programs display a wide range of characteristics. Some pick up on regular recycling days—their only difference from curbside programs is the prior notification requirement.

Others pick up on different days but (given notification) the same day of the month each time. Still others make a specific appointment for pickup on a future date. Some require containers provided by the program; others do not. Some want used oil placed on the curb; others, at the door. The requirement these programs all share is prior notification.

We decided on this classification in order to see if we could test a hypothesis about the effectiveness of regular curbside collection. Mixing curbside with prior-notification programs was inadvisable, because prior notification seems significantly less convenient and more demanding than regular curbside pickup. A full test was not possible because prior-notification programs have not been widely enough adopted to yield reliable findings about differences between the two programs. We were not able to detect differences between them in their rates of improper disposal. (See Appendix 6, “Prior-Notification Programs,” and Appendix 10.)

To assign local residential programs and their collected oil to the two program types we received information from Used Oil Program staff, exchanged email messages and telephone calls with program people, and studied their websites to determine program characteristics.
Emphasis on Curbside Collection, by County

The amount of oil collected curbside from DIYers in 2003–04 is shown in column 1 of Table 19.

Column 2, the estimated curbside percent of all oil collected in the counties, is a measure of the extent to which counties and their localities have emphasized curbside collection over other modes of collection: certified and non-certified centers, HHW facilities, ABOPs, mobile programs and collection events, and prior-notification programs.

The estimated curbside percent of all oil collected varies widely, from zero in the 30 counties with no oil collected curbside to 78.2 percent in Santa Clara County. Statewide oil collection estimates show 9.9 percent of the oil collected from DIYers obtained by curbside collection in 2003–04. Consistent with that figure, the statewide survey estimates that 10.3 percent of DIYers put oil out for curbside pickup, accounting for an estimated 8.6 percent of properly disposed oil, ± 4.4 percent margin of error.

Column 3, total DIY oil disposed, is copied from the same column of Table 18 to provide the denominator for the computation of the column 4 figure: oil collected curbside as a percent of the estimated oil disposed by DIYers, including STMs.

Scope of Curbside Collection in Relation to Total Disposed Oil

Column 4 is a measure of the scope of curbside collection, not in relation to total oil collected but in relation to the size of the problem, the volume of oil disposed. The scope of curbside collection ranges from 0 to 46.7 percent in Santa Clara County. Only there does curbside take more than 14 percent of the oil disposed by DIYers.

Table 19. Oil Collected Curbside, by County, 2003–04

<table>
<thead>
<tr>
<th>County</th>
<th>Oil Collected Curbside 2003–04 (Gallons)</th>
<th>Curbside Percent of All Oil Collected from DIYers</th>
<th>Estimated Oil Disposed by DIYers in 2003–04</th>
<th>Oil Collected Curbside as Percent of Estimated DIY/STM Oil (Col. 4) = (Col. 1)/ (Col. 3) x 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa Clara</td>
<td>412,830</td>
<td>78.2</td>
<td>884,385</td>
<td>46.7</td>
</tr>
<tr>
<td>Tehama</td>
<td>7,307</td>
<td>44.1</td>
<td>91,023</td>
<td>8.0</td>
</tr>
<tr>
<td>San Mateo</td>
<td>33,470</td>
<td>32.5</td>
<td>321,812</td>
<td>10.4</td>
</tr>
<tr>
<td>Alameda</td>
<td>81,683</td>
<td>32.3</td>
<td>767,118</td>
<td>10.6</td>
</tr>
<tr>
<td>San Benito</td>
<td>6,200</td>
<td>25.9</td>
<td>46,484</td>
<td>13.3</td>
</tr>
<tr>
<td>Solano</td>
<td>32,417</td>
<td>24.6</td>
<td>356,392</td>
<td>9.1</td>
</tr>
<tr>
<td>Sacramento</td>
<td>62,373</td>
<td>23.8</td>
<td>894,112</td>
<td>7.0</td>
</tr>
<tr>
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<td>Column 2 Curbside Percent of All Oil Collected from DIYers</td>
<td>Column 3 Estimated Oil Disposed by DIYers in 2003–04</td>
<td>Column 4 Oil Collected Curbside as Percent of Estimated DIY/STM Oil (Col. 4) = (Col. 1)/(Col. 3) x 100</td>
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<td>Oil Collected Curbside 2003–04 (Gallons)</td>
<td>Curbside Percent of All Oil Collected from DIYers</td>
<td>Estimated Oil Disposed by DIYers in 2003–04</td>
<td>Oil Collected Curbside as Percent of Estimated DIY/STM Oil (Col. 4) = (Col. 1)/ (Col. 3) x 100</td>
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Note: Columns 3 and 4 are subject to sampling error in the estimation of disposed oil. Columns 1, 2, and 4 draw upon block grantee reports as adjusted by the Used Oil Program and by the author.

**Curbside Collection in North and South**

Curbside collection plays a much larger role in northern and central California than in the southern part of the state. We estimate that 12.1 percent of oil disposed by DIYers in northern and central California is collected via curbside collection. In southern California, only 1.2 percent of DIY oil is collected curbside.* About five-sixths of the oil collected curbside in California was collected in the northern and central counties in 2003–04, and those counties comprised all of the counties that collected curbside more than 1 percent of their oil from DIYers.

**Oil Collection by Mode Statewide**

Almost all of the oil collected from DIYers in California in 2003–04 was collected either by curbside collection (9.9 percent) or by centers to which DIYers bring their oil. These included certified and non-certified centers, HHW facilities, and ABOP sites (85.6 percent). Prior-notification programs for residential pickup collected 1.9 percent of the DIY oil, and mobile collection programs and collection events generated 2.6 percent.

**Implications**

Survey and census data and block grantee reports can be used to estimate the following interesting quantities by county:

1. The amount of oil disposed at oil changes by STMs and other DIYers and the amount collected as a percent of oil disposed by DIYers (Table 18).

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* Northern and central California is defined here as all counties north of Santa Barbara, Kern, and San Bernardino counties. The nine counties in southern California by this classification are Kern, Santa Barbara, Ventura, Los Angeles, Orange, San Bernardino, Riverside, San Diego, and Imperial.
2. The amount of oil collected curbside as a percent of oil collected from DIYers, a measure of program emphasis in counties (Table 19).

3. The amount of oil collected curbside as a percent of oil disposed by DIYers, a measure of the scope of curbside programs in collecting DIY used oil (Table 19).

These estimates should be useful to cities, counties, and the state in assessing the adequacy of used oil collection.
6. Improper Disposal—Which Collection Method Is Superior?

This section compares collection of used oil by the following methods:

- **Center collection**, in which DIYers take their used oil to a collection center.
- **Curbside collection**, in which waste disposal or recycling services pick up oil curbside on neighborhood waste collection and recycling days, without a prior notification requirement.

The objective is to determine whether one of the methods is superior in effectiveness. We define effectiveness as **reducing the rate or volume of improper disposal**. See Appendix 6 for additional detail about methodology.

**Main Findings**

1. Both center collection and curbside collection reduce improper disposal substantially, for those DIYers for whom they are both convenient and available.

2. Curbside collection demonstrates in the data that it can reduce improper disposal to zero where it is widely available. Center collection reduces improper disposal much less, even where it is very convenient. Thus curbside collection meets the statutory objective of enhancing recycling “to the greatest extent possible.” Center collection does not.

3. Widely available curbside collection reduced improper disposal to zero in the distinctive subpopulation it serves—DIYers who reside in single-family dwellings, who are disproportionately older. That group already disposes improperly at a somewhat lower rate than younger DIYers.

   BUT even in localities where curbside collection has been implemented, it is not available to the majority of DIYers, who are younger and typically live in multifamily dwellings.

4. Where center collection has been well implemented—where centers are convenient to DIYers—it reduces improper disposal substantially.

   BUT even where center collection is well implemented and centers account for most oil collected from DIYers, it still fails to engage the participation of a significant fraction of DIYers and leaves a large amount of oil uncollected.

5. Thus both programs miss substantial parts of the DIY population and of the used oil that DIYers dispose of.

6. Curbside collection competes successfully with the trash bin for used oil collection because it is almost as convenient as throwing oil in the trash. The challenge for curbside collection programs is to make them available to the large population of DIYers they do not now reach—residents of multifamily dwellings, typically younger.

7. The challenge for center collection programs is to increase knowledge about used oil recycling and the convenience of centers for DIYers. Program managers need to find a way to increase DIYers’ commitment to take their oil to a center. These steps, if they are feasible, would reduce the DIY rate of improper disposal below the rates currently achieved by well-implemented programs. This goal may not be attainable at a reasonable cost without a credible threat of enforcement.
8. Making collection centers “very convenient” for every DIY household in the state would collect about 3.5 million gallons of additional used oil. Extending curbside collection of used oil to 90 percent of the state’s DIY households will collect an estimated 12.5 million gallons of drained oil that is now illegally disposed. If curbside collection includes oil filters and the empty oil containers, about 3 million gallons of additional used oil is recoverable.

9. Cost is often cited as a reason for not adopting curbside collection. But the statutory objective is to enhance recycling “to the greatest extent possible,” and curbside collection achieves that objective. Therefore, program costs for any comparison of curbside and center collection should be measured as the long-term cost of achieving zero or near-zero improper disposal. Comparisons should take into account the tendency of the privately owned certified collection centers to lose focus on oil collection because of staff turnover and changing priorities.

10. Cost per gallon of oil presently collected is not a meaningful basis for comparison of curbside and center-based collection. From the point of view of the statutory objective, curbside collection is successful in reducing improper disposal “to the greatest extent possible”; center-based collection has not yet shown it can succeed in that respect. Of course it is less expensive to collect less of the available oil.

11. Cost is important. We recommend that the Used Oil Program work with local programs to develop best practices for successful, cost-effective curbside collection and, if necessary, to sponsor studies of the comparative long-term costs of driving illegal disposal of used oil to zero under each method.

12. To further curbside collection, the Board should encourage localities to establish, expand, and improve curbside collection of oil, filters, and empty oil containers. The CIWMB should disseminate information about low-cost, effective, secure curbside collection systems, and it should develop model contracts. The Board should encourage the development of markets in which enthusiastic providers of effective recycling services engage in real competition to offer genuinely effective recycling services.

Introduction: Convenience, Availability, and Collection

Center collection and curbside collection account for almost all of the used oil collected from DIYers in California. Collection centers to which DIYers take their oil—certified and noncertified collection centers and permanent HHW and ABOP facilities—accounted for 85.6 percent of oil collected from California DIYers in 2003–04.* Regular curbside pickup from residences accounted for 9.9 percent; prior-notification pickup from residences, another 1.9 percent.

The fact that center collection accounts for so much of the total oil collected from DIYers does not mean that center collection is more “effective.” It means that center collection has been more widely adopted. Whether center collection is more effective than curbside collection at reducing improper disposal remains to be determined. Both kinds of programs are still in development, and both need further development to improve their effectiveness.

The relative emphasis on and relative implementation of center and curbside collection in counties can be measured by the percentage of oil collected from DIYers by the two methods,

* HHW = household hazardous waste. ABOP = antifreeze, batteries, oil, and paint. The 85.6 percent collected by all centers includes 71.7 percent collected by certified centers; 4.7 percent, by noncertified centers; and 9.1 percent, by permanent HHW facilities and ABOP sites.
calculated from grantee reports as described in Section 5. Emphasis on center collection—the percentage of oil collected that was collected through any kind of fixed site or center—ranged from 22 to 100 percent over California counties in 2003–04. Emphasis on curbside collection ranged from 0 to 78 percent. At least some curbside collection was available in 23 counties. In 11 counties, curbside collection accounted for more than 10 percent of total oil collected from DIYers. Only four counties obtained more than 30 percent of their collected DIY oil via curbside collection in 2003–04: Santa Clara (78 percent), Tehama (44), San Mateo (33), and Alameda (32).

As we noted in Section 5, curbside collection of used oil has developed almost entirely in the northern and central counties of California. Most counties, including the most populous counties of southern California, rely almost entirely on center collection.

The effectiveness of a method of used oil collection in reducing improper disposal in a county is a function of the convenience and the availability of the method. Improper disposal rates will be lowest in counties in which localities have adopted very convenient collection methods and they have made those methods widely available.

**Curbside collection is convenient but not available.** The paradox of curbside collection is that it is very convenient for DIYers whom it serves, but it is not available to most DIYers, even in counties that rely on it to collect most of the oil they collect from DIYers. We show this below. Thus, the determinant of the effectiveness of curbside collection in a county is its real availability to DIYers.

**Center collection is available but not always convenient.** Center collection is universally available, in that almost every county has at least one center to which DIYers can take oil, but the counties vary in the extent to which their collection center systems are convenient and are seen as convenient by their DIYers. In addition, center collection is by its very nature less convenient than curbside collection because DIYers have to run an additional errand to recycle their oil. The determinant of the effectiveness of center collection is its convenience for the county’s DIYers.

**Impact of Curbside and Center Collection on Improper Disposal**

We want to know the impact of curbside and center collection on improper disposal rates of individual DIYers. First we want to know whether the two methods are similarly effective in reducing improper disposal for DIYers who do not use the other method. That is, we want to know the following:

- Whether the availability of curbside collection effectively reduces improper disposal among DIYers who do not recycle their oil at collection centers.

- Whether the convenience of taking oil to centers effectively reduces improper disposal among DIYers who do not recycle via curbside collection. Almost always, these will be DIYers for whom curbside collection is not available.

We estimate in Figure 9 the probability that a DIYer disposes improperly in 2003–04, given the convenience of centers for non-curbside disposers and given the availability of curbside for non-center disposers. The top dashed line shows the decline in improper disposal as the convenience of center collection increases for DIYers who do not recycle their oil via curbside pickup.

The bottom line traces the decline in improper disposal as the availability of curbside collection increases, for DIYers who do not take their oil to centers. We take county emphasis on curbside collection—the proportion of oil collected that was collected by curbside collection—as a measure of availability.
Both lines slope downward in Figure 9, because both methods reduce the probability of improper disposal as convenience and availability increase. Both show about the same high level of improper disposal at the worst-case point: the centers are not at all convenient, or curbside is not at all available. But increasing the availability of curbside collection reduces the probability of improper disposal much more.

**Figure 9. Probability of Improper Disposal for Center Collection and Curbside Collection of Used Oil**

![Graph showing the probability of improper disposal for center collection and curbside collection.](image)

Levels of the lines in Figure 9 are different. The probability of improper disposal, given increasing availability of curbside collection (the bottom solid line), is much lower than the probability of improper disposal given increasing convenience of centers. This holds true for most of the range of convenience and availability among DIYers who do not use curbside (top dashed line).

Where availability and convenience approach 0 (no curbside collection, very inconvenient), predicted probabilities of improper disposal for both groups are very high—between 0.75 and 0.80—and almost equal. This suggests that the difference in performance between the two methods is not a function of a difference in the populations they serve. But the desired reduction in probability of improper disposal is much greater for curbside collection than it is for center collection. Improper disposal approaches zero for DIYers in counties where curbside collection is most available, while the predicted probability of improper disposal falls only to 0.48 for non-curbside DIYers who perceive that taking oil to a center is very convenient. Making curbside collection widely available reduces the rate of improper disposal more than making center collection very convenient.
The effect of curbside collection on improper disposal cannot be understood without looking at the way in which curbside collection intersects with residence in multifamily dwellings and therefore with age.

**Curbside Collection Reduces Improper Disposal Only Among Older DIYers**

The following factors are important links between age of DIYers, kind of housing, and curbside collection:

1. Because curbside collection is so convenient, it is very effective at reducing improper disposal where it is available to DIYers, as we have just shown.

2. But curbside collection, if it exists at all, is usually available only to residents of single-family dwellings.

3. Younger DIYers are more likely to rent than to own housing, which means they usually live in multifamily dwellings.*

4. Therefore, curbside collection is typically available to older DIYers but not to younger ones.

5. Curbside collection reduces improper disposal mainly among older DIYers.

In counties where curbside collection is implemented, it is actually not available to most younger DIYers, who reside mostly in multifamily dwellings. (See Appendix 6 for supporting data on this point.) This is a significant shortcoming of curbside collection because most of the improperly disposed oil is generated by DIYers under 40.

Curbside collection has a very strong effect on improper disposal—but the effect is mostly true for older DIYers. We can see the differential effects of curbside collection on younger and older DIYers with great clarity in Figure 10. Here we plot estimated improper disposal by county availability of curbside collection for the two age groups.

The estimated improper disposal rate of all older DIYers drops down to zero with increasing curbside collection—but improper disposal by younger DIYers drops much less and is higher over the entire range of availability. In other words, for younger DIYers, county availability of curbside collection does not translate so readily into individual availability. Their improper disposal rate does not drop to zero because many younger DIYers do not reside in the single-family dwellings where curbside collection is actually available.

* The relationships between age, single-family dwelling, and curbside collection are shown in Appendix 6, Figure 19 and Figure 20.
Convenient Collection Centers Reduce Improper Disposal by All DIYers—But Less

Figure 11 plots improper disposal rates for the under-40 and 40-plus groups by DIYer-rated convenience of taking oil to centers. With increasing convenience of collection centers, the improper disposal rate for both older and younger DIYers falls, starting somewhat higher and dropping more rapidly for the younger group. Both groups show improper disposal rates of 0.46 where centers are very convenient.
In short, both curbside and center collection can produce substantial reductions in improper disposal:

- Curbside collection, where it is widely available, very effectively reduces the rate of improper disposal among older DIYers—all the way to zero. But curbside collection does not, as presently implemented, have an equal effect on the higher improper disposal rate of younger DIYers. This is an important shortcoming.

- The best-implemented and most convenient center collection programs yield reduced rates of improper disposal among both groups, to 0.46. Convenience reduces high rates of improper disposal among both younger and older DIYers.

**County-Level Evidence on Effectiveness of Curbside Collection**

The previous graphs on improper disposal as a function of availability and convenience of collection methods can be replicated at the county level. In Figure 12 we look at the relationship between the amount of used oil collected from DIYers in counties and the availability of curbside collection in counties.

On the vertical axis, Figure 12 uses the estimate of countywide effectiveness, which is total used oil collected as a percent of DIY oil generated in the county. As before, availability of curbside collection in counties, on the horizontal axis, is measured by the amount of oil collected curbside as a proportion of all DIY oil collected in the county.

If curbside collection increased total county used oil collection in 2003–04, then total collection should be positively related to the availability of curbside collection. Figure 12 shows that total oil collected and the availability of curbside pickup in counties are not clearly related. A number of counties with increasing availability of curbside collection are strung out to the right, but there is no definitive sign of increase in oil collected. The modest increase that seems to be there is
entirely the result of one county at the right-hand side of the graph—Santa Clara. Take away Santa Clara County, and the relationship between overall oil collection and the availability of curbside pickup appears to be slightly negative.

Counties with little curbside pickup and therefore high reliance on center collection are stacked near the vertical axis. Effective centers programs are high on total collection—these are the counties that have developed relatively convenient centers with good location, publicity, and DIYer participation. Overall, the counties focused on centers are just as high in the percent of oil collected as the curbside-focused counties, and many counties with little or no curbside collection are collecting as much or more DIY oil than the curbside-focused counties.

In short, modest increases in the availability of curbside collection will not necessarily increase overall used oil collection in a county. This is true even though widely available curbside collection in a county reduces improper disposal by older DIYers to zero. The county data are consistent with the evidence and explanation about improper disposal set forth above in this section. Making curbside collection available to single-family dwellings does very well at reducing improper disposal and increasing oil collection from older DIYers, but it misses the larger amounts of oil disposed by younger DIYers.

But the lesson of Santa Clara County is also instructive. It collects far more of its DIY used oil curbside than any other county: 78.2 percent (Table 19, column 2). It also collects substantially more DIY used oil overall than any other large, highly urbanized county (Table 18, column 5). Santa Clara County shows that a mature curbside collection program, almost universally available to single-family dwellings, can propel overall used oil collection to very high levels.

Figure 12. Program Effectiveness by Program Emphasis: Oil Collected from DIYers by County Availability of Curbside Collection

Volumes of Oil that Are Collectable Curbside and by Centers

We know already that the improper disposal rate drops with increasing convenience of taking oil to centers. That has been amply demonstrated in the 2002 CIWMB report Initial Results and in the graphs of this section.
1. Does it follow that we can collect a great deal more used oil if we make centers more convenient?

2. We have already seen that the rate of improper disposal does not drop to zero even with very convenient centers, but can we still reduce the volume of oil improperly disposed to very low levels by focusing on making centers very convenient?

**Very Convenient Centers Will Collect More Oil**

The answer to the first question is yes—if centers could be made more convenient statewide, much more used oil would be collected. Ninety-one percent of the improperly disposed oil of non-curbside users originates with DIYers who say that taking oil to a center is less than very convenient for them, and their improper disposal rate is 73 percent.

If collection centers could be made very convenient for this group, how much oil could we expect to collect? Assuming that their improper disposal rate would then be 48 percent—the rate for the present very convenient group—an estimated additional 3.80 million gallons would be collected.

**…But Not Enough**

The answer to the second question is no. Making collection centers very convenient for all DIYers who do not have curbside collection would still leave us with a predicted 48 percent improper disposal rate. Only 34 percent of the total improperly disposed oil of these DIYers would be collected, and it would leave an estimated 7.32 million gallons of oil uncollected.

Collection centers are collecting a great deal of used oil, they could collect more, and the rate of improper disposal does drop markedly from not at all convenient to very convenient. But the data show that increasing convenience from present levels is not enough to achieve reduction of improper disposal “to the greatest extent possible.” Collection centers are unavoidably inconvenient compared to the alternatives: no matter how convenient they are, they still require an extra errand. Even very convenient centers are much less convenient than throwing oil in the trash or pouring it in a hole in the ground.*

**Converting to Curbside Collection Will Collect Much More Oil**

What if curbside collection were implemented statewide—how much of the presently improperly disposed oil could we expect to collect? In Section 3, we estimated total improperly disposed oil at 13.84 million gallons. We estimate that curbside collection reduces improper disposal to zero or close to it; we do not know what proportion of households in California are potentially accessible to waste disposal trucks outfitted to take used oil containers.

If statewide curbside collection could be implemented for the 90 percent of California’s DIY households that do not presently have it, 12.46 million gallons of improperly disposed oil could be collected (0.90 \times 13.84); 1.38 million gallons would remain uncollected.

*Unless, as one focus group participant suggested, used oil tanks are placed on every block in high-demand neighborhoods. The suggestion seems preposterous—what city would do that? But the DIYer who made it was calculating correctly the level of convenience that would be required to get almost everyone to recycle their used oil. Convenience of collection centers is good but has limits.
Implications for Collection Programs

Curbside

Curbside collection looks superior to center collection. However, as presently implemented in California, it favors older DIYers. Although curbside collection has a great impact on the disposal practices of older DIYers, younger DIYers also dispose of a great deal of oil and most of the improperly disposed oil. Older DIYers reside in single-family dwellings where curbside is much more likely to be available. Oil generated by the younger DIYers is not well tapped by the most effective collection method.

Therefore, curbside collection limited to single-family dwellings does not constitute a satisfactory oil collection program by itself. Localities that already operate curbside programs should expand the coverage of curbside pickup to multifamily dwellings. The Board should support such efforts and dissemination of knowledge about their successful implementation.

Another possibility for localities that operate effective curbside programs is to strengthen the implementation of their center collection programs, especially in areas with many multifamily dwellings. However, if a locality has curbside pickup of used oil for single-family residences, it is difficult to argue that it should not institute curbside pickup for multifamily dwellings as well, notwithstanding the opposition of landlords.

Arguably, residents of multifamily dwellings need curbside pickup more than residents of single-family dwellings. The former are more likely to change their own oil, and they are less likely to have a place to store oil so that they can make the collection center stop more convenient by accumulating oil or by combining a trip to the collection center with other errands.

Some landlords want nothing to do with oil, oil changing, or oil recycling. This might be an inappropriate and inequitable constraint on a lawful recycling service that is meeting a statutory objective. Even though landlords routinely forbid oil changing on their property, they should not be able to prevent curbside collection of oil.

Centers

Improvement in center-based collection systems should involve improvement in the location and operations of collection centers, which are often deficient in many ways.

A second implication is that factors other than convenience are important. A DIYer who says it is convenient to take oil to a center but does not do it is acknowledging implicitly that they have other barriers to recycling. We review the survey and focus-group data on convenience, knowledge, barriers to recycling, and collection center operations in Section 7 of this report, where we reach new conclusions about these factors.

Which Method Is Best?

The development of curbside and center collection is still in process in California. As presently implemented, both programs show promise but neither is fully satisfactory.

Curbside collection has demonstrated already that it can reduce improper disposal to zero. Center collection has not. Curbside collection obviously meets the statutory objective to reduce illegal disposal “to the greatest extent possible” when it is available to DIYers.

If curbside collection can be implemented for DIYers in multifamily dwellings, it is likely to result in much lower improper disposal rates than well-implemented center collection programs. The reason is that curbside collection is so very convenient and, in a mature program, more stable than a network of largely voluntary collection centers. Center collection will always be less
convenient for DIYers; therefore, it will always incur higher rates of improper disposal than a well-implemented curbside collection program.

**Cost**

Cost is *not* appropriately measured as cost per gallon collected by existing programs. If a good center-based collection program achieves a lower cost per gallon collected but leaves 40 percent of oil uncollected, does the advantage lie with centers or with curbside? Focusing on cost per gallon collected leaves the uncollected, improperly disposed oil out of the equation. A curbside program that collects all or almost all of the disposable oil is accomplishing an objective that is far beyond the reach of center-based programs.

Using either method, what is the cost of reducing improper disposal of oil and filters to zero or near-zero? That is a more appropriate measure of cost because, besides reducing the volume of trash that is sent to landfills, the Board is trying to meet a specific statutory objective for used oil and stop a substantial flow of carcinogenic hydrocarbons and heavy metals into the environment.*

One disadvantage of center collection, relying as it does on private businesses, is the tendency of the system to break down. A center collection program requires resources to recruit new centers, train and retrain center staff, and conduct ongoing outreach to DIYers to arouse and maintain their commitment.

A highly effective center collection program will indeed require continuing outreach, continuing recruitment of centers, and continuing training and monitoring of personnel, especially the personnel of the many privately owned certified and noncertified centers. Many centers have high turnover of staff, and their highest priorities are elsewhere. Some of their policies, such as fencing off their lots and installing security measures, are intended to discourage the collection of oil from large disposers, which works directly against the disposal needs of STMs.

The staff turnover in auto parts stores, the backbone of the center system, is high. Maintaining effectiveness of a system that relies on collection centers that are businesses is difficult. The collection of used oil and filters is a low priority for them, and program staff will struggle to keep the complex and voluntary network of centers from losing its focus on collection.

Furthermore, maintaining high levels of outreach over time will probably lead to declining returns on investment. The easily persuaded DIYers are already taking their oil to centers. We know DIYers will put oil out for curbside pickup. But persuading the last 20-30 percent of DIYers to take their oil to collection centers with conventional outreach, or even with community-based social marketing, will be challenging and perhaps impossible.

**Enforcement**

In some areas, curbside pickup is not feasible. Perhaps the only workable way to achieve 100 percent DIYer compliance with center collection programs is to carry out some well-publicized enforcement. Enforcement strategies might be worth trying.

If enforcement is not feasible, then perhaps center collection is not a way to reach near-zero improper disposal.

Overcoming Barriers to Curbside Collection

Expanding curbside collection will also run into barriers, especially institutional and private-interest barriers. We have already mentioned the barrier of landlord opposition; local ordinances that grant autonomy to the owners of multifamily dwellings in matters of waste management and disposal can also constitute local barriers to expansion of curbside pickup of used oil. Localities that do not require use of an approved waste and recycling collector by residents should consider doing so in order to move to pickup of used oil and other hazardous waste.

Local arrangements for waste hauling can constitute a barrier to adoption of curbside collection of used oil. It is one thing for a locality to sign a contract with a waste hauler that adds a small amount per unit to cover used oil pickup. It is another for a city that operates its own waste collection system to contemplate the capital cost of retrofitting the city’s trucks.

Some waste haulers try to avoid effective recycling programs, and local government agencies often lack resources and priorities to address this barrier. These haulers may insist on prior-notification provisions. Local government staff, often wearing too many hats and not giving used oil sufficiently high priority, will accept such provisions, which may limit used oil collection significantly.

If the cost of curbside collection is an obstacle to expansion, sponsoring research on the effectiveness, costs, and cost-effectiveness of mature, well-implemented curbside and center collection programs may be useful. Research should assess the startup and maintenance costs of such programs per DIY customer and per gallon collected. Most important, however, are the long-term costs of driving improper disposal of used oil toward zero; the effectiveness of programs in terms of how much of the locally generated DIY oil they actually collect; and the legal, contractual, and institutional arrangements that will foster curbside collection.

To promote curbside collection, the Board should encourage localities to establish, expand, and improve curbside collection; disseminate information about low-cost, effective, secure curbside collection systems; develop model contracts; and encourage the development of a market in which enthusiastic providers engage in real competition to offer genuinely effective recycling services.
7. Knowledge and Collection Revisited

Here we show that information about specific impacts of used oil on the environment can be important to the reduction of improper disposal. We show the relationship between knowledge of specific impacts and convenience of collection centers in their effect on improper disposal. We also note two ways of increasing the convenience of recycling that are not ways of making collection centers more convenient.

Main Findings

1. Contrary to the findings presented in the Board’s 2002 Initial Results, knowledge of specific environmental impacts of used oil does reduce improper disposal among some DIYers. DIYers who find taking oil to a collection center not convenient dispose improperly at a lower rate if they have some knowledge. Knowledge of impact is a partial substitute for convenience, presumably because it increases commitment.

2. Similarly, increased convenience reduces improper disposal, especially among DIYers who have little or no knowledge of specific impacts of used oil. Convenience has a greater impact on improper disposal than does knowledge, in terms of the way in which convenience and knowledge were measured in the statewide survey.

3. Knowledge and increased convenience together reduce improper disposal substantially but still not to low levels.

4. Convenience should be viewed as more than the convenience of collection centers. DIYers find ways of making recycling more convenient than it would otherwise be by taking oil to collection centers for friends and relatives and by depositing oil at places of work, from which it is recycled. These initiatives suggest ways in which local programs might be able to activate environmental concern in neighborhoods to increase proper disposal of used oil and other hazardous waste.

Knowledge Does Affect Used Oil Recycling

We reported in Initial Results that half of DIYers had not heard of specific adverse environmental impacts of used oil. Furthermore, having specific information was not clearly related to how DIYers dispose of their used oil—people who knew something about the impact of used oil still disposed improperly at nearly the same rate as people who had no knowledge. This was surprising because it is hard to imagine that what people know about the impact of used oil on the environment would be irrelevant to their commitment to recycle.

The 2001 statewide survey asked DIYers two questions to determine their knowledge and beliefs about used oil:

• Q121. What do you think is the main reason that used oil is supposed to be recycled? Do you think it’s because … [READ: environmental issues; conserve energy; cheaper]?

• Q124. Have you heard, read or seen anything about the specific impact of used oil on the environment? [IF YES:] What information do you know? [CODE, DO NOT READ: pollutes drinking water; pollutes waterways; reduces soil productivity; introduces toxic chemicals into the environment; is bad for sewage treatment processes]

More than one-half of DIYers (55 percent) knew of no specific impacts of used oil. Those who did know a specific impact were only slightly less likely to dispose of oil improperly, 61 percent
vs. 69 percent for those who did not know a specific impact. The difference is not statistically significant ($p = .2513$).

Initial Results reported in 2002 that what people had heard about specific impacts of used oil on the environment (Q124) was not related to improper disposal. With the close multivariate analysis we have developed in this report and our revised measure of improper disposal, we did find a relationship. However, it was mediated by convenience. Convenience and knowledge work together to produce a much stronger impact on disposal of used oil.

**Knowledge of Specific Impacts Reduces Improper Disposal When Taking Oil to a Center Is Inconvenient**

Although we see only a modest relationship between disposal and knowledge examined alone, a stronger relationship appears when we control for convenience. The impact of knowledge of specific impacts on disposal depends on convenience, and the impact of convenience depends on knowledge. The impact of each of these factors can only be fully understood by accounting for the other simultaneously.

Table 20 lays out the data on improper disposal, classifying by knowledge and convenience at the same time. We have highlighted the grid of the internal cells of the table. These cells show the rate of improper disposal for each combination of convenience and knowledge. Knowledge is here defined as “heard of any specific impact of used oil”: respondents coded as having knowledge of a specific impact mentioned one or more valid impacts of used oil.

DIYers who see it as not convenient to take used oil to a collection center (column 1) have a very high 84 percent improper disposal rate if they have not heard of any specific impact of used oil—but their improper disposal rate drops about one-sixth, to 68 percent, if they have heard of a specific impact ($p = .0594$).

Table 20. Improper Disposal Rate, by Convenience and Knowledge, for Non-Curbside Users

| Knowledge: Q124 Heard of Any Specific Impact of Used Oil? | Convenienct to Take to Collection Center | | | | |
|---|---|---|---|---|
| | (1) Not | (2) Somewhat | (3) Very | Total |
| No | 84% | 72% | 47% | 69% |
| Yes | 68% | 66% | 50% | 61% |
| Total | 78% | 69% | 48% | 65% |
| N | 181 | 220 | 276 | 677 |

Convenience scale: 1 Not=very or somewhat inconvenient, 2 Somewhat=neither convenient nor inconvenient or somewhat convenient; 3 Very=very convenient.

Knowledge does not have a statistically significant impact on the improper disposal rate in the “somewhat convenient” and “very convenient” columns. Similarly, convenience does not make as much difference for improper disposal rates when DIYers know a specific impact of used oil, dropping from 68 to 50 percent ($p = .3487$). But convenience makes a big difference when DIYers have less knowledge, dropping from 84 to 72 to 47 percent ($p = .0010$).

Both lack of knowledge and inconvenience are barriers to recycling. Lack of knowledge provides no support for motivation, while inconvenience is a direct barrier, raising the amount of effort and
motivation it takes to recycle. Overcoming either barrier reduces improper disposal. The effect of convenience on improper disposal appears to be greater than the effect of specific knowledge.

We might have thought just the opposite—it is plausible to suppose that knowing specific impacts of used oil would reduce improper disposal only if convenient centers were available. Instead, knowing about impacts reduces improper disposal only when centers are not convenient.

Thus knowledge does have an impact on improper disposal, overcoming for a group of improper disposers the inconvenience of taking their oil to a center and reducing their improper disposal rate by one-sixth. Convenience reduces improper disposal among DIYers who do not use curbside recycling, but it has an additional impact on improper disposal if DIYers lack specific knowledge.

Very high rates of improper disposal may be reducible either through dissemination of information about impacts of used oil in the environment or by increasing the convenience of collection centers. Improving the convenience of centers—making them very convenient—in effect reduces the additional impact of specific knowledge to zero. Of course this relationship assumes that DIYers have general knowledge about recycling used oil even if they lack knowledge of specific impacts.

**Convenience Is Broader Than Centers**

There are many ways to increase the convenience of used oil recycling. Items mentioned by participants in focus groups as inconvenient included having to wait for a store employee to finish something else; being turned away because a tank was full; and being discriminated against because they were Hispanic. In addition, two aspects of convenience are highlighted by strategies that DIYers have developed to make proper oil disposal more convenient for themselves.

**Friends and neighbors—the present and latent reality of the social.** DIYers volunteered in the statewide survey that someone else—a friend, neighbor, or relative—disposed of their oil for them. An estimated 1.5 percent of DIYers rely on someone else to dispose of their used oil. Combining oil from several households or getting someone else to take it to a collection center should be seen as another way to increase the convenience of the errand—a distinctive way because people can organize it on their own. Individuals, families, and neighbors have developed this strategy on their own. Local programs and community organizations can also help neighborhoods develop sharing arrangements—“oilpooling”—that maximize convenience, minimize trips, and reduce improper disposal. The spread of oilpooling would not only increase convenience for individuals but would also spread the expectation of proper disposal.

In an upscale suburban neighborhood a resident had placed a box by the driveway, with a hand-lettered sign: “Put your batteries, paint, and other household hazardous waste in this box and I will take them for recycling.” The box was one-third full of batteries and small containers, and two 1-gallon containers of paint sat on the ground next to it. Again, wastepooling. Could more such efforts be organized in many neighborhoods?

When we think of DIYers, we tend to see only individuals and to think only of the relationship between our programs and those individual targets of our efforts. “Community-based social marketing” is not only an approach to individuals. Neighborhoods have resources of environmental concern and community orientation that might be activated to increase recycling.

**Alternative collection sites—places of work.** Another innovation revealed in the statewide survey is taking used oil to a place of employment. We noted in Section 3 that 2.6 percent of DIYers volunteered that they took their used oil to work and put it into a tank there, from which the employer had it hauled away for recycling. This oil does not get counted in CIWMB block
grantees’ collection statistics, but it is being collected for recycling. From the DIYer’s point of view, taking oil to work represents a way to make used oil recycling more convenient by combining it with a trip that the DIYer makes anyhow.

These other ways of increasing convenience remind us to see convenience as broader than just the convenience of collection centers. The convenience of the whole collection system is the issue. Local programs may be able to find ways of stimulating friends and neighbors to organize themselves more effectively to increase the proper collection of used oil. Whether place-of-work oil collection can be similarly expanded is another question.

**Implications**

Knowledge does have an effect on improper disposal. Knowledge itself does not produce proper disposal, and many DIYers who know one or more specific impacts of used oil still dispose improperly. But knowledge of specific impacts is one of the things that can create the motivation to dispose properly, overcoming inconvenience for some DIYers.

Knowledge about pollution may be able to generate enough motivation to overcome barriers in the collection system for some DIYers. This may imply that continued outreach, perhaps including information about specific impacts, is likely to be useful. Because it will be difficult, perhaps impossible, to make centers very convenient for all DIYers, knowledge and motivation remain important for DIYers for whom collection centers are not convenient.

Both knowledge about specific impacts and increased convenience of centers reduce improper disposal; however, knowledge and increased convenience together were still not successful in reducing improper disposal to low levels.

Convenience should be viewed as more than the convenience of collection centers. DIYers find ways of making recycling more convenient than it would otherwise be by taking oil for collection for friends and relatives and by depositing oil at places of work, from which it is recycled. These self-organizing efforts may suggest ways in which local programs, perhaps working with environmental organizations, can stimulate the emergence of more such initiatives.

Knowledge is also more than knowledge of specific impacts. More important than knowledge of specific impacts is a sense of urgency about recycling—a belief that used oil is very damaging to the environment. Commitment to action is also very important. DIYers may recall one or more specific impacts but not believe that recycling is an urgent issue and not be committed to recycling.
8. Age, Gender, Income, Rural Residence, Immigrants, and Improper Disposal

This section includes do-it-yourself (DIY) and shade-tree mechanic (STM) rates and volumes of improperly disposed oil by four demographics: age, gender, household income, and the urban-rural makeup of counties. It also includes data for immigrants. Here we are not explaining improper disposal. Instead, we are showing how DIYers, STMs, improper disposers, and improperly disposed oil are distributed across the categories of the demographics. For example, from the data on age we learn that 92 percent of oil improperly disposed by U.S.-born DIYers originates with those under age 50 (Table 21, first three rows of column 9). This kind of information helps used oil programs define target groups for outreach.

Main Findings

1. **Age**: Both DIY and STM activity decline with age, especially over age 50. However, there are still a great many middle-aged DIYers; it is not accurate to think of DIY and STM activity as only an activity of young men and women.

2. **Women** make up higher proportions of DIYers in the northern and central region of California, where they constitute one-fifth of DIYers. Female DIYers in less urbanized areas dispose improperly at higher rates than men.

3. **Income**. Among younger DIYers, those in lower income households (less than $25,000) are more likely to dispose improperly than those in households with higher incomes. Improper disposal is not related to income among older DIYers. DIY and STM rates are not strongly related to income except that they both drop off sharply in households with incomes of $100,000 or more. Households with incomes under $70,000 dispose of about four-fifths of improperly disposed oil. STMs account for half or more of improperly disposed oil in every DIY household income range. Among lower-income DIY households, STMs account for 95 percent of improperly disposed oil.

4. **DIYers in rural areas**. The DIY rate is greater in rural counties. People who live in rural areas and the local governments that serve them face special challenges in the collection of used oil. Most STMs, other DIYers, and improperly disposed oil are in the most urban counties, partly because of the distribution of population but also because average gallons of oil improperly disposed are higher in the most urban counties. In the most urban counties, STMs account for 85 percent of improperly disposed oil, while in the most rural counties, STMs account for only 14 percent.

5. **Immigrants**. Immigrant DIYers are younger, and the most recent immigrants are younger still. Immigrants may be less likely to be STMs, and they may dispose of less oil improperly on average, than U.S.-born DIYers. Immigrant STMs are concentrated not in low-income but in moderate-income households ($25,000–$69,999), while nearly half of non-STM immigrant DIYers are in low-income households (less than $25,000).

**DIY, STM, and Improper Disposal Rates and Volumes by Age**

Table 21 pulls together the most important DIYer, STM, and improper disposal data related to age. To avoid confounding these data with years lived in the United States for immigrants, the data in Table 21 and many other tables in this section are based only on U.S.-born DIYers. We consider immigrants below.
Column 1 is the percentage of households in each age group (U.S.-born) in which household vehicles are serviced by a DIYer. Column 1 shows that the DIY rate over all households is highest in the youngest (18–29) age group—33 percent. It declines at ages 30–64, then declines sharply over age 65, where the DIY rate is lowest.

Column 2 shows that the STM rate also falls sharply with age. STMs are found in about 12 percent of households where a DIYer is age 18–29 but comprise less than 4 percent of each age group for age 30 and over, less than 1 percent for ages 50 and over.

Column 3 gives the number of interviews on which columns 1 and 2 are based.

Column 4 shows the estimated STM rate among DIYers, while column 5 gives the number of interviews on which the column 4 estimates are based. Column 4 is the percentage of DIYers in each age group who also change oil on vehicles that belong to people outside the household. DIY generally declines with age, and STM work among DIYers also declines very sharply over 50.

Column 6 shows how improper disposers are distributed by age: 61 percent are less than 40 years of age; 80 percent, less than 50.

Columns 7 and 8 show improperly disposed oil by age: mean gallons and total millions of gallons, respectively. Both mean gallons of improperly disposed oil per DIYer and total improperly disposed oil drop sharply over age 50.

Column 9 shows how total improperly disposed oil (column 8) is distributed by age in percentage terms: 93 percent of improperly disposed oil is disposed by DIYers 18-49.

Because far more oil overall is improperly disposed by DIYers age 18-49 than by older DIYers, that is the age range to focus on. As we have already noted, one reason why older DIYers dispose of less oil improperly has to do with the availability of curbside collection for that group. The other reason is that both the DIY rate and the STM rate drop in older DIYers.

**STMs and Other DIYers Compared on Improper Disposal by Age**

Table 22 compares STMs and other DIYers, showing the breakdown of improperly disposed oil for STMs and other DIYers by age. (Here we present fewer categories of age because we are dealing with smaller numbers of observations once we divide DIYers into these two groups.)

STMs and other DIYers are very differently distributed by age (columns 1–2 of Table 22). More than half of all STMs are under 30, while only 8 percent are 50 and over. Among high-volume STMs (15 or more gallons per year, not shown in Table 22), the concentration in the 18–29 age group is even greater (65 percent). In contrast, other DIYers (non-STMs) as a whole are rather evenly distributed over the age categories in Table 22, but 59 percent of high-volume non-STMs are 40 or over, almost all of them under 65.

For STMs, total improperly disposed oil decreases with age in column 3 of Table 22: the youngest STMs (18 to 29) generate more improperly disposed oil (6.35 million gallons) than all other STMs and other DIYers combined (columns 3 and 4). Among other DIYers, in contrast, column 4 shows that total improperly disposed oil is fairly evenly distributed over age categories, except the youngest.

Columns 5 and 6 of Table 22 show how improperly disposed oil is distributed between STMs and other DIYers in each age group. Up to age 40, the great majority of improperly disposed oil is generated by STMs. Above age 40, most is generated by DIYers who are not STMs. The reasons for this pattern are that the STM rate of DIYers declines rapidly with increasing age (Table 21,
column 4) and that the youngest STMs are responsible for so much of the improperly disposed oil.

In sum, STM and high-volume STM work are primarily activities of young men; an estimated 73 percent of high-volume STMs (15 or more gallons of oil per year) are less than 40 years old, and an estimated 84 percent are men. (Even so, older and female STMs cannot be ignored: some of them dispose of hundreds of gallons of oil per year.) Other DIYers tend to be older, when incomes and number of vehicles in the household tend to be greatest.
Table 21. U.S.-Born STMs and All DIYers, Rates and Improperly Disposed Oil by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
<th>Column 7</th>
<th>Column 8</th>
<th>Column 9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DIY Rate</td>
<td>STM Rate</td>
<td>Number of Household</td>
<td>STM Rate of DIYers</td>
<td>Number of DIY Interviews In Sample</td>
<td>Ages of Improper Disposers</td>
<td>Mean Gallons Improperly Disposed Oil</td>
<td>Total Improperly Disposed Oil (Millions of Gallons)</td>
<td>Percent Improperly Disposed Oil</td>
</tr>
<tr>
<td>18 to 29</td>
<td>33%</td>
<td>12.0%</td>
<td>198</td>
<td>36%</td>
<td>155</td>
<td>30%</td>
<td>16.24</td>
<td>6.55</td>
<td>56%</td>
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<tr>
<td>30 to 39</td>
<td>20%</td>
<td>3.7%</td>
<td>185</td>
<td>19%</td>
<td>126</td>
<td>31%</td>
<td>6.33</td>
<td>2.46</td>
<td>21%</td>
</tr>
<tr>
<td>40 to 49</td>
<td>20%</td>
<td>2.8%</td>
<td>194</td>
<td>14%</td>
<td>122</td>
<td>17%</td>
<td>6.94</td>
<td>1.80</td>
<td>15%</td>
</tr>
<tr>
<td>50 to 64</td>
<td>16%</td>
<td>0.8%</td>
<td>205</td>
<td>5%</td>
<td>124</td>
<td>11%</td>
<td>2.89</td>
<td>0.62</td>
<td>5%</td>
</tr>
<tr>
<td>65 and over</td>
<td>8%</td>
<td>0.6%</td>
<td>131</td>
<td>7%</td>
<td>58</td>
<td>11%</td>
<td>2.06</td>
<td>0.25</td>
<td>2%</td>
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<tr>
<td>All</td>
<td>19%</td>
<td>3.6%</td>
<td>913</td>
<td>19%</td>
<td>585</td>
<td>100%</td>
<td>8.42</td>
<td>11.68</td>
<td>100%</td>
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<td><em>p of difference</em></td>
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<td>&lt;.00005</td>
<td>&lt;.00005</td>
<td></td>
<td></td>
<td>.2903*</td>
<td>.1688</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p of difference between proper and improper disposers. Improper disposers are slightly younger on average.
Table 22. U.S.-Born STMs and Other DIYers, Improperly Disposed Oil by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Percent by Age</th>
<th>Total Improperly Disposed Oil (Millions of Gallons)</th>
<th>Share of Oil Improperly Disposed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Column 1</td>
<td>Column 2</td>
<td>Column 3</td>
</tr>
<tr>
<td></td>
<td>STMs</td>
<td>Other DIYers</td>
<td>STMs</td>
</tr>
<tr>
<td>18 to 29</td>
<td>55%</td>
<td>23%</td>
<td>6.35</td>
</tr>
<tr>
<td>30 to 39</td>
<td>21</td>
<td>21</td>
<td>1.76</td>
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<tr>
<td>40 to 49</td>
<td>17</td>
<td>24</td>
<td>1.14</td>
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<td>50 and over</td>
<td>8</td>
<td>32</td>
<td>0.02</td>
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<tr>
<td>All</td>
<td>100%</td>
<td>100%</td>
<td>9.27</td>
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<td>N</td>
<td>95</td>
<td>490</td>
<td>95</td>
</tr>
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<td>p of difference</td>
<td>&lt;.00005</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Gender**

Women are DIYers at one-fifth the rate of men, 6 percent compared to 30 percent ($p < .00005$). If we look at all California households, 17 percent have a male DIYer but only 2.4 percent have a female DIYer.

However, among DIY households, the STM rate is the same among women as among men, 19 percent and 16 percent respectively ($p = .6357$). DIY women are just as likely as DIY men to change oil for others.

Men are also not more likely to be high-volume STMs than women are: 27 percent of male STMs do 15 or more STM oil changes per year, compared to 36 percent of female STMs (the difference is not statistically significant, $p = .5343$).

Statewide, women are the oil changers in 12 percent of DIY households. The DIYers are women in higher proportions of DIY households in the northern and central region of California, where 18 percent are women, than they are in the nine southern counties, where only 8 percent are women ($p = .0010$).

Women DIYers are especially numerous in the highly rural valley and mountain counties of northern California, where they change oil in 21 percent of DIY households. However, the regional difference remains when we control for the urban-rural makeup of counties. Why this regional difference exists is not clear.

The difference in rate of female DIY by region means that 67 percent of female-DIY households and 63 percent of female improper disposers reside in the north-central part of the state. About 88,000 female improper disposers reside in the southern tier, about 147,000 in the north-central counties.

Among immigrants, women change the oil in few DIY households: an estimated 6 percent, vs. 15 percent of U.S.-born DIYers ($p = .0229$). Looking at it the other way around, 90 percent of female DIYers are U.S.-born; 10 percent are immigrants. Among DIY men, 75 percent are U.S.-born; 25 percent are immigrants.

The rate of DIY oil changing among men is virtually the same between U.S.-born and immigrants: 29 percent and 32 percent ($p = .6002$). Among U.S.-born women, however, the rate of DIY oil changing is 6 percent; among immigrant women, 3 percent ($p = .0677$).

DIY women dispose improperly more than men in the more rural counties. In Table 23, women’s improper disposal rates are much higher than men’s in counties that are at least 10 percent rural, where the difference in improper disposal rates is more than 20 percentage points.

### Table 23. Improper Disposal Rate by Gender and County Percent Rural

<table>
<thead>
<tr>
<th>Gender</th>
<th>County Percent Rural 2000</th>
<th>Total</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–4%</td>
<td>5–9%</td>
<td>10–29%</td>
</tr>
<tr>
<td>Men</td>
<td>63%</td>
<td>67%</td>
<td>59%</td>
</tr>
<tr>
<td>Women</td>
<td>62%</td>
<td>75%</td>
<td>86%</td>
</tr>
<tr>
<td>Total</td>
<td>63%</td>
<td>68%</td>
<td>66%</td>
</tr>
<tr>
<td>Difference</td>
<td>-1%</td>
<td>8%</td>
<td>27%</td>
</tr>
<tr>
<td>$p$ of difference</td>
<td>.9145</td>
<td>.7093</td>
<td>.0064</td>
</tr>
<tr>
<td>N</td>
<td>247</td>
<td>90</td>
<td>260</td>
</tr>
</tbody>
</table>
**Income**

Improper disposal is slightly higher among DIYers at lower income levels (74 percent) than at higher levels (59 percent, Table 24), and the relationship is statistically significant ($p = .008$, see Appendix 8).

However, when we re-examine the relationship with income separately for younger and older DIYers, we find that it holds only among younger DIYers (Table 25). Among older DIYers, improper disposal is not related to income: the improper disposal rate is the same for lower and higher income households (55 percent). Among younger DIYers, 82 percent in low-income households (less than $25,000) dispose improperly compared to 62 percent in households with incomes $25,000 and over.

Table 24. Improper Disposal Is Slightly Higher in Low-Income DIY Households, U.S.-Born DIYers

<table>
<thead>
<tr>
<th>Disposal of Used Oil</th>
<th>Household Income</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than $25,000</td>
<td>$25,000 plus</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Proper</td>
<td>26%</td>
<td>41%</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td>Improper</td>
<td>74</td>
<td>59</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>486</td>
<td>108</td>
<td>594</td>
<td></td>
</tr>
</tbody>
</table>

$p = .008$

Table 25. Improper Disposal Rate by Age and Household Income, U.S.-Born DIYers

<table>
<thead>
<tr>
<th>Age</th>
<th>Household Income</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than $25,000</td>
<td>$25,000 plus</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>18–39</td>
<td>82%</td>
<td>62%</td>
<td>67%</td>
<td></td>
</tr>
<tr>
<td>40 and over</td>
<td>55%</td>
<td>55%</td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>74%</td>
<td>59%</td>
<td>62%</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>486</td>
<td>108</td>
<td>594</td>
<td></td>
</tr>
</tbody>
</table>

Note: cell percentages are rates of improper disposal for each combination of age and household income. $p$ of difference in improper disposal between low-income and higher-income DIYers age 18–39 = .0322.

Table 26 presents STM and DIY rates and improperly disposed oil by income for U.S.-born DIYers. Perhaps surprisingly, STM and DIY rates are not strongly related to income. DIY rates (column 1) are a bit lower in the lowest and highest income categories; so are STM rates (columns 2 and 4), but the differences are not clearly statistically significant.

Columns 6–9 might help programs decide what income groups to target. The improper disposal rate does drop slightly from the lowest to higher incomes, and improper disposers have somewhat lower incomes than proper disposers (column 6, $p = .0393$); even so, about one-half of improper disposers are found in households with incomes $40,000 and over (column 6). Improper disposal is not confined to low-income households.

Lower income DIYers dispose of much more oil improperly, on average (column 7). We already know that low- and moderate-income STMs account for a very large part of improperly disposed oil (Section 4, Table 14). What we are seeing here has more to do with STM activity than with
income in general. Programs that can reach high-volume STMs and get them to recycle are likely to achieve substantial reductions in improper disposal, and high-volume STMs are concentrated in lower-income households. Columns 8 and 9 show that most improperly disposed oil is generated in households with incomes less than $40,000. More than 80 percent is generated in households with income less than $70,000; but not a high portion (12 percent) is generated in the very lowest-income households.

In Table 27, we can see that STMs and other DIYers are similarly distributed over income intervals (column 1). STMs dispose improperly of much more oil in total in the lowest and middle income categories, while the middle-income other DIYers dispose of more oil improperly than either lower-income or upper-income groups (columns 3–4). In the lowest-income group, almost all of the improperly disposed oil is produced by STMs. In the highest-income group, about half is generated by other DIYers (columns 5–6).

This is useful information. You can find most of the improperly disposed oil among STMs in low and middle-income households, and among other DIY households with many vehicles or high miles driven and income in the $25,000–$70,000 range. Lesser but still substantial volumes of oil are improperly disposed by higher-income households, about 1 million gallons each by STMs and other DIYers with $70,000 or more income.

**Urban-Rural Residence**

Table 28 provides various rates and the volume of improperly disposed oil for U.S.-born DIYers in counties from the most urban to the most rural. Column 1 shows that DIY activity is higher in rural than in urban counties. STM activity appears to increase slightly as a percentage of all households, but the increase is not statistically significant (column 2). We might have expected more STM activity in rural areas, but the STM rate as a percentage of DIYers drops in the most rural counties (column 4).

More than half of improper disposers are located in the most urban counties (column 6), only because that is where most of the population lives. The rate of improper disposal is not significantly different in rural and urban counties. However, the average volume of oil improperly disposed by DIYers is much greater in the most urban counties and lowest in the most rural counties (column 7). Total gallons and percent of improperly disposed oil clearly decline from the urban to rural counties because of the smaller total size of the DIY population in rural areas and because of lower volumes of STM work there, and 76 percent of improperly disposed oil is disposed in the most urban counties (0–4.9 percent rural, columns 8–9).

In Table 29, STMs and other DIYers are about identically distributed over urban and rural counties (columns 1–2). Most of the improperly disposed oil is generated by STMs in the most urban counties (7.61 million gallons), with DIYers in those counties second (1.33 million gallons, columns 3–4). In the most urban counties, STMs account for 85 percent of improperly disposed oil; in the most rural counties, other DIYers account for 86 percent of it (columns 5–6). It is more important in urban and mixed urban-rural counties than it is in the most rural counties to reach, regulate, or serve the needs of a relatively small number of high-volume STMs.
Table 26. U.S.-Born STMs and All DIYers, Rates and Improperly Disposed Oil by Income

<table>
<thead>
<tr>
<th>Income</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
<th>Column 7</th>
<th>Column 8</th>
<th>Column 9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DIY Rate (CA households)</td>
<td>STM Rate (CA households)</td>
<td>Number of Household Interviews in Sample</td>
<td>STM Rate of DIYers</td>
<td>Number of DIY Interviews in Sample</td>
<td>Mean Gallons Improperly Disposed Oil</td>
<td>Total Improperly Disposed Oil (Millions of Gallons)</td>
<td>Percent Improperly Disposed Oil</td>
<td></td>
</tr>
<tr>
<td>Less than $15,000</td>
<td>14%</td>
<td>2.2%</td>
<td>70</td>
<td>16%</td>
<td>40</td>
<td>8%</td>
<td>19.7</td>
<td>1.39</td>
<td>12%</td>
</tr>
<tr>
<td>$15,000-24,999</td>
<td>20%</td>
<td>3.6%</td>
<td>107</td>
<td>18%</td>
<td>68</td>
<td>17%</td>
<td>22.0</td>
<td>4.54</td>
<td>39%</td>
</tr>
<tr>
<td>$25,000-39,999</td>
<td>19%</td>
<td>4.4%</td>
<td>223</td>
<td>23%</td>
<td>149</td>
<td>27%</td>
<td>5.5</td>
<td>2.01</td>
<td>17%</td>
</tr>
<tr>
<td>$40,000-69,999</td>
<td>22%</td>
<td>4.4%</td>
<td>313</td>
<td>20%</td>
<td>208</td>
<td>30%</td>
<td>4.1</td>
<td>1.79</td>
<td>15%</td>
</tr>
<tr>
<td>$70,000-99,999</td>
<td>21%</td>
<td>4.2%</td>
<td>111</td>
<td>20%</td>
<td>74</td>
<td>12%</td>
<td>4.8</td>
<td>0.89</td>
<td>8%</td>
</tr>
<tr>
<td>$100,000 or more</td>
<td>13%</td>
<td>1.0%</td>
<td>100</td>
<td>8%</td>
<td>55</td>
<td>8%</td>
<td>8.1</td>
<td>1.08</td>
<td>9%</td>
</tr>
<tr>
<td>All</td>
<td>19%</td>
<td>3.6%</td>
<td>924</td>
<td>19%</td>
<td>594</td>
<td>100%</td>
<td>8.4</td>
<td>11.72</td>
<td>100%</td>
</tr>
</tbody>
</table>

* $p$ of difference in household income between proper and improper disposers.
Table 27. U.S.-Born STMs and Other DIYers, Improperly Disposed Oil by Income

<table>
<thead>
<tr>
<th>Income</th>
<th>Percent by Income</th>
<th>Total Improperly Disposed Oil (Millions of Gallons)</th>
<th>Share of Oil Improperly Disposed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Column 1</td>
<td>Column 2</td>
<td>Column 3</td>
</tr>
<tr>
<td>Less than $25,000</td>
<td>13%</td>
<td>15%</td>
<td>5.614</td>
</tr>
<tr>
<td>$25,000–69,000</td>
<td>67%</td>
<td>59%</td>
<td>2.662</td>
</tr>
<tr>
<td>$70,000 or more</td>
<td>19%</td>
<td>26%</td>
<td>1.002</td>
</tr>
<tr>
<td>All</td>
<td>100%</td>
<td>100%</td>
<td>9.278</td>
</tr>
</tbody>
</table>

Table 28. U.S.-Born STMs and All DIYers, Rates and Improperly Disposed Oil by Percent of Housing in Rural Areas

<table>
<thead>
<tr>
<th>Percent Rural</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
<th>Column 7</th>
<th>Column 8</th>
<th>Column 9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DIY Rate (CA households)</td>
<td>STM Rate (CA households)</td>
<td>Number of Household Interviews in Sample</td>
<td>STM Rate of DIYers</td>
<td>Number of DIY Interviews in Sample</td>
<td>Urban-Rural Location of Improper Disposers</td>
<td>Mean Gallons Improperly Disposed Oil</td>
<td>Total Improperly Disposed Oil (Millions of Gallons)</td>
<td>Percent Improperly Disposed Oil</td>
</tr>
<tr>
<td>0 – 4%</td>
<td>18%</td>
<td>3.5%</td>
<td>313</td>
<td>19%</td>
<td>173</td>
<td>56%</td>
<td>11.32</td>
<td>8.93</td>
<td>76%</td>
</tr>
<tr>
<td>5 – 9%</td>
<td>14%</td>
<td>2.8%</td>
<td>131</td>
<td>20%</td>
<td>70</td>
<td>16%</td>
<td>4.70</td>
<td>1.10</td>
<td>9%</td>
</tr>
<tr>
<td>10 – 29%</td>
<td>23%</td>
<td>4.9%</td>
<td>284</td>
<td>21%</td>
<td>196</td>
<td>18%</td>
<td>5.71</td>
<td>1.30</td>
<td>11%</td>
</tr>
<tr>
<td>30 – 100%</td>
<td>31%</td>
<td>4.2%</td>
<td>196</td>
<td>13%</td>
<td>155</td>
<td>9%</td>
<td>2.61</td>
<td>0.40</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>19%</td>
<td>3.6%</td>
<td>924</td>
<td>19%</td>
<td>594</td>
<td>100%</td>
<td>8.37</td>
<td>11.73</td>
<td>100%</td>
</tr>
<tr>
<td>p of difference</td>
<td>.0012</td>
<td>.4802</td>
<td>.1706</td>
<td>.3950*</td>
<td>.0390</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p of difference between improper and proper disposers; the difference in their urban-rural location is negligible.
Table 29. U.S.-Born STMs and Other DIYers, Improperly Disposed Oil by Urban/Rural

<table>
<thead>
<tr>
<th>Percent Rural</th>
<th>Percent by Rural Area</th>
<th>Total Improperly Disposed Oil (Millions of Gallons)</th>
<th>Share of Oil Improperly Disposed at Each Level of Percent Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Column 1</td>
<td>Column 2</td>
<td>Column 3</td>
</tr>
<tr>
<td>STMs</td>
<td>Other DIYers</td>
<td>STMs</td>
<td>Other DIYers</td>
</tr>
<tr>
<td>0–4%</td>
<td>57%</td>
<td>57%</td>
<td>7.61</td>
</tr>
<tr>
<td>5–9%</td>
<td>16%</td>
<td>15%</td>
<td>0.75</td>
</tr>
<tr>
<td>10–29%</td>
<td>19%</td>
<td>16%</td>
<td>0.87</td>
</tr>
<tr>
<td>30–100%</td>
<td>8%</td>
<td>12%</td>
<td>0.05</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>9.28</td>
</tr>
<tr>
<td>$p$ of difference</td>
<td>.6825</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Immigrants**

Data on immigrants in the statewide survey is insufficient to yield reliable results in the detail of the big tables of this section. We summarize here the most reliable findings about immigrants.

The DIY rate of immigrants is 20 percent; of U.S.-born residents, 19 percent. This is not a significant difference ($p = .7758$).

Immigrants are less likely to be STM than are U.S.-born residents. In 1.8 percent of households an immigrant is the DIYer. In 3.6 percent of households, the DIYer is U.S.-born ($p = .0454$). The percentages of STM of the DIYers in the two groups are 9 percent for immigrants and 19 percent for U.S.-born DIYers ($p = .0178$). Given the reputation of high levels of STM work among immigrants, this is a surprising finding that needs to be corroborated with further research.

The estimated rate of high-volume STM work (10 or more STM changes per year) among immigrant DIYers as a whole is 1 percent; among U.S.-born DIYers, 7 percent ($p = .0304$).

The estimated improper disposal rate of immigrants is not significantly greater than the rate for U.S.-born DIYers: 68 percent vs. 62 percent ($p = .3689$).

However, the statewide survey data lead to the estimate that immigrants dispose of much less oil improperly on average (2.26 gallons) than U.S.-born DIYers (8.37 gallons), a significant difference ($p = .0423$). This seems unlikely to us, and in Section 4, Table 17, we assumed that immigrant STMs disposed improperly of the same volume of oil on the average as U.S.-born STMs. There are several possible explanations for this result. One is that non-U.S.-born STMs are more guarded about the amount of oil they dispose of—that is, their response bias is greater than the response bias of U.S.-born STMs.

Another possibility is that immigrants are really less likely to be STMs, and that is why they dispose of less oil on the average. But the data shows this to be unlikely. Even among STMs, less oil on average is improperly disposed by immigrants than by U.S.-born STMs ($p = .0131$).

New immigrant DIYers are probably less likely to be STMs (we estimate only 3.6 percent) than immigrants who have lived in the U.S. 15 years or more (13 percent, $p = .0929$). Again, that could be the result of a more guarded response to the survey. Or perhaps immigrants require time to become established in the STM trade.

A third possible explanation is that immigrants who are DIYers have lower household incomes than U.S.-born DIYers, on average. Lower income implies fewer people changing oil in their own households, therefore less disposed oil overall and less improperly disposed oil.

Examination of data on total drained disposed oil, which is less likely to be biased, indicates that U.S.-born DIYers dispose of more than twice as much oil on average, 11.5 to 5.1 gallons ($p = .0028$). This finding tends to imply a real difference in average improperly disposed oil between immigrants and U.S.-born DIYers, much of it due to the greater amount of oil disposed by the latter overall.

* The data are insufficient for detailed analysis in two ways. (1) The statewide survey interviewed only 235 immigrants, which is a smallish subsample. The immigrant subsample includes 154 DIYers and only 12 STMs. (2) Of the many languages spoken by immigrants in California, the survey was conducted in Spanish only. The survey certainly missed a substantial number of non-Hispanic DIY immigrants because of this.
Further research would be needed to determine whether DIYers and STMs who are immigrants really dispose of less oil improperly than U.S.-born DIYers and STMs.

**Age**

DIY immigrants are somewhat younger: 62 percent are less than 40, compared to 50 percent of U.S.-born DIYers ($p = .0389$). The most recent immigrants are younger still—more than half are under 30. Income, age, and the length of U.S. residency of the immigrant are all closely related.

**Rural**

The DIY rate for immigrants appears to rise somewhat from urban to rural counties, from 19 to 29 percent, like the DIY rate for the U.S.-born, but $p = .2845$. We have insufficient data to determine if the amount of oil improperly disposed by immigrants drops from the most urban to the most rural counties, as it does for U.S.-born DIYers.

**Income**

The DIY rate of immigrants falls with higher income, as it does with U.S.-born households. The immigrant DIY rate is 20–25 percent in households with income below $70,000, 10 percent in households with income $70,000 and over ($p = .0740$).

The STM rate of the very lowest-income immigrant households (N=103) is only 0.3 percent, rising to 10.3 percent in the $25,000–$69,999 range, falling to 4.0 percent in households with income $70,000 and over ($p = .0113$). As a consequence, 85 percent of immigrant STMs are in the $25,000–$69,999 range, and only 2.5 percent are below $25,000. In contrast, nearly half (45 percent) of other immigrant DIYers—not STMs—are in households with less than $25,000 income; 45 percent are in the $25,000–$69,999 range, and 10 percent $70,000 and over.
9. Improper Disposal—Best Targets

Section 8 showed many correlates of improper disposal, some of which imply targeting particular subgroups of DIYers. Here we focus on that question explicitly: What subgroups should be targeted by oil collection programs? We focus on subgroups defined by age, STM work, and immigrant status. We examined three criteria for targeting—improper disposal rate, average oil improperly disposed, and total oil improperly disposed.

Main Findings

1. Three criteria oil collection programs can use to target groups of improper disposers are the group’s improper disposal rate, the average volume of oil improperly disposed per DIY household, and the total volume of oil improperly disposed by the group.

2. Younger U.S.-born STMs (less than 40 years old) are at the top on all three criteria. They have the highest improper disposal rate and they dispose of far more oil, both on average and in total, than any other group.

3. Younger STMs should be the highest priority target for oil collection efforts. If programs need to focus on subgroups, next in priority should be older STMs, then other (non-STM) younger immigrant DIYers and older U.S.-born DIYers who are not STMs.

4. These recommendations apply for the state of California. In particular jurisdictions within the state, differences in age distributions and in the percentage of the population who are immigrants might change the priorities.

5. It is likely that younger STMs—certainly U.S.-born STMs, perhaps immigrants as well—will be the highest priority target group in many localities. Homogeneous higher-income localities, however, may contain very few or no STMs.

6. These findings lend great urgency to efforts to extend high-recovery recycling programs—curbside recycling—to younger DIY households, to the multifamily dwellings in which they typically reside, and especially to the STMs in this group.

Highest Priority Target Groups for Oil Collection Programs

Three Criteria for Targeting Oil Collection Efforts

Three measures of improper disposal might help us decide how to focus our oil collection programs on particular subgroups of DIYers: the rate of improper disposal, the average volume of oil improperly disposed, and the total volume of oil improperly disposed.

Highest rates of improper disposal. An obvious way of focusing programs is to target groups with the highest rates of improper disposal. Knowing that age is closely related to length of time since the immigrants entered the U.S., we can view improper disposal rates conveniently in Table 30 as a function of immigrant status (born in U.S. or not), age (less than 40, 40 and older), and STM activity. Going simply on improper disposal rates, Table 30 indicates we should first target younger U.S.-born STMs and younger immigrants with 78 and 75 percent improper disposal rates, respectively. Then we might go after U.S.-born STMs 40 and older (68 percent). At the lowest priority—lowest improper disposal rates—would be other U.S.-born DIYers under 40 (60 percent), then other immigrant DIYers 40 and older (54 percent). To be sure, though these differences are important, there are plenty of improper disposers in every subgroup.
Table 30. Rate of Improper Disposal by Age, STM, and Immigration

<table>
<thead>
<tr>
<th>Immigration</th>
<th>Age</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18–39</td>
<td>40 and Older</td>
</tr>
<tr>
<td>Not Born in U.S.</td>
<td>75%</td>
<td>56%</td>
</tr>
<tr>
<td>Born in U.S.</td>
<td>60%</td>
<td>54%</td>
</tr>
<tr>
<td>Total</td>
<td>66%</td>
<td>63%</td>
</tr>
</tbody>
</table>

* Data not shown in these cells because of insufficient observations for reliable estimation, but are included in total row and column. Numbers of survey respondents in each cell are provided in Appendix 9.

The improper disposal rate of recent immigrants. Table 31 shows the same pattern of relationship we reported in the 2002 Initial Results report: the improper disposal rate is high among new immigrants and falls sharply with years lived in the United States. Immigrant DIYers who have been in the U.S. for 0–10 years dispose improperly at an estimated rate of 86 percent, but in the immigrant cohort that has been in the U.S. 10–15 years, the estimated improper disposal rate of 60 percent is already down to the rate for U.S.-born DIYers (62 percent).

Table 31. Improper Disposal Is Higher Among the Newest Immigrants

<table>
<thead>
<tr>
<th>Disposal of Used Oil</th>
<th>Years Lived in the United States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–10</td>
</tr>
<tr>
<td>Proper</td>
<td>14%</td>
</tr>
<tr>
<td>Improper</td>
<td>86</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
<tr>
<td>N</td>
<td>35</td>
</tr>
</tbody>
</table>

$\rho = .0292$

The shorter the learning period about recycling used oil, the greater the benefit to the used oil recycling effort. New immigrants tend to be younger immigrants. If they are provided with high-quality collection services and they can be persuaded to use them soon after they arrive in the U.S., improper used oil disposal may be reduced on a long-term basis.

Average oil improperly disposed. A different picture emerges from an examination of average gallons of oil improperly disposed in Table 32. Average gallons improperly disposed is one plausible criterion, because converting one high-volume DIYer to proper disposal has greater impact on the volume of oil collected than converting many low-volume disposers. With the average oil criterion, U.S.-born STMs are far and away the highest priority in both age groups, with 24.9 and 14.4 gallons per year. Both of these STM subgroups dispose of used oil improperly at many times the average volume of oil disposed improperly by other subgroups. If we believe that immigrant STMs probably dispose as much oil improperly as U.S.-born STMs (in spite of the survey data), then we would target immigrant STMs as well.
Table 32. Average Oil Improperly Disposed (in Gallons) by Age, STM, and Immigration

<table>
<thead>
<tr>
<th>Immigration</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18–39</td>
<td>40 and Older</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other DIYer</td>
<td>STM</td>
<td>Other DIYer</td>
<td>STM</td>
</tr>
<tr>
<td>Not Born in U.S.</td>
<td>2.7</td>
<td>--*</td>
<td>1.8</td>
<td>--*</td>
</tr>
<tr>
<td>Born in U.S.</td>
<td>1.9</td>
<td><strong>24.9</strong></td>
<td>2.9</td>
<td><strong>14.4</strong></td>
</tr>
<tr>
<td>Total</td>
<td>2.2</td>
<td>24.2</td>
<td>2.7</td>
<td>13.2</td>
</tr>
</tbody>
</table>

* Cell data not shown due to insufficient observations, but included in totals.

**Total volume.** Finally in Table 33 we look at the total volume of oil improperly disposed by DIYers in these groups. This criterion takes into account not just the average but also the number of DIYers generating used oil in each group. Now we see that the single group of young, U.S.-born STMs dispose improperly of far more oil in total than any other group: 8.1 million gallons, or 64 percent of all the improperly disposed oil.

Table 33. Total Volume of Oil Improperly Disposed (Millions of Gallons), by Age, STM, and Immigration

<table>
<thead>
<tr>
<th>Immigration</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18–39</td>
<td>40 and Older</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other DIYer</td>
<td>STM</td>
<td>Other DIYer</td>
<td>STM</td>
</tr>
<tr>
<td>Not Born in U.S.</td>
<td>0.7</td>
<td>--*</td>
<td>0.2</td>
<td>--*</td>
</tr>
<tr>
<td>Born in U.S.</td>
<td>0.9</td>
<td><strong>8.1</strong></td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Total</td>
<td>1.6</td>
<td>8.1</td>
<td>1.8</td>
<td>1.2</td>
</tr>
</tbody>
</table>

* Cell data not shown due to insufficient observations, but included in totals.

Note: The volumes in this table somewhat underestimate the actual volumes; some data are lost in this classification because of missing (refused) data on age, in particular. The actual total volume of improperly disposed oil is 13.84 million gallons (Section 3).

Implications for Priorities and Programs

These data show that STMs must be effectively brought into the oil collection system, especially younger STMs. U.S.-born STMs under age 40 rate higher than other groups on all three criteria: rate of improper disposal, average oil improperly disposed, and total oil improperly disposed. The data establish that younger STMs should be the highest priority target for any oil collection effort. If your program is not collecting STM oil, it is missing by far the largest single part of total DIY used oil.

Targeting STMs may pose special problems for oil collection programs. Oil-recycling outreach programs have typically been designed as “broadband” marketing efforts. These efforts center on the concept of a large number of small-volume DIYers who had to be informed about the importance of recycling and about how to recycle used oil and filters.

The data show much work to be done to convince small-volume DIYers to recycle used oil. But the data may also point toward a different model for outreach to STMs. Are the relatively few high-volume STMs the same as the large number of small-volume DIYers? STMs are somewhat
different. They tend to be younger: statewide, 53 percent are under 30, compared to 24 percent of other DIYers. They tend to have less information about the environmental impact of used oil, and they tend to be more hostile to the premise of recycling and governmental efforts to increase recycling.*

STMs are mostly in low-to-moderate income households. Many STMs are in effect running small, informal businesses below the business-regulation radar screen. They have a strong interest in remaining relatively invisible. They will often be practicing their trade in violation of neighborhood zoning provisions. They do not want to pay business license fees, and they do not want to pay someone to haul their used oil away. They may want to dispose of their used oil properly, but they have a lot of oil to dispose of, and how can they dispose of it properly without risking official recognition of their activities?

This group is surely responsible for the “midnight deliveries” of large volumes of used oil to the parking lots of certified collection centers. Ironically, certified centers such as auto parts stores go to considerable lengths to discourage such deliveries. While this is understandable, it means that the volume restrictions imposed do not meet the needs of high-volume DIYers.

Reducing illegal disposal of used oil “to the greatest extent possible” will require tapping the very large volume of STM used oil. A successful curbside collection program must allow unlimited volume of STM oil. (The city of Sacramento operates a no-limit oil and filter pickup program on recycling days at the curb; however, prior notification is required.) A well-focused, mature, no-limit curbside collection program is likely to achieve very high levels of participation and reduce improper disposal to zero. Such a program would not need to find special ways of reaching STMs.

Center-based collection programs should develop means to reach STMs and encourage—or require?—their participation in oil collection. Continuous marketing will probably be necessary to persuade this group to recycle their oil in large numbers. The need is likely to continue indefinitely because young drivers continuously enter the DIY population and newcomers continuously enter California. Some enforcement may also be necessary.

Localities should also make provisions for capturing large amounts of oil that a few STMs and some other DIYers have stored. On average, STMs store or reuse twice as much used oil as other DIYers. The survey data suggest that older STMs are less likely to store oil than any other group of DIYers, but when they do store oil they tend to store more on average than any other group. Oil storage is probably a function of residence in a single-family dwelling.

10. Improper Disposal—Best Explanations

Section 6 showed how rates of improper disposal are related to oil collection methods. Section 9 found the best target groups among DIYers. In this section we summarize the findings of multivariate analysis in order to determine which factors have net effects on improper disposal after the effects of other factors are taken into account, and what the findings say about the underlying processes at work. An important task of this work is to confirm that relationships described in Sections 6 and 9 are sustained when we take many other factors into account.

We look at three subgroups of DIYers: immigrants, younger DIYers, and older DIYers.

We evaluate three conceptions of how DIYers are brought to recycle or not recycle their used oil: (a) learning, (b) convenience and competing priorities, and (c) belief.

The statistics on which our findings are based are presented in Appendix 10.

Main Findings

Findings Confirmed

1. The analysis of this section confirms these findings of Section 6:
   a) Curbside collection effectively reduces improper disposal, more among older than among younger DIYers.
   b) Prior-notification collection programs may also effectively reduce improper disposal; we are less certain of the effect because prior-notification programs have not been as widely adopted as regular curbside collection.
   c) Convenient center collection of used oil is also associated with lower rates of improper disposal among both younger and older DIYers.

2. The multivariate analyses also confirm the finding in the 2002 CIWMB report Initial Results. Among immigrants, years lived in the U.S. is a major factor in reducing improper disposal.

Finding in Initial Results Changed

3. An important finding about STMs is changed by these analyses. The analysis of this section shows that U.S.-born STMs dispose of oil improperly at a higher rate than other U.S.-born DIYers. This reinforces the same conclusion reached in Section 9 with a more limited analysis.

More Findings about the Determinants of Improper Disposal

4. a) Knowledge of specific environmental impacts of used oil reduces improper disposal a little.
   b) There is a modest media effect: the more attentive DIYers are to TV and radio, the less likely they are to dispose of oil improperly. However, DIYers who are seriously inattentive to radio and TV are not numerous enough to impact improper disposal rates if they could be reached.
   c) The volume of oil disposed affects the likelihood of improper disposal: among small disposers, the more oil disposed, the less likely a DIYer is to dispose improperly. The highest rate of improper disposal is found among those who dispose of the least oil. Among DIYers who dispose of greater volumes of oil, the very-high-volume DIYers are more likely to dispose improperly. The highest rates of improper disposal are found among those who dispose of the most oil.
5. DIYers who do not know that oil should be recycled and DIYers who reject the pollution premise of used oil recycling or who are hostile to used oil recycling have much higher rates of improper disposal. Basic knowledge of recycling requirements is still a problem for a fraction of DIYers, both immigrants and U.S.-born.

6. The findings support three complementary models of how DIYers are brought to recycle their used oil: a learning model, a model of convenience and competing priorities, and a belief model. Each model implies an approach to reducing improper disposal.

**Implications of the Multivariate Analyses**

Analyzing the three groups separately allows us to distinguish between them with respect to the factors that affect their improper disposal. However, the three groups already differ in their rates of improper disposal of used oil:

- Immigrants: 68 percent
- Younger U.S.-born (18–39): 69 percent
- Older U.S.-born (40 and over): 55 percent

Age is the distinguishing difference between the second and third groups. Age is also closely related to years in the U.S. for immigrants, and years in the U.S. is also associated with improper disposal. So age is a factor in improper disposal as well as the other variables included in the models. Younger DIYers dispose improperly at higher rates.

Shade-tree mechanic work is also related to age. Age and STM work have important and partly independent effects on improper disposal.

Table 34 summarizes the relationships, in addition to age, revealed by multivariate analyses in Appendix 10. All of the factors included in these analyses have a clear effect on improper disposal in at least one group; most have reasonably consistent results across all three groups.

**Factors Associated with Consistently Reduced Improper Disposal**

Large effects include the following:

- Availability of regular curbside pickup of used oil in the county of residence. The effect of curbside collection on improper disposal is large, even when we account for the effects of other factors. This confirms the graphical analysis of Section 6.

- Availability of residential used oil pickup, prior notification required, in the county of residence. (We are less confident about this result than about the curbside finding because far less oil is collected by prior-notification programs, so the data are too sparse for reliable estimation.

- Years in the U.S. (immigrants only).

Small-to-moderate effects include the following:

- Convenience of taking oil to collection centers. The effect of convenience remains smaller than the effect of curbside collection even when we take the other factors in Table 34 into account.

- Knowledge of specific environmental impacts of used oil. Smaller impact than either curbside collection or convenience of taking oil to centers.
• Attention to media (radio and TV).
There is some difference between attentive and less attentive groups, but there are not enough DIYers in the less attentive groups to make much of a dent in improper disposal by reaching them.

Table 34. Summary of Relationships of Improper Disposal with Many Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Group</th>
<th>Overall Relationship</th>
<th>Average Effect*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Immigrants</td>
<td>U.S.-Born Under 40</td>
<td>U.S.-Born 40 Plus</td>
</tr>
<tr>
<td>Regular curbside pickup</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Pickup with prior notification</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Convenience of centers</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Knowledge of specific impact</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Years in U.S. (immigrants)</td>
<td>–</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Female</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Listen to radio daily</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Never watch TV</td>
<td>n/a</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Do STM work</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Volume of oil disposed/year</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
</tbody>
</table>

Source: multivariate logistic regression analyses in Appendix 10.

Key: – means a negative relationship: estimated probability of improper disposal falls as the factor increases. + means a positive relationship: estimated probability of improper disposal rises as the factor increases. ? means uncertainty about a relationship. n/a means not available (TV watching among immigrant DIYers) and not applicable (years in U.S. for U.S.-born DIYers).

* Mean across groups of the estimated change in the probability of improper disposal over the range of the predictor, holding other predictors at their means. If the relationship is causal, this is a plausible measure of effect.

Factors with different relationships in one or more groups include the following:

• Gender: female DIYers are less likely to dispose improperly among immigrants (large effect), more likely among U.S.-born DIYers (small effect).

• STM work: U.S.-born STMs are more likely than other DIYers to dispose improperly, while immigrant STMs are less likely to do so (small to moderate effects).

• Volume of oil disposed per year: among immigrants, high-volume DIYers are less likely to dispose improperly; among the U.S.-born, more likely (large effects). This difference may conceal a similarity. We estimate that U.S.-born STMs especially dispose of far greater volumes of oil than immigrant STMs (38.1 vs. 10.6 gallons on average, p = .0188)—the scale of work and oil generated by the two groups is very different. In a separate analysis not shown here we find the probability of improper disposal is highest for very-small-disposers in both groups, then declines rapidly with increasing volume.

However, for U.S.-born DIYers, the rate of improper disposal rises again above about 6–8 gallons per year. Because U.S.-born DIYers include far more very-high-volume STMs, the relationship between improper disposal and volume is positive, while for immigrant DIYers it
is negative. Therefore, the observed difference in the relationship of improper disposal and volume for the two groups may be a result of the much greater volumes of oil disposed by U.S.-born STMs and an effect of very high volumes of oil on the probability of improper disposal. This difference is not a function of an intrinsic difference between U.S.-born and immigrant DIYers in their propensity to dispose improperly.

The multivariate analyses in Appendix 10 confirm important findings of Section 6: improper disposal by DIYers is clearly substantially reduced both by curbside collection and by convenience of taking oil to a collection center, perhaps also by residential prior-notification programs.

**Learning and Other Explanations of Proper Disposal**

The three main models that are plausibly associated with the factors that affect improper disposal in these analyses are the learning model, the convenience and competing priorities model, and the belief model.

**The Learning Model**

Most of the factors identified in these analyses are related to learning and knowledge about proper disposal of used oil. By learning and knowledge, we mean inclusively both learning, and being persuaded, that oil is a pollutant that must be recycled, and learning about oil collection arrangements in a particular locality. The following factors are best understood as indicators of learning and knowledge about proper disposal.

**Factors related to learning and knowledge**

- Among immigrants, years lived in the United States: new immigrants learn more the longer they live in the U.S.

The higher improper disposal rate among new immigrants is largely a learning issue. As a Latino DIYer said during a Spanish-language focus group in Los Angeles County:

> When you come from Mexico, you have to learn many things. In Mexico I didn’t have a car; here, after a few months, I bought a car. You don’t know how to take care of a car—you have to learn that. You have to learn about recycling, too—you don’t know it when you come to this country.

Focus group participants also talked about traditional beliefs in Mexico—“Oil comes out of the ground, it should go back into the ground.” People have to unlearn old beliefs and learn new ones as well as pick up specific information about used oil and recycling.

A few respondents volunteered that they did not know that used oil was supposed to be recycled. Participants in focus groups also reported that they had not heard about oil recycling for months, even several years, until after they began changing the oil in their cars. **Basic knowledge** is still a problem for a fraction of DIYers, both immigrants and U.S.-born.

- Age: youth, new drivers, new DIYers know less, learning takes time.
- Attentiveness to media: DIYers who listen to radio and/or watch television learn more and know more.
- Gender: on average, men know more about automotive maintenance, including recycling, because males are socialized differently.
Women typically grow up exposed to different things than men. A former DIYer tells the story of an uncle who stopped the car on a trip in order to show the boy with his hands what a universal joint is and how it works—it was that important. The uncle’s daughter, on hearing the story decades later, said her father had never explained anything mechanical to her.

**The Convenience and Competing Priorities Model**

Another model that helps explain rate of improper disposal is a convenience or competing priorities model. This model acknowledges that used oil changing is a messy job, the most convenient thing to do with used oil is to let it run out on the ground or put it in the trash, and oil recycling has low priority for most DIYers. The oil collection method that works best, therefore, is one that makes recycling very convenient. For many DIYers, only such a method can be expected to overcome resistance to expending time and energy on recycling.

Curbside collection offered to DIYers in single-family dwellings in some localities is an extremely convenient solution for that group. For many of the vast majority of DIYers who do not have curbside collection, even the second errand—taking the used oil to a center after buying new oil and installing it—is unacceptable. Focus group participants wanted some sort of oil collection right on their block; that would be convenient. Clearly, making proper oil disposal very convenient removes a major barrier to it.

Taking competing priorities seriously, it is obvious that some people are more stressed than others. People who are under severe pressure from other needs and demands are less likely to dispose properly. For example, a working single mother with modest income and small children changes the oil in her automobile to save money. She would like to recycle, but the demands on her time and attention are great, and to avoid an additional errand to the auto-parts store with her children to recycle the used oil, she puts it in the trash instead.

The convenience and competing-priorities model might explain most improper disposal, and it probably explains part of the higher rate of improper disposal among women. It might also explain part of the higher rate of improper disposal among new immigrants and perhaps among low-income DIYers, and improper disposal not yet accounted for in these analyses.

Research should focus on characteristics of DIYers that might be related to stress or that directly compete with the motivation to recycle. Among the characteristics that should be examined are:

- The number of children, especially young children, in the household.
- The number of adults in the household.
- The ratio of household income to number of people in the household.
- The time spent per week working or looking for work.
- The DIYer’s assessment of stress in his or her life.
- The DIYer’s sense of competing demands and priorities.
- The DIYer’s sense of the urgency of recycling used oil.

**The Belief Model and Hostility to Recycling**

We mentioned above as part of the learning model that people have to learn new beliefs as well as information about pollution and recycling. Clues in the data also suggest a broader range of more or less intensely held beliefs about used oil—beliefs that are likely to be more resistant to information.
One small group of DIYers, estimated at 1–3 percent, rejected the premise of the question—that used oil should be recycled—and expressed hostility toward recycling in their responses to Q121. Here are some of their comments:

“People who have extreme views about the environment.”

“There’s no reason to recycle, oil should be able to go back to the environment.”

“The Sierra Club is over-neurotic.”

“Just want to make it complicated. It’s a political conspiracy.”

The estimated improper-disposal rate for those who didn’t know and those who expressed hostility combined (non-curbside users) is an extremely high 93 percent, far above the 65 percent estimate for all other DIYers excluding curbside users ($p = .0079$). And the number of DIYers hostile to recycling is probably larger than we detected because respondents had to go out of their way to express these views.

The very high improper disposal rate of this group indicates that beliefs about used oil and the environment make a great deal of difference for improper disposal. Focus group discussions also generated skepticism about the importance of used oil recycling and the existence of any environmental problem with used oil disposal. (Focus group participants also recalled earlier television spots on used oil pollution—and noted that they had not seen them in some time.)

The data suggests a correlation of hostile attitudes toward used oil recycling. Almost no users of curbside pickup programs were hostile (0.3 percent); nonusers of curbside pickup were more so (3.3 percent, $p = .0180$). DIYers who could mention no environmental impacts were much more likely to be hostile, 5.4 percent to 0.3 percent of those who mentioned an impact ($p = .0002$). No DIYers in the coastal and near-coastal counties north of Santa Barbara County were hostile to oil recycling. In the nine southern counties, 2.5 percent were hostile. DIYers in the northern Central Valley and northern mountain counties were much more likely to be hostile to oil recycling—16 percent. Hostility to oil recycling is also concentrated among younger men (5.9 percent of men 18–39); older men were less likely to be hostile (1.4 percent, $p = .1082$). No female DIYers were hostile to recycling.

**Relationships Between the Models**

We do not see the three models as competing with each other across the board. A more likely scenario is that each model offers a partial understanding of one subgroup or of one part of the process of shifting DIYers from improper to proper disposal. Successful learning that leads to recycling may involve changing beliefs about environmental impacts. Coming to believe in the urgency of recycling will be sufficient for some DIYers to overcome or reduce the burden of inconvenience of recycling used oil. The actively hostile group, on the other hand, is not likely to respond to information or persuasion. They may not be amenable to persuasive outreach and learning or to improved convenience. Enforcement may be necessary to convince this group it should recycle used oil.

**Summary of Implications of Multivariate Analyses**

Overall, the multivariate analyses for immigrants and U.S.-born DIYers constitute a plausible and reasonably clear statistical description of improper disposal.
Collection Methods

The multivariate analyses confirm the simpler graphical analysis of collection methods in Section 6. Even after accounting for characteristics of individuals that affect improper disposal, the pattern of association of collection methods with improper disposal remains.

- County availability of curbside collection is associated with reduced greatly improper disposal among immigrants and older U.S.-born DIYers. Among younger U.S.-born DIYers, the effect is more modest but still clear.
- Convenience of collection centers of all kinds is associated with more modest reduction in improper disposal, with almost identical effects in the three groups.
- On the whole, regular curbside collection without prior notification reduces improper disposal more than very convenient collection centers. Residential collection with prior notification required may also reduce improper disposal substantially, perhaps as much as curbside collection.

Volume of Oil Disposed

High volumes of used oil are a principal characteristic of STMs. Up to 6–8 gallons per year of used oil, higher-volume disposers are less likely to dispose improperly. But the super-high-volume U.S.-born disposers are more likely to dispose improperly. This suggests again (see Section 9) the urgency of finding ways of reaching the highest-volume U.S.-born DIYers—STMs in particular—and reducing improper disposal among them.

Overall Explanations of Improper Disposal

On the whole, the findings support all three main models of used oil recycling: a learning model, a convenience and competing priorities model, and a belief model.

Supporting the learning model are findings about the impact of attentiveness to media (listening to radio, watching television) and the impact of years lived in the U.S., for immigrants. Other data supporting the model include the difference between men and women, if we accept an initial knowledge disadvantage among female DIYers. The relationships of these factors to improper disposal are all what we should expect, if learning about used oil recycling arrangements increases over time and with exposure to media.

The findings also support the convenience and competing priorities model. Years lived in the U.S. and the gender effect might imply competing priorities as well as learning. Certainly the relationship with perceived convenience supports the convenience-and-competing-priorities model, as does the strong effect of regular curbside and prior-notification collection on improper disposal. Convenience of taking oil to a center is relative to competing priorities. Some groups are more pressured by competing priorities than others, perhaps including female DIYers and recent immigrants.

A learning process and the importance of convenience and competing priorities are complementary rather than mutually exclusive.

Other data reviewed in Appendix 10 support the belief model of improper disposal as well. DIYers who actively reject the premise that used oil is seriously polluting are much more likely to dispose improperly.

Each of these three models of recycling behavior suggests an approach or a program element for reduction of improper disposal.
A great deal of variation in the improper disposal data remains that we cannot explain. Among the predictors needed in future survey research are homeownership and residence in multifamily or single-family dwellings. Other needed predictors are the kinds of barriers and competing priorities that DIYers experience in their lives, the specific characteristics of the collection programs available to them, and their degree of belief in the polluting effects of used oil and the importance of recycling it.
11. Disposal and Collection of Used Oil Filters

Introduction

The objectives of the analysis of reported oil filter disposal are to (a) describe the frequency and methods of filter disposal; and (b) take into account the volume of oil disposed in filters for the analysis of total volume of oil consumed and disposed. The study of disposed filters and the oil they contain is a relatively recent development. Our approach benefited greatly from available reports, but we also identified a number of areas in which further research could be of great value in improving the precision of survey and other disposed-filter estimates.

We first present the overall number of filters used and methods of filter disposal reported by survey respondents, followed by a detailed description of the steps we took to estimate the quantity of oil attributable to discarded filters. The analysis concludes with consideration of individual averages and estimated population totals across proper and improper disposal methods, and a discussion of implications.

Main Findings

1. Controlled studies show that the residual oil remaining in automotive oil filters disposed by DIYers is considerably greater than previously thought. The estimated range is 10–11 oz. per filter on average, compared to ranges of 3.5–8 oz. and 2–8 oz. commonly cited.

2. We estimate that 2.18 million gallons of oil remained in filters that California DIYers disposed of (properly and improperly) in 2003–04.

3. Improperly disposed DIY filters contained an estimated 2.09 million gallons in 2003–04, about twice what we might have estimated if we used the midpoints of the commonly cited ranges of residual oil.

4. We estimated the approximate number of filters disposed by STMs and other DIYers in each county and the percent of the filters disposed that were collected by block grantees in 2003–04. Combining data from the statewide survey and block grantee reports to the Board, we estimate that statewide, only 3.9 percent of DIY filters were collected. Most counties collected less than 5 percent of DIY filters. Only six counties collected more than 20 percent.

5. The probability of improper filter disposal by individual DIYers is related to county collection rate, as it should be. Media outreach shows some effect on filter disposal. Not much else explains improper disposal of filters: improper disposal is pervasive across demographic groups, reflecting the lack of filter-collection infrastructure statewide. No single group disposes improperly at a significantly higher rate than any other.

6. The amount of oil remaining in improperly disposed filters has been seriously underestimated. Many DIYers are not aware that disposal of filters is a problem. The collection rate for filters is very low statewide and in most localities. Increasing the collection of filters for recycling is a more effective way of recovering used oil than previously thought.

* Most of the research and writing for this section was done by John D. Rogers, Ph.D., Associate Director of the Public Research Institute.
7. The CIWMB helps to operate Earth 911 (1-877-EARTH911) and 1-800-CLEANUP phone lines. These public referral systems provide information about used oil recycling, but assistance with oil filter recycling is difficult to obtain. Filters should be much more prominent on these systems, and vigorous efforts should be made to promote filter recycling and provision of curbside pickup for filters.

8. For the same reason that curbside collection is so effective at reducing improper disposal of liquid oil to zero, so curbside collection should also collect used oil filters and new oil containers so that the oil remaining in them can also be recycled “to the greatest extent possible.”

9. The Board should assess and revise the system for reporting filter collection. In particular, it should re-evaluate the rules for translating a known weight of collected filters into the number of filters collected.

Filter Use

The statewide survey included questions about the number of oil changes in 2003–04 for each vehicle in the household, the amount of oil changed for each vehicle, and the number of oil changes done on vehicles outside the household. We used this information to estimate total numbers of filters used by DIYers, including shade tree mechanics (STMs), and the numbers disposed properly and improperly.

From the survey data we estimate that DIYers in California used 24.9 million oil filters in 2003–04.

Filter Disposal Methods

The most prevalent method reported for filter disposal was “throwing it in the trash” (47 percent, Table 35). The other major response was “take it to a gas station or other collection center” (42 percent). These two responses account for an estimated 89 percent of DIY households. Curbside pickup was reported by only 3.8 percent, and 3.2 percent reported taking their used oil filters to a public dump or landfill. Coded as proper disposal were “take to gas station or other collection center” provided the respondent could name the center or at least its location; “curbside pickup”; “take to public dump or landfill” (see table note); “take to work”; “give to someone else”; and “keep in storage.” Factories, workshops, and ranches were mentioned as workplaces where oil and filters were recycled.
Underestimation of Improper Disposal

The survey estimate of proper disposal (59 percent) is not consistent with the CIWMB block grantee reports of oil filter collection for 2003–04, which show the following:

Only 968,585 filters, or 3.9 percent of 24.9 million estimated DIY filters, were collected from DIYers by filter collection programs statewide.*

Table 35. Methods of Filter Disposal (Detail)

<table>
<thead>
<tr>
<th>Method of Filter Disposal</th>
<th>Number*</th>
<th>Population Estimate</th>
<th>Disposal Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throw in trash</td>
<td>334</td>
<td>46.6%</td>
<td>Improper</td>
</tr>
<tr>
<td>Take to gas station or other collection center**</td>
<td>311</td>
<td>42.0</td>
<td>Proper</td>
</tr>
<tr>
<td>Curbside pickup</td>
<td>27</td>
<td>3.8</td>
<td>Proper</td>
</tr>
<tr>
<td>Take to public dump or landfill***</td>
<td>36</td>
<td>3.2</td>
<td>Proper</td>
</tr>
<tr>
<td>Take to work and recycle there</td>
<td>13</td>
<td>1.7</td>
<td>Proper</td>
</tr>
<tr>
<td>Filter not changed</td>
<td>5</td>
<td>1.05</td>
<td>Not disposed by DIYer</td>
</tr>
<tr>
<td>Keep in storage</td>
<td>11</td>
<td>0.95</td>
<td>Proper</td>
</tr>
<tr>
<td>Burn****</td>
<td>7</td>
<td>0.35</td>
<td>Improper</td>
</tr>
<tr>
<td>Someone else changes filter</td>
<td>2</td>
<td>0.30</td>
<td>Not disposed by DIYer</td>
</tr>
<tr>
<td>Give to someone else for disposal</td>
<td>2</td>
<td>0.10</td>
<td>Proper</td>
</tr>
<tr>
<td>Bury</td>
<td>1</td>
<td>0.05</td>
<td>Improper</td>
</tr>
<tr>
<td>Total</td>
<td>749</td>
<td>100.00%</td>
<td></td>
</tr>
</tbody>
</table>

* In this and other tables, observations are weighted to obtain accurate population estimates. Actual frequencies of respondents are provided for interpretation, but they do not reproduce the percentages exactly because respondent weights appropriate to sample design enter the calculations.

** In the questionnaire (q90), this option was described as “Take to gas station, oil change service, HHW facility, or other collection center.”

*** We interpreted this response to mean that DIYers turned in used filters at a facility at or near a public landfill.

**** Usually burn, then bury; coded only as burn.

* Collection by certified and noncertified centers, antifreeze, batteries, oil, and paint (ABOPS), permanent HHW facilities, recycling events, mobile collection programs, curbside collection, and “door-to-door” programs, per CIWMB database as of April 2005. Agricultural, marina, and airport collection programs were excluded in order to limit attention to DIY filters.
Table 36. Survey Estimates of Total Filters Used and Filters Properly and Improperly Disposed

<table>
<thead>
<tr>
<th>DIYer Filter Disposal</th>
<th>Total (Millions)</th>
<th>Margin of Sampling Error</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td></td>
</tr>
<tr>
<td>Total filters disposed</td>
<td>24.9</td>
<td>17.1</td>
<td>32.7</td>
</tr>
<tr>
<td>Improperly disposed</td>
<td>10.3</td>
<td>6.8</td>
<td>13.8</td>
</tr>
<tr>
<td>Properly disposed</td>
<td>14.6</td>
<td>7.4</td>
<td>21.8</td>
</tr>
</tbody>
</table>

Survey responses about modes of disposal lead to estimates that 41 percent of DIYers dispose of filters improperly; 59 percent, properly (Table 36).

We think the Board’s data on collected filters are more accurate than the survey estimates from the responses of DIYers because DIYers are inclined to overreport proper disposal. The block grantees have every incentive to report the number of filters collected—certainly not to underestimate collections—yet their numbers are still minuscule compared to CIWMB estimates and our survey estimates of filter consumption.

However, we do not know whether the collection methods of Board grantees produce entirely accurate totals. For example, rules of thumb for translating pounds into numbers of filters collected may be outdated in their assumptions about sizes of filters, which are changing, and about the amount of oil that is still in filters at the point of disposal, which affects the conversion from weight to number of filters. Nevertheless, we accept for the purposes of this report the 3.9 percent collected from DIYers of all DIY filters consumed that emerges from the Board’s grantee reports. We also accept the overall survey estimate of 24.9 million filters, and we use that percentage to estimate the volume of residual oil in filters in Table 38 and Table 39 below.*

The difference between the survey and CIWMB estimates of improperly disposed oil indicates that undersampling improper disposers and overreporting proper disposal are significant factors for used filters as they are for drained oil. Evidence from remarks by focus group participants and survey respondents suggest that fewer DIYers are aware of disposal requirements for filters than they are of the requirements for drained oil. Still, enough are aware of the requirements for filters to bias their survey responses about disposal of filters.

Most of the difference between the survey and aggregate-data estimates is probably due to the unwillingness of survey respondents to admit improper disposal; a smaller portion is probably the result of undersampling improper disposers.

The principal use of the data on filter disposal is to find patterns and relationships rather than to assert that the survey generates accurate estimates of improper disposal.

Filter Disposal and Oil Disposal

Proper disposers of drained oil were somewhat more likely to take their filters to a collection center, to keep them in storage, to have them collected curbside, and to take them to work where

* We are unable to apply to filters the same sort of model that we developed in Section 3 for oil to re-weight observations and re-estimate the rate of improper disposal. With so few filters collected statewide, the re-weighting would be too extreme: too few observations would be assigned huge weights.
oil and filters are collected for recycling. They were less likely to throw them in the trash, compared to improper disposers of drained oil.

Respondents frequently reported improper filter disposal even when they disposed of their oil properly (Table 37): 45 percent of those coded as proper disposers reported that they threw their filters in the trash. Somewhat more improper disposers of drained oil reported throwing filters in the trash, but about one-third of improper disposers of oil claimed they took filters to a gas station or other collection center, an unlikely event.

All the DIYers who cited “curbside pickup” for disposal of their oil filters were also proper disposers of drained oil. Almost all of them dispose of their drained oil via curbside pickup as well.

**Survey Estimates of Oil Volume in Disposed Filters**

Oil filters in current use vary greatly in size. Filters used in motorcycles, passenger cars, and trucks hold different quantities of oil, and filter designs have become smaller in recent years. Secondly, the amount of oil remaining in disposed filters varies according to the type of filter and the method of disposal. We accounted for both of these factors in our estimates. We first estimated the expected capacity of filters before drainage, and then adjusted for drainage and disposal methods to estimate residual oil remaining in disposed filters. See Appendix 11 for details.

**Table 37. Method of Filter Disposal by Drained Oil Disposal**

<table>
<thead>
<tr>
<th>Method of Filter Disposal</th>
<th>Proper Disposers of Drained Oil</th>
<th>Improper Disposers of Drained Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Population Estimate</td>
</tr>
<tr>
<td>Throw in trash</td>
<td>284</td>
<td>44.8%</td>
</tr>
<tr>
<td>Take to gas station or other collection center</td>
<td>277</td>
<td>43.3</td>
</tr>
<tr>
<td>Take to public dump</td>
<td>34</td>
<td>3.1</td>
</tr>
<tr>
<td>Filter not changed</td>
<td>4</td>
<td>0.91</td>
</tr>
<tr>
<td>Someone else changes filter</td>
<td>2</td>
<td>0.34</td>
</tr>
<tr>
<td>Keep in storage</td>
<td>9</td>
<td>0.96</td>
</tr>
<tr>
<td>Burn</td>
<td>6</td>
<td>0.34</td>
</tr>
<tr>
<td>Curbside pickup</td>
<td>27</td>
<td>4.3</td>
</tr>
<tr>
<td>Take to work</td>
<td>12</td>
<td>1.8</td>
</tr>
<tr>
<td>Give to someone else to take care of</td>
<td>2</td>
<td>0.11</td>
</tr>
<tr>
<td>Bury</td>
<td>1</td>
<td>0.06</td>
</tr>
<tr>
<td>Total</td>
<td>658</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Omitting classifications with fewer than 11 observations, $p$ of difference between proper and improper disposers of drained oil = .0092.
Filter Oil Capacity

We relied on industry sources in combination with the survey data on the model and year of each household vehicle to classify the likely oil capacity of vehicle filters into three categories:

- Motorcycles and similar vehicles: 5 oz.
- Vehicles with no more than six quarts of replaced oil were classified as using medium-sized LD filters with an average oil capacity of 14.75 oz.
- Vehicles in which respondents replaced more than 6 quarts of oil were assumed to use heavy duty (HD) filters with estimated capacity of 25 oz., the high end of the FMC’s range.

There is a considerable range of sizes in HD filters. The use of by-pass filtration systems for demanding applications is a potentially important factor that was not addressed in the current study. Further research concerning the use and market distribution of heavy duty and by-pass filters could substantially improve the precision of oil filter usage and filter capacity estimates.

Residual Oil in Filters

Various sources cite estimates of residual oil. The amount of oil remaining in filters at the point of disposal is typically 3.5–8 oz. or 2–8 oz. At least two reports by agencies in other states have arrived at such estimates from figures provided by the Filter Manufacturers Council, based on a 1996 study. See Appendix 11.

However, recent research indicates that considerably more residual oil remains in used filters than previously thought.

A surprising result appeared in a technical bulletin for the Missouri Department of Natural Resources describing laboratory tests. Peaslee and Roberts reported that “a typical LD used oil filter is still nearly 40 percent used oil by weight even after being hot punched and drained for at least 12 hours.”

In additional reports based on laboratory studies of a wide variety of filters across different methods and conditions of drainage, the authors reported ranges of 25–75 percent of oil remaining in the filters even after hot punching and draining.

If the anti-siphon valve is not punched as recommended by the U.S. Environmental Protection Agency, filters were found to retain 73 percent of oil on average, regardless of temperature or oil viscosity. This was true even after extended periods of drainage. Optimal drainage also depends on filter orientation, with punched filters drained at angles of 30° and 180° from vertical.

* We use “filter oil capacity” to refer to the maximum amount of oil contained in a filter when it is removed from a vehicle and full of oil. The expression “filter capacity” is also sometimes used in the research literature to describe a filter’s ability to absorb contaminants.


obtaining the best results. Some filter orientations during drainage resulted in significantly lower amounts of recovered oil.

Anecdotal reports and the expert opinion of FMC staff suggest that very few DIYers actually punch their filters. Therefore, we adopted 70 percent as a likely figure for average residual oil in filters discarded by DIYers.

Out of the mix of filters used by California DIYers, 70 percent residual oil generates an estimated average of 0.3522 quarts of residual oil, or 10.57 oz. per filter. This is substantially higher than the commonly cited ranges.

**Oil Attributable to Disposed DIY Filters**

We combined three numbers to obtain the total oil attributable to disposed DIY filters, per DIYer. These included our estimates of filter capacity of each vehicle, the 70 percent figure for residual oil per filter, and the number of oil changes reported by respondents. We used that to estimate the total oil attributable to disposed DIY filters for the population of California DIY households.

About 2.18 million gallons of oil remained in filters disposed of in 2003–04 by California DIYers, by all methods, proper and improper.

As noted previously in this report, a small number of STMs dispose of large volumes of oil, therefore of filters and their residual oil as well. STMs comprise 17 percent of DIYers but dispose of 54 percent of used filters and their residual oil (Table 38).

<table>
<thead>
<tr>
<th>California Households</th>
<th>Filters Used (Millions)</th>
<th>Estimated Total Residual Oil (Millions of Gallons)</th>
<th>Percent of Total Residual Oil &amp; Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>24.9</td>
<td>2.18</td>
<td>100%</td>
</tr>
<tr>
<td>STM (n=104)</td>
<td>13.4</td>
<td>1.17</td>
<td>54</td>
</tr>
<tr>
<td>Other DIYer (n=638)</td>
<td>11.5</td>
<td>1.00</td>
<td>46</td>
</tr>
</tbody>
</table>

Note: For all estimates, residual oil is estimated at 70 percent of filter capacity, with average residual oil of 10.57 oz. Includes filters discarded properly and improperly.

**Improperly Disposed Oil Attributable to Filters**

Combining survey and CIWMB block grantee report data, we estimated the volume of oil attributable to properly and improperly disposed filters.

An estimated 23.9 million filters containing 2.09 million gallons of residual oil were disposed improperly by DIYers in 2003–04. Only 85,852 gallons of residual oil were potentially recovered via proper disposal of used filters (Table 39).

This estimate of residual oil in improperly disposed filters is twice what we would estimate based on the midpoints of the commonly cited ranges of residual oil. We judge that the amount of oil remaining in improperly disposed filters has been seriously underestimated. Even if some of the residual oil is lost in collection and processing, increasing the collection of filters for recycling is a promising way of recovering used oil.
Table 39. Estimates of Properly and Improperly Disposed Oil in Filters, 2003–04

<table>
<thead>
<tr>
<th>Filter Disposal*</th>
<th>Average Residual Oil (Oz.)</th>
<th>Number of Filters</th>
<th>Estimated Total Residual Oil (Gallons)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improper</td>
<td>10.57*</td>
<td>23,948,071</td>
<td>2,094,148</td>
</tr>
<tr>
<td>Proper</td>
<td>10.57*</td>
<td>971,878</td>
<td>85,852</td>
</tr>
</tbody>
</table>

Note: In practice, not all DIY residual filter oil will be recoverable. Classification of improper and proper disposal is based on Board data indicating 3.9 percent collected (properly disposed) DIY filters, out of the survey-estimated 24,919,949 total DIYer-disposed filters.

* 10.57 oz. average over all filters, estimated by applying best estimates in the research literature to the survey data.

** Number of filters x 10.57 oz. per filter/30 oz. per qt./4 qts. per gallon

Who Disposes of Filters Improperly?

More than 95 percent of filters were disposed improperly in 2003–04, according to the Board’s data from block grantees. Therefore, little variation is present in the statistics. None of the standard demographics are associated with improper disposal of filters: not gender, age, income, immigrant or U.S.-born, STM activity, or rural-urban. What explains improper disposal is not variation among DIYers, but the lack of an infrastructure for oil filter recycling statewide. We can examine rates of collection—that is, proper disposal—in counties by combining survey and block grantee report data.

Effectiveness of County DIY Filter Collection Programs

The percentage of used filters generated in a county that are collected by county programs is a valid measure of program effectiveness. Number of filters collected per 1,000 population is not a good measure because it does not take many important factors into account. A more accurate approach is to estimate how many used filters are generated in a way that takes into account the number of vehicles per household and the rate of DIY and STM work in a locality. Here we estimate how many used DIY/STM filters were generated in each county in 2003–04 and list the percentage of filters collected by county. The method is potentially applicable to cities or areas of counties as well. See Appendix 11 for details of estimation.

In Table 40 we list the counties and the estimates of numbers of STM and DIY oil changes. These lead in Column 5 to the estimated percent of DIY filters generated and presumed disposed in the county that are collected and reported by county programs. The counties are listed in Table 40 in order of estimated percent of filters collected. This is our measure of program effectiveness.

In 2003–04, all but three counties collected less than 25 percent of the estimated filters disposed by DIYers (including STMs).

Counties in the mountainous, rural, northern part of the state are heavily represented among the highest-performing collectors of used filters. Most counties, including all the largest and most urban counties, collected less than 9 percent.

Paradoxically, because some DIYers in rural counties are not served by regular refuse collection, they have an incentive to take all of their refuse to a county landfill or transfer station. These stations accept oil and filters along with other refuse. This factor might account for part of the higher estimated collection rates in many rural counties in Table 40.
## Table 40. Estimated Oil Changes and Percent DIY Filters Collected by County

<table>
<thead>
<tr>
<th>County</th>
<th>Column 1 Estimated Other DIY Oil Changes</th>
<th>Column 2 Estimated STM Oil Changes</th>
<th>Column 3 Estimated Total Oil Changes (Col. 3) = (Col. 1) + (Col. 2)</th>
<th>Column 4 Total DIY Filters Collected*</th>
<th>Column 5 Estimated Percent of DIY Filters Collected (Col. 5) = (Col. 4)/(Col. 3) x 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sierra</td>
<td>4,095</td>
<td>926</td>
<td>5,021</td>
<td>2,800</td>
<td>55.8</td>
</tr>
<tr>
<td>Mariposa</td>
<td>20,140</td>
<td>5,622</td>
<td>25,762</td>
<td>10,750</td>
<td>41.7</td>
</tr>
<tr>
<td>Nevada</td>
<td>103,188</td>
<td>23,328</td>
<td>126,515</td>
<td>45,587</td>
<td>36.0</td>
</tr>
<tr>
<td>Glenn</td>
<td>28,869</td>
<td>12,179</td>
<td>41,049</td>
<td>13,250</td>
<td>32.3</td>
</tr>
<tr>
<td>Inyo</td>
<td>22,125</td>
<td>6,176</td>
<td>28,301</td>
<td>6,500</td>
<td>23.0</td>
</tr>
<tr>
<td>Napa</td>
<td>81,187</td>
<td>39,915</td>
<td>121,102</td>
<td>26,780</td>
<td>22.1</td>
</tr>
<tr>
<td>Humboldt</td>
<td>102,216</td>
<td>31,638</td>
<td>133,853</td>
<td>22,000</td>
<td>16.4</td>
</tr>
<tr>
<td>Santa Barbara</td>
<td>184,873</td>
<td>147,576</td>
<td>332,449</td>
<td>51,780</td>
<td>15.6</td>
</tr>
<tr>
<td>Siskiyou</td>
<td>55,928</td>
<td>11,548</td>
<td>67,476</td>
<td>10,219</td>
<td>15.1</td>
</tr>
<tr>
<td>Trinity</td>
<td>17,473</td>
<td>7,371</td>
<td>24,844</td>
<td>3,125</td>
<td>12.6</td>
</tr>
<tr>
<td>San Benito</td>
<td>33,930</td>
<td>18,195</td>
<td>52,125</td>
<td>6,000</td>
<td>11.5</td>
</tr>
<tr>
<td>Placer</td>
<td>194,220</td>
<td>70,187</td>
<td>264,407</td>
<td>27,954</td>
<td>10.6</td>
</tr>
<tr>
<td>Del Norte</td>
<td>27,452</td>
<td>5,668</td>
<td>33,120</td>
<td>3,500</td>
<td>10.6</td>
</tr>
<tr>
<td>Santa Clara</td>
<td>590,913</td>
<td>413,855</td>
<td>1,004,768</td>
<td>105,729</td>
<td>10.5</td>
</tr>
<tr>
<td>Santa Cruz</td>
<td>149,108</td>
<td>65,069</td>
<td>214,177</td>
<td>22,236</td>
<td>10.4</td>
</tr>
<tr>
<td>Solano</td>
<td>228,045</td>
<td>177,571</td>
<td>405,616</td>
<td>39,386</td>
<td>9.7</td>
</tr>
<tr>
<td>Sonoma</td>
<td>299,595</td>
<td>172,735</td>
<td>472,330</td>
<td>44,071</td>
<td>9.3</td>
</tr>
<tr>
<td>Plumas</td>
<td>25,100</td>
<td>5,674</td>
<td>30,774</td>
<td>2,800</td>
<td>9.1</td>
</tr>
<tr>
<td>Marin</td>
<td>60,128</td>
<td>42,280</td>
<td>102,408</td>
<td>8,628</td>
<td>8.4</td>
</tr>
<tr>
<td>Lassen</td>
<td>29,073</td>
<td>6,003</td>
<td>35,075</td>
<td>2,700</td>
<td>7.7</td>
</tr>
<tr>
<td>Mendocino</td>
<td>80,502</td>
<td>23,780</td>
<td>104,282</td>
<td>7,000</td>
<td>6.7</td>
</tr>
<tr>
<td>Monterey</td>
<td>252,942</td>
<td>135,638</td>
<td>388,580</td>
<td>25,524</td>
<td>6.6</td>
</tr>
<tr>
<td>Tuolumne</td>
<td>61,853</td>
<td>17,267</td>
<td>79,120</td>
<td>5,154</td>
<td>6.5</td>
</tr>
<tr>
<td>Lake</td>
<td>57,421</td>
<td>16,962</td>
<td>74,383</td>
<td>4,541</td>
<td>6.1</td>
</tr>
<tr>
<td>Modoc</td>
<td>11,459</td>
<td>2,366</td>
<td>13,825</td>
<td>780</td>
<td>5.6</td>
</tr>
<tr>
<td>San Bernardino</td>
<td>1,027,081</td>
<td>773,234</td>
<td>1,800,315</td>
<td>95,235</td>
<td>5.3</td>
</tr>
<tr>
<td>Mono</td>
<td>15,972</td>
<td>4,459</td>
<td>20,430</td>
<td>1,080</td>
<td>5.3</td>
</tr>
<tr>
<td>Tehama</td>
<td>67,394</td>
<td>28,432</td>
<td>95,825</td>
<td>4,750</td>
<td>5.0</td>
</tr>
<tr>
<td>Calaveras</td>
<td>51,146</td>
<td>14,278</td>
<td>65,424</td>
<td>3,146</td>
<td>4.8</td>
</tr>
<tr>
<td>Yolo</td>
<td>90,592</td>
<td>97,550</td>
<td>188,142</td>
<td>8,917</td>
<td>4.7</td>
</tr>
<tr>
<td>El Dorado</td>
<td>133,735</td>
<td>54,662</td>
<td>188,397</td>
<td>8,693</td>
<td>4.6</td>
</tr>
<tr>
<td>Shasta</td>
<td>133,176</td>
<td>44,766</td>
<td>177,941</td>
<td>8,175</td>
<td>4.6</td>
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<td>Colusa</td>
<td>19,417</td>
<td>8,192</td>
<td>27,609</td>
<td>1,250</td>
<td>4.5</td>
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<tr>
<td>San Mateo</td>
<td>215,014</td>
<td>148,354</td>
<td>363,368</td>
<td>16,081</td>
<td>4.4</td>
</tr>
<tr>
<td>County</td>
<td>Column 1: Estimated Other DIY Oil Changes</td>
<td>Column 2: Estimated STM Oil Changes</td>
<td>Column 3: Estimated Total Oil Changes (Col. 3) = (Col. 1) + (Col. 2)</td>
<td>Column 4: Total DIY Filters Collected*</td>
<td>Column 5: Estimated Percent of DIY Filters Collected (Col. 5) = (Col. 4)/(Col. 3) x 100</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------------------------------</td>
<td>------------------------------------</td>
<td>---------------------------------------------------------------------</td>
<td>----------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Stanislaus</td>
<td>315,532</td>
<td>209,593</td>
<td>525,125</td>
<td>21,627</td>
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<tr>
<td>Yuba/Sutter</td>
<td>120,011</td>
<td>73,313</td>
<td>193,325</td>
<td>7,750</td>
<td>4.0</td>
</tr>
<tr>
<td>Tulare</td>
<td>273,771</td>
<td>130,122</td>
<td>403,893</td>
<td>14,445</td>
<td>3.6</td>
</tr>
<tr>
<td>Amador</td>
<td>38,624</td>
<td>10,782</td>
<td>49,407</td>
<td>1,378</td>
<td>2.8</td>
</tr>
<tr>
<td>Ventura</td>
<td>353,071</td>
<td>245,757</td>
<td>598,827</td>
<td>16,289</td>
<td>2.7</td>
</tr>
<tr>
<td>San Luis Obispo</td>
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<td>125,243</td>
<td>287,397</td>
<td>7,358</td>
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<tr>
<td>Fresno</td>
<td>450,046</td>
<td>306,128</td>
<td>756,175</td>
<td>19,359</td>
<td>2.6</td>
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<tr>
<td>Kern</td>
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<td>663,790</td>
<td>16,210</td>
<td>2.4</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>361,250</td>
<td>294,273</td>
<td>655,522</td>
<td>14,078</td>
<td>2.1</td>
</tr>
<tr>
<td>Sacramento</td>
<td>510,289</td>
<td>515,419</td>
<td>1,025,708</td>
<td>20,258</td>
<td>2.0</td>
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<tr>
<td>San Joaquin</td>
<td>365,062</td>
<td>239,006</td>
<td>604,069</td>
<td>10,750</td>
<td>1.8</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>3,197,599</td>
<td>2,759,375</td>
<td>5,956,974</td>
<td>100,015</td>
<td>1.7</td>
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<td>Merced</td>
<td>160,183</td>
<td>80,364</td>
<td>240,547</td>
<td>4,006</td>
<td>1.7</td>
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<tr>
<td>San Diego</td>
<td>1,241,061</td>
<td>1,062,492</td>
<td>2,303,554</td>
<td>33,930</td>
<td>1.5</td>
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<tr>
<td>Imperial</td>
<td>99,426</td>
<td>55,559</td>
<td>154,986</td>
<td>2,060</td>
<td>1.3</td>
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<tr>
<td>Alameda</td>
<td>473,111</td>
<td>401,963</td>
<td>875,074</td>
<td>8,330</td>
<td>1.0</td>
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<tr>
<td>Orange</td>
<td>995,314</td>
<td>856,470</td>
<td>1,851,785</td>
<td>15,094</td>
<td>0.8</td>
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<tr>
<td>San Francisco</td>
<td>103,549</td>
<td>61,117</td>
<td>164,666</td>
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<td>Madera</td>
<td>105,998</td>
<td>28,774</td>
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<td>912</td>
<td>0.7</td>
</tr>
<tr>
<td>Riverside</td>
<td>939,229</td>
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<td>7,073</td>
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<td>Butte</td>
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<td>121,268</td>
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<td>Alpine</td>
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<td>413</td>
<td>1,892</td>
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<td>0.0</td>
</tr>
<tr>
<td>Kings</td>
<td>83,263</td>
<td>47,214</td>
<td>130,477</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Note: Yuba and Sutter counties are combined in a Joint Powers Authority.

* From the CIWMB database, entered from grantee reports.

**Effective Programs**

The oil and other materials in used oil filters are collectable from DIYers with effective programs. Systematic study of such programs was outside the scope of this project. In one county, staff told us that a relatively high rate of filter collection was achieved through the following actions:

- Vigorous and innovative outreach to the public about oil filter recycling, including attention-getting use of a mascot—a staff person who dressed up as an oil filter and danced the filter-recycling message before crowds at the county fair and other venues.
- Continuous information about filter recycling possibilities and locations on the county’s website.
- Provision of curbside recycling of filters and oil in some areas of the county.
• Arrangements with collection centers to take filters as well as oil.

• Training of collection center personnel to ask for filters when they receive oil.

In contrast, many recycling web pages do not mention filters at all, or they only mention filters when the user gets to detailed listings of places that accept used oil. Some detailed listings of oil collection facilities, including those on the CIWMB website, do not indicate whether the centers also accept filters and do not tell the user whether curbside pickup is available in the locality. And in many localities, fewer than half of the listed oil collection centers accept filters.

The www.earth911.org site lists “Used Motor Oil Recycling” but only mentions filters in the fine print about particular locations that accept used oil. The large amounts of oil and reusable metal in filters get zero attention.

The Board could do much to increase the rate at which used oil filters are recycled. A requirement for substantial progress in this area is greatly increased public awareness of the importance of recycling filters.

Many DIYers believe, falsely, that their filters are thoroughly drained before they throw them in the trash. They are not aware that so much oil remains in the filter even after draining for many hours; therefore, they may not be aware of the importance of disposing of filters properly. More effective outreach directed toward filter disposal and better collection programs are needed.

We cannot identify particular demographic groups who should receive special attention with respect to filter disposal. Improper disposal of DIY/STM filters is a significant problem throughout the state.

Conclusions and Implications

Past analyses of residual filter oil in California and elsewhere have substantially underestimated the scope of the problem. The previously cited North Carolina report attributed 154,000 gallons of improperly disposed oil to an estimated 5 million filters disposed in that state in 1997. Our analysis suggests that this figure may have been understated by nearly three times that volume. In 1997, more than 440,000 gallons was actually disposed improperly with filters in North Carolina.

California’s population continues to increase. More than 2 million gallons of used oil entered California’s waste stream with improperly disposed filters in 2003–04, posing a significant problem.

Because the great majority of improperly disposed filters are simply put in the trash, efforts to change individual behavior should focus on this area. Qualitative reports from focus groups conducted by the Public Research Institute (PRI) and comments obtained during survey interviews suggest that DIYers are largely unaware that filters can and should be recycled. Many more DIYers are aware of the importance of recycling liquid used oil.

In substantial numbers, DIYers in the survey report proper disposal of their oil but improper disposal of their filters. This suggests that significant improvements are possible through simple education and through provision of collection centers that accept used filters as well as oil. Many centers that accept oil do not accept filters. However, as indicated in Section 6, curbside collection of both oil and filters (and used new oil containers) is much more likely to proceed quickly to the objective of recycling oil “to the greatest extent possible.”

Filter recycling is valuable for a range of materials recovered as well as for control of waste oil, and the value of these materials is likely to increase over time.
Recommendations for Programs

In the existing web and other information sources about used oil, including the Board’s own website, filters are almost ignored. No opportunity should be missed to mention filters as well as oil.

Recruitment of certified collection centers should include intensive efforts to get them to accept filters; many now do not. Managers of used oil collection centers should accept oil filters, because not accepting filters will ensure that most filters are thrown in the trash. We know that convenience is essential for the collection of oil and filters—requiring DIYers to go to different places to recycle oil and filters works directly against the recycling objective.

Localities that depend on centers for collection of oil should conduct outreach to greatly increase the collection of used filters. Better yet, they should adopt effective curbside pickup programs for filters as well as oil.

Recommendations for Future Research

The measurement of oil filter disposal can be substantially improved by asking more detailed survey questions about hot-punching and draining, drainage time, filter re-use, seasonal differences in oil changing activity, and the use of auxiliary and HD filters. Methodological innovations that should be employed in future surveys include timeline follow-back methods to improve recall and sampling larger numbers of STMs.

The Board should assess the system for reporting filter collection. In particular, the rule for translating a known weight of collected filters into the number of filters collected should be reexamined periodically to track changes in size and capacity of oil filters. The finding that 70 percent of DIY filter oil capacity remains in the filter yields a very different estimate of the number of filters per given weight than an assumption of 25 percent. As noted in Section 3, “Oil Removed from the System by Remaining in Containers and Filters,” the weight to volume conversion factor for oil should be 7.5 pounds per gallon, not 8.5. Because filter design is changing, the residual oil remaining in used filters needs to be reassessed from time to time.

The Board needs better market information regarding filters and applications to specific vehicle types. The rapidly changing filter market may be one of the most important determinants of trends of the overall amount of oil entering the waste stream from disposed filters. Collaborative work with industry groups such as the FMC could yield significant gains in the precision of estimates of residual oil.

More complete information is needed on the capacity and use of filters for motorcycles and vehicles used for heavy-duty applications. As with estimation of oil consumption, more detailed descriptions of vehicles could be used to look up manufacturer’s filter specifications instead of relying on respondents’ inevitably imperfect memories of filter size.

Collaborative work with other interested agencies such as the U.S. Environmental Protection Agency on the methodology of estimation of oil and filter use and disposal could also improve the precision of estimates of residual oil and its disposal and recovery. Accurate market data, continued evaluation of the retention of residual oil in filters, and more probing and detailed investigation of the actual practices of DIYers would give the Board and local programs much better estimates of the volume and disposition of residual oil in filters.

Although not considered in the current study, DIY oil and filter disposal by boat owners may also be an important contributor to the statewide total of oil and filters collected. We excluded filters collected by marina oil collection programs from the present analysis, but some oil and filters
collected at marinas might be generated by automotive oil changing. Collaborative work with the Department of Boating and Waterways might help to fill this gap in knowledge.

Summary

The survey data estimate total consumption of automotive filters quite well: 24.9 million in 2003–04. However, the survey approach underestimates the percentage of used oil filters that were disposed of improperly: 41 percent from the survey vs. 96 percent uncollected (presumed disposed improperly) from CIWMB block grantee reports. Assuming that the grantee reports are accurate, the difference is due to undersampling of DIYers and underreporting by DIYers of their improper disposal.

Therefore, the principal use of the filter disposal survey data is to investigate patterns of disposal and patterns of relationship between improper disposal and other characteristics of DIYers. It is not to produce accurate estimates of total numbers of filters properly and improperly disposed by California’s DIYers. Instead, we use the filter collection numbers in block grantees’ reports to generate the estimates of properly and improperly disposed filters and oil remaining in filters in this chapter.

By far the most common method of filter disposal is simply to throw it in the trash.

Many DIYers who apparently recycle their oil properly dispose of filters improperly. People are less aware of filter disposal as a problem, and opportunities for disposal of filters are more limited than for disposal of liquid oil. In particular, many certified collection centers do not accept filters.

An estimated 2.18 million gallons of oil remained in filters discarded by DIYers in California in 2003–04. Of that total, 2.09 million gallons were not collected by public collection programs and are presumed disposed improperly.

Outreach to increase filter recycling, combined with provision of user-friendly ways of recycling, can substantially reduce the rate of improper disposal of filters and their residual oil. For the same reason that curbside collection of used oil is so effective, curbside collection of filters and of empty new oil containers will also be much more effective than center collection.

Additional research could improve the precision of survey estimates in several areas. These include the use of more detailed questions, better knowledge of market trends, continued assessment of residual oil factors in the changing filter mix, and consideration of non-automotive applications.
12. Media Use and Event Attendance

Introduction

Our objective is to provide the following information to State and county programs that will help them target do-it-yourself (DIY) oil changers and improper disposers:

- Information about the media use patterns of DIYers and improper disposers.
- Information about patterns of event attendance and participation in activities.
- Information about groups with higher rates of improper disposal: new immigrants, women, young people.

In Section 2, “Where Are the DIYers?” we estimated the proportions and numbers of DIYers in each county in California.

Program managers also need to know the media-use and event-attendance patterns of groups that are prime candidates for outreach efforts to increase oil recycling. In this section we describe the media coverage of improper disposers and of the largest groups of DIYers with high rates of improper disposal: the young, women, recent immigrants, and shade-tree mechanics (STM). This section contains a wealth of information that oil program managers can use to target outreach efforts more effectively.

The findings of this section should not be used as the sole determinant of outreach programs. They should be combined with knowledge about the reach and audience characteristics of local and regional media, about the effectiveness of media in changing disposal behavior, and about DIYers and improper disposers in the local area.

Main Findings

1. **Media coverage of improper disposers.** Overall—without regard to programming or time of day—radio and television each reach 89 percent of improper disposers once a week or more. Together, they reach almost all improper disposers once a week or more.

2. **Newspapers** reach smaller proportions of improper disposers and reach relatively few Hispanic improper disposers. Newspapers can be a good way to reach Asian improper disposers; readership of Chinese-language newspapers in particular is high among Chinese immigrants.

3. **DIYers who rarely or never listen to radio or television.** The estimated improper disposal rate is substantially higher for DIYers who rarely or never listen to radio—77 percent. The rate is even higher for those who rarely watch television—84 percent—compared to 61 percent for DIYers who use these media more often.

4. **Almost all high-volume STMs can be reached by television,** and they account for half of the improperly disposed oil in the state.

5. **Lack of knowledge of used oil collection.** As noted in Section 7, some DIYers still do not know that used oil should be recycled, and many do not know about local arrangements for used oil collection.

6. **Recommendation:** media or other programs of outreach should be repeated from time to time, especially in areas with many new immigrants from other countries or in-migration from other states. This is necessary to maintain and increase recycling in center-based
collection programs. However, because most DIYers (and improper disposers) already
know they should not dispose improperly, repeated outreach is not likely to reduce
improper disposal dramatically.

7. **Recommendation: use both radio and television.** The high rates of improper disposal
among non-users of radio and television and the almost 100 percent reach of both media
together support the use of both media in order to reach improper disposers.

8. **Radio programming that reaches many improper disposers:** news and talk radio, hip-
hop rock music, and country music. Top-ranked radio programming of younger improper
disposers is hip-hop, news and talk radio, rock, alternative, Top 40, and Spanish-
language.

9. **Spanish-language radio** reaches 21 percent of Hispanic DIYers and 35 percent of recent
Hispanic immigrant DIYers (in the U.S. for 15 years or less).

10. **Radio time of day.** Most DIYers listen during morning hours, with declining proportions
later in the day. Young DIYers are more likely to listen in the late-night period. U.S.-born
shade-tree mechanics are less likely to listen in the morning but more likely to listen at
other times, compared to other DIYers.

11. **TV programming.** The TV programming that reaches the most DIYers includes news,
educational TV, movies, sports, comedy, and Spanish-language programs. Spanish-
language TV reaches most immigrant Hispanics who are improper disposers.

12. **TV time of day.** Three-quarters of DIYers watch television in the evening, with
decreasing proportions in late night, morning, and afternoon. Younger, U.S.-born DIYers
are less likely to watch in the morning and more likely to watch late-night TV.

13. **Events and activities.** DIYers most frequently participate in team sports, attend church
or other religious activities, or attend sports events or fairs, markets, and children’s
events.

14. **Activities of younger improper disposers.** Younger improper disposers are particularly
likely to participate in team sports and to attend sports events.

15. **Female improper disposers.** Team sports and sports events are also the best sites at
which to reach female improper disposers. Female DIYers participate at about the same
rates as male DIYers.

16. **Immigrants.** Immigrants who are improper disposers are mostly new immigrants, 15
years or less in the U.S. In their first years in the U.S., new immigrants are relatively
likely to participate in team sports and more likely to attend church than they are later.
They are unlikely to attend sports events. They are much less likely to attend sporting
events or engage in boating and beach recreation than U.S.-born improper disposers.
Other sites to reach new immigrants are community-based organizations that deliver
housing assistance and language and other instruction to immigrants.

17. **Trust, media, and personal contact.** Evidence from focus groups suggests that personal
trust and personal contact may be important for new immigrants, perhaps especially those
from traditional sectors of their countries of origin. This suggests non-media approaches
or special attention to the source of messages about used oil collection and recycling.
**Media Coverage and Efficiency**

For each media and event type, we estimate the following two important characteristics of the audience—those who say they use that media type, or attend or participate in that kind of event regularly:

1. **Coverage** (also commonly called *reach*): the percentage of the target group who are in the audience. How many of the target group can we reach through a given medium or kind of event?

2. **Audience efficiency**: the percentage of the audience for a medium who are members of the DIY target group. When we use a given medium or event to get out a message about used oil and filters, how many of the audience are DIYers?

Coverage is the more important of these two criteria. It is usually more important to reach the target group, even if the message is sent to many who are not in the target group.

Coverage is often easier to achieve than audience efficiency. We may well find media and events that reach most DIYers (high coverage); but most media and events will also reach many non-DIYers and DIYers who are not improper disposers (low audience efficiency). We estimate 64.1 percent of DIY households were improper disposers in 2003–04 but only 11.3 percent of all households. To reach those 11.3 percent, we will typically have to use media and events that reach many who are not DIYers or do not dispose improperly.

Of course it can also be cost-effective to conduct outreach at events that have high audience efficiency but low coverage. For example, well-conducted outreach at auto shows, auto races, demolition derbies, and sports events may not have very high coverage—they do not reach a high percentage of all DIYers—but they may well be an efficient way to reach a number of DIYers with personal contact.

Note that we are not able to compare the media and event attendance patterns of DIYers and non-DIYers. For budgetary reasons, detailed data on media use and event attendance could be obtained only from DIYers in the 2001 statewide survey.

**Media Use**

**Radio, Television, and Newspapers**

Table 41 yields two results about coverage of improper disposers by radio, television, and newspapers:

- Radio and television reach improper disposers at a rate of 73–82 percent, and they are much more likely to use radio and television than to read newspapers daily (46–49 percent).

- Estimated improper disposers may be slightly less likely than proper disposers to use radio daily.
Table 41. Daily Use of Radio, Television, and Newspapers by DIYers, by Used Oil Disposal

<table>
<thead>
<tr>
<th>Daily Media Use*</th>
<th>Used Oil Disposal</th>
<th>p of difference**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proper (n = 635-639)</td>
<td>Improper (n = 95-98)</td>
</tr>
<tr>
<td>Radio</td>
<td>82%</td>
<td>73%</td>
</tr>
<tr>
<td>Television</td>
<td>78</td>
<td>81</td>
</tr>
<tr>
<td>Newspaper</td>
<td>46</td>
<td>49</td>
</tr>
</tbody>
</table>

* Cell entries are percentages of proper and improper disposers who use a particular medium daily. For example, 73 percent of improper disposers listen to radio daily.

** Smaller values mean more confidence that there is a difference between the populations of proper and improper disposers. See Glossary of Terms.

Television and radio each reach 90 percent of improper disposers once a week or more (not shown).

DIYers in rural counties tend to use all three of these media at slightly lower rates than in urban counties. There are no consistent differences between northern and southern California DIYers in daily use of these media.

Hispanic DIYers are less likely to read a newspaper every day (34 percent), because of lower levels of education and literacy among Hispanic immigrants. Among Hispanic improper disposers, the rate of daily newspaper use is even lower: 23 percent. Rates of television and radio use among Hispanic DIYers overall are comparable to the rates among other groups.

** Immigrants, Media Use, and Ethnic Media **

Recent immigrants use radio and television about as much as earlier immigrants, but newspaper use increases sharply with years in the U.S. in groups that come to the U.S. with low levels of education and literacy. The rate of daily newspaper use among Hispanic immigrants who have been in the country for 15 years or less is only 13 percent, but the rate is 37 percent among those in the U.S. more than 15 years ($p = .0322$). Daily newspapers reach relatively few new Hispanic immigrants. The corresponding estimates for non-Hispanic immigrants are 39 percent (15 years or less) and 56 percent (more than 15 years, $p = .3796$).

Literacy in Chinese and newspaper reading rates for Chinese immigrants are much higher. Chinese-language newspapers are effective means of reaching new immigrants; other media in the language of origin are also effective.

NCM Media Placement Services, a unit of New California Media, operates a one buy-one bill service that is able to advise on these issues and plan and place ads in hundreds of ethnic and other new media. The service can also “transcreate” ads—not merely translating but re-creating them to make them “culturally relevant for diverse ethnic audiences.” See www.ncmonline.com or http://news.ncmonline.com/news/view_custom.html?custom_page_id=42 for more information.

Younger DIYers listen to radio more than older: 88 percent listen daily in the 18–29 group, vs. 63 percent among those 65 and over. Among improper disposers only, 99 percent of those 18–29 and 43 percent of those 65 and over listen daily. **Radio is a good way to reach almost all new drivers and improper disposers early in their DIY “careers.”**

The reverse is true for daily newspaper reading, which is lowest—36 percent—in the 18–29 age group of all improper disposers and increases to 42 percent (30–39), 79 percent (40–49), and 71 percent (50–64).
Groups That Rarely Use These Media

As noted, listening to radio and watching television infrequently (almost never or never) are associated with higher rates of improper disposal.

The estimated rate of improper disposal for DIYers who almost never or never watch television is 82 percent vs. 57 percent for those who watch sometimes \((p = .0137)\); for DIYers who never listen to radio, it is 74 percent vs. 57 percent for those who listen sometimes \((p = .1097)\).

Even though most DIYers and most improper disposers can be reached through television and radio, a modest but important fraction of improper disposers almost never use these media. Improper disposers are more likely than estimated proper disposers to use them almost never or never, as we see in Table 42. There, improper disposers at 11.1 percent are three times as likely as proper disposers, at 3.6 percent, to watch television almost never or never. Improper disposers tend to be somewhat less connected to major media.

Table 42. Almost Never or Never Use Radio, Television, and Newspapers: Percent Who Never Use Media Type, by Estimated Used Oil Disposal

<table>
<thead>
<tr>
<th>Almost Never or Never Use*</th>
<th>Used Oil Disposal</th>
<th>(p) of Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proper ((n = 644–646))</td>
<td>Improper ((n = 109–112))</td>
</tr>
<tr>
<td>Radio</td>
<td>5.8%</td>
<td>11.4%</td>
</tr>
<tr>
<td>Television</td>
<td>3.6%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Newspaper</td>
<td>16.0%</td>
<td>20.9%</td>
</tr>
</tbody>
</table>

* Cell entries are percentages of proper and improper disposers who almost never or never use a particular medium. For example, 20.9 percent of improper disposers almost never or never read a newspaper.

In other words, the relatively high rates of reach in Table 41 mean that we should not be content with our reach to improper disposers through any single medium. Even though most DIYers watch television and listen to the radio, each of these media, used alone, misses some. Improper disposers are more likely not to use the media than are proper disposers.

We know also, both from the 2001 statewide survey and from focus groups, that some DIYers literally still do not know that used oil should be collected and recycled. This is especially true in areas with many new immigrants, but also in areas with substantial in-migration from other states and in areas with substantial movement of population in and out. Many DIYers will not know about used oil collection and recycling and will certainly not know about local arrangements and facilities, which differ widely from county to county and place to place within counties. This suggests that media or other outreach should be repeated from time to time.

Can we reach never-watchers and never-listeners through the other media? What media do improper disposers use who do not listen to radio or do not watch television?

- Among DIYers who never watch television, **76 percent listen to radio daily** and 40 percent read a newspaper daily.
- Among DIYers who never listen to radio, **83 percent watch television daily** and 35 percent read a newspaper daily.
- An estimated 4 percent of DIYers and 2 percent of improper disposers both watch television less than daily and listen to radio less than daily.
In short, most DIYers and improper disposers who never watch television can be reached via radio, and most who never listen to radio can be reached via television. The two media combined achieve 98 percent coverage of improper disposers.

The high rates of improper disposal among the never-watch and never-listen groups—together with these findings about the other media they use—support the use of both radio and television to ensure reach to these groups and support the goal of reducing their improper disposal. However, because the groups of DIYers who never watch television or never listen to radio are small, reaching them might produce some modest reductions of improperly disposed oil.

**Audience Efficiency**

Table 43 shows that the three main media types do not differ appreciably in audience efficiency for improper disposers. The percentages of each audience who are improper disposers are about the same. This is typical in these media-use and event-attendance data: shares of DIY audiences who are improper disposers tend to be similar from one media type or event to another.

Note that the audience-efficiency figures in Table 43 are percentages of DIYers. The corresponding percentage of improper disposers in all households would be about 11 percent. Use of media to reach improper disposers is bound to reach lots of people for whom the message is not directly relevant.

**Table 43. Audience Efficiency of Radio, Television, and Newspapers: Shares of Daily-Use Audiences of DIYers Who Are Proper and Improper Disposers**

<table>
<thead>
<tr>
<th>Estimated Used Oil Disposal*</th>
<th>DIYer Daily-Use Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Radio</td>
</tr>
<tr>
<td>Proper</td>
<td>40%</td>
</tr>
<tr>
<td>Improper</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
<tr>
<td>N</td>
<td>576</td>
</tr>
</tbody>
</table>

* For example, an estimated 60 percent of daily radio listeners are improper disposers.

**Radio Programming**

Here we show how proper and improper disposers respond to the question: “What kinds of radio stations do you most often listen to?” Table 44 lists kinds of radio stations in order of the percentage of improper disposers who listen to them. Radio station types with less than 5 percent use by DIYers are not shown.
Table 44. Q164: What Kinds of Radio Stations Do You Most Often Listen To?

<table>
<thead>
<tr>
<th>Kind of Radio Station Listened To*</th>
<th>Used Oil Disposal by DIYers</th>
<th>p of Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proper (n = 650)</td>
<td>Improper (n = 101)</td>
</tr>
<tr>
<td>News, talk</td>
<td>33.5%</td>
<td>20.8%</td>
</tr>
<tr>
<td>Hip-hop</td>
<td>9.5</td>
<td>21.8</td>
</tr>
<tr>
<td>Alternative</td>
<td>9.2</td>
<td>12.9</td>
</tr>
<tr>
<td>Rock</td>
<td>20.1</td>
<td>12.3</td>
</tr>
<tr>
<td>Country music</td>
<td>14.3</td>
<td>11.9</td>
</tr>
<tr>
<td>Classical music</td>
<td>5.5</td>
<td>9.4</td>
</tr>
<tr>
<td>Educational, public</td>
<td>6.4</td>
<td>9.4</td>
</tr>
<tr>
<td>Top 40</td>
<td>11.1</td>
<td>8.9</td>
</tr>
<tr>
<td>Spanish language</td>
<td>4.8</td>
<td>8.9</td>
</tr>
<tr>
<td>Jazz</td>
<td>5.5</td>
<td>8.4</td>
</tr>
</tbody>
</table>

* For example, of DIYers who are improper disposers and listen to radio at least once a month, 20.8 percent listen to news or talk radio stations. (Almost all improper disposers actually listen at least once a week.)

Improper disposers listen to news and talk radio, hip-hop, rock, and alternative radio most frequently. Compared to proper disposers, improper disposers listen to somewhat less news and talk radio and to much more hip-hop. Perhaps they listen to somewhat less rock and more classical music, though the p-values are not convincing. Listening to hip-hop is not a rural phenomenon: the estimated rate of listening to hip-hop among improper disposers is 24 percent in counties 0–30 percent rural but falls to zero in counties 30–100 percent rural (p=.1349).

If reaching younger improper disposers is a priority—and it should be—it is useful to know that the radio listening patterns of improper disposers in the 18–39 age group are quite different from the patterns of those 40 and over (Table 45). The 18–39 group of improper disposers is more likely to listen to hip-hop and Spanish-language radio. They are less likely to listen to news and talk radio, country music, and educational and public television.

Young improper disposers are spread out over many kinds of radio programming. Few of them mentioned more than one kind of radio programming they most often listened to, so these are largely independent audiences: the audience for one kind of programming may not often listen to other kinds. To reach most of this group via radio might require running messages over several kinds of radio programming.
Table 45. Radio Stations You Most Often Listen To, Younger vs. Older Improper Disposers

<table>
<thead>
<tr>
<th>Kind of Radio Station Listened to*</th>
<th>Age</th>
<th>p of Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18–39</td>
<td>40 plus</td>
</tr>
<tr>
<td></td>
<td>(n = 55)</td>
<td>(n = 27)</td>
</tr>
<tr>
<td>Hip-hop</td>
<td>27.5%</td>
<td>8.8%</td>
</tr>
<tr>
<td>Rock</td>
<td>12.6%</td>
<td>12.3%</td>
</tr>
<tr>
<td>Alternative</td>
<td>14.1%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Top 40</td>
<td>9.1%</td>
<td>8.8%</td>
</tr>
<tr>
<td>Classical music</td>
<td>12.0%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Spanish language</td>
<td>12.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Country music</td>
<td>7.7%</td>
<td>21.1%</td>
</tr>
<tr>
<td>Jazz</td>
<td>8.5%</td>
<td>8.8%</td>
</tr>
<tr>
<td>Educational, public</td>
<td>4.2%</td>
<td>21.1%</td>
</tr>
<tr>
<td>News, talk</td>
<td>14.8%</td>
<td>33.2%</td>
</tr>
</tbody>
</table>

* For example, of improper disposers who are 18–39 years old and listen to radio at least once a month (almost all listen at least once a week), 13.6 percent listen to news or talk radio stations.

Although the audience for Spanish-language radio comprises only 7 percent of all DIYers, it includes 29 percent of Hispanic DIYers overall, 38 percent of Hispanic improper disposers, and 90 percent of Hispanic improper disposers who have lived in the U.S. for 15 years or less. Spanish-language radio is a good way to reach many new Hispanic immigrants who are improper disposers.

**Time of Day**

For most people, morning is the main time of day for listening to the radio. As Table 46 shows, listening declines steadily throughout the day, and the patterns of “main times” for listening are not very different for proper and improper disposers.

U.S.-born and immigrant DIYers show similar patterns except for late-night listening, which is higher among the U.S. born: 16 percent vs. 9 percent (p = .08), and afternoon listening, which may also be higher among the U.S. born: 51 percent to 44 percent (p = .22). DIYers who listen mostly to Spanish-language stations may listen less in the late-night period, 6 percent vs. 15 percent of DIYers who listen mostly to non-Spanish stations (but p = .27).

Surprisingly, younger improper disposers (18–39) tend to listen to radio at about the same times as the 40-and-over group.

The main times at which U.S.-born shade tree mechanics (STM) listen to radio differ from the main times other DIYers listen (Table 47). DIYers who are also STMs are less likely than other U.S.-born DIYers to listen to radio during the morning hours but quite a bit more likely to listen at all other times. There are too few STMs in the foreign-born subsample to replicate this comparison for that group.
Table 46. Q162: What Are the Main Times That You Listen to the Radio? by Used Oil Disposal

<table>
<thead>
<tr>
<th>Time of Day*</th>
<th>Estimated Used Oil Disposal by DIYers</th>
<th></th>
<th></th>
<th>p of Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proper (n = 598)</td>
<td>Improper (n = 85)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning (7–12am)</td>
<td>77%</td>
<td>78%</td>
<td>.8850</td>
<td></td>
</tr>
<tr>
<td>Afternoon (12–5pm)</td>
<td>50</td>
<td>41</td>
<td>.2074</td>
<td></td>
</tr>
<tr>
<td>Evening (5–10pm)</td>
<td>29</td>
<td>24</td>
<td>.4800</td>
<td></td>
</tr>
<tr>
<td>Late night (10pm–2am)</td>
<td>14</td>
<td>14</td>
<td>.9570</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: of DIYers who listen once a month or more; almost all listen once a week or more.
* For example, morning is a "main time" to listen to radio for 78 percent of DIYers who are improper disposers and listen to radio once a month or more. For 41 percent, afternoon is a main time. More than one period may be a "main time."

Table 47. Main Times You Listen to the Radio, U.S.-Born Shade Tree Mechanics Compared to Other U.S.-Born DIYers

<table>
<thead>
<tr>
<th>Time of Day*</th>
<th>Shade Tree Mechanic</th>
<th></th>
<th></th>
<th>p of Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No (n=464)</td>
<td>Yes (n=94)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning (7–12am)</td>
<td>80%</td>
<td>71%</td>
<td>.1299</td>
<td></td>
</tr>
<tr>
<td>Afternoon (12–5pm)</td>
<td>48</td>
<td>64</td>
<td>.0194</td>
<td></td>
</tr>
<tr>
<td>Evening (5–10pm)</td>
<td>26</td>
<td>42</td>
<td>.0098</td>
<td></td>
</tr>
<tr>
<td>Late night (10pm–2am)</td>
<td>14</td>
<td>23</td>
<td>.0568</td>
<td></td>
</tr>
</tbody>
</table>

* For example, late night is a "main time" to listen to radio for 23 percent of U.S.-born DIYers who are shade tree mechanics and listen to radio once a month or more. Almost all of this group listen once a week or more.

**Television**

**Programming**

Table 48 shows that DIYers are more likely to watch television news than other TV programming. Improper disposers watch TV movies at higher rates than proper disposers. They probably watch Spanish-language TV at higher rates, and they watch sports programming and science fiction at much lower rates than proper disposers. Other kinds of TV programming not listed in Table 48 yielded even lower coverage of DIYers than the programs listed.
Table 48. Q154: What Kinds of Television programs Do You Most Often Watch?

<table>
<thead>
<tr>
<th>Kinds of TV programs Watched*</th>
<th>Estimated Used Oil Disposal by DIYers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proper (n = 639–40)</td>
</tr>
<tr>
<td>News</td>
<td>48%</td>
</tr>
<tr>
<td>Movies</td>
<td>17</td>
</tr>
<tr>
<td>Educational</td>
<td>27</td>
</tr>
<tr>
<td>Spanish language</td>
<td>13</td>
</tr>
<tr>
<td>Comedy</td>
<td>17</td>
</tr>
<tr>
<td>Sports</td>
<td>22</td>
</tr>
<tr>
<td>Reality</td>
<td>5.9</td>
</tr>
<tr>
<td>Celebrity</td>
<td>3.9</td>
</tr>
<tr>
<td>Science fiction</td>
<td>5.2</td>
</tr>
</tbody>
</table>

* For example, of DIYers who are improper disposers and watch television once month or more, 44 percent watch news programs. Almost all members of this group watch at least once a week.

As with radio programming, important differences exist between younger and older viewers. Table 49 shows the different distributions of programs most frequently watched by improper disposer, by age. Younger improper disposers (18–39) still watch television news more often than other programs, but clearly much less than improper disposers 40 and over. The younger group may also watch movies on television less often, 28 to 43 percent, but this difference is not clearly statistically significant. Unfortunately, these results do not give us a television “silver bullet” that can reach a very large proportion of younger improper disposers.

It may not always be necessary to reach the individual younger DIYer via a particular medium. DIYers change oil for vehicles in a household, and in many households an older adult will be present who might pass information on to the younger DIYer.

**Spanish-Language Television**

Although the audience for Spanish-language television comprises 14 percent of all DIYers, it includes 64 percent of Hispanic improper disposers (U.S.-born and immigrants) and 83 percent of Hispanic immigrants who are improper disposers. Spanish-language television offers by far the best way to reach most Hispanics who dispose of used oil improperly.

**High-Volume STMs**

Of high-volume STMs carrying out 25 or more oil changes per year, 99 percent watch television once a week or more, compared to 91 percent of lower-volume STMs ($p = .0391, N = 87$ lower-volume and 22 high-volume STMs). In other words, almost all high-volume STMs can be reached by television.

Higher-volume DIYers who are not STMs are neither more nor less likely to watch TV daily than DIYers with lower volume. Of non-STM DIYers, 82 percent watch television daily.
Table 49. Kinds of Television programs Most Often Watched, Improper Disposers by Age

<table>
<thead>
<tr>
<th>Kinds of TV programs Watched*</th>
<th>Age</th>
<th></th>
<th>p of Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18–39</td>
<td>40 plus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 50)</td>
<td>(n = 31)</td>
<td></td>
</tr>
<tr>
<td>News</td>
<td>33</td>
<td>64</td>
<td>.0344</td>
</tr>
<tr>
<td>Movies</td>
<td>28</td>
<td>43</td>
<td>.2981</td>
</tr>
<tr>
<td>Educational</td>
<td>20</td>
<td>27</td>
<td>.5575</td>
</tr>
<tr>
<td>Spanish language</td>
<td>20</td>
<td>19</td>
<td>.8986</td>
</tr>
<tr>
<td>Comedy</td>
<td>16</td>
<td>11</td>
<td>.5712</td>
</tr>
<tr>
<td>Sports</td>
<td>9</td>
<td>9</td>
<td>.9139</td>
</tr>
<tr>
<td>Reality</td>
<td>9.3</td>
<td>8.0</td>
<td>.8819</td>
</tr>
<tr>
<td>Celebrity</td>
<td>8.5</td>
<td>8.0</td>
<td>.9507</td>
</tr>
<tr>
<td>Science fiction</td>
<td>0.8</td>
<td>1.3</td>
<td>.7047</td>
</tr>
</tbody>
</table>

* For example, of DIYers who are improper disposers age 18–39 and watch television once month or more, 33 percent watch news programs. Almost all members of this group watch television at least once a week.

Time of Day

Most DIYers, improper disposers or not, watch television in the evening: 73–76 percent (Table 50). Overall, “main times” for watching TV are very similar for proper and improper disposers.

Table 50. Q152: What Are the Main Times That You Watch TV? by Used Oil Disposal

<table>
<thead>
<tr>
<th>Time of Day*</th>
<th>Estimated Used Oil Disposal by DIYers</th>
<th>p of Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proper (n = 650)</td>
<td>Improper (n = 86)</td>
</tr>
<tr>
<td>Morning (7–12 am)</td>
<td>18%</td>
<td>12%</td>
</tr>
<tr>
<td>Afternoon (12–5 pm)</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Evening (5–10 pm)</td>
<td>76</td>
<td>73</td>
</tr>
<tr>
<td>Late night (10 pm–2 am)</td>
<td>24</td>
<td>34</td>
</tr>
</tbody>
</table>

Note: data are for DIYers who watch once a month or more; almost all listen once a week or more.

* For example, for DIYers who are improper disposers and watch TV once a month or more, morning is a “main time” to watch TV.

U.S.-born and immigrant DIYers show similar patterns of TV watching except for the morning period, when U.S.-born DIYers watch at a much higher rate: 21 percent vs. only 4 percent for immigrants (p<.00005).

U.S.-born shade-tree mechanics show no clear differences in the times at which they watch television, compared to U.S.-born DIYers who are not STMs.

All groups of U.S.-born DIYers are more likely to watch television in the evening, but younger DIYers are somewhat less likely than older ones to watch then (Table 51). Younger U.S.-born DIYers are less likely to watch television in the morning (14 percent), but more likely to watch late-night TV (30 percent) than older DIYers (21 percent).
### Table 51. Times Watching TV by Age, U.S.-Born DIYers

<table>
<thead>
<tr>
<th>Time of Day*</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18–39</td>
<td>40 plus</td>
<td>Total</td>
<td>p of Difference</td>
</tr>
<tr>
<td>Morning (7–12 am)</td>
<td>14%</td>
<td>28%</td>
<td>20%</td>
<td>.0008</td>
</tr>
<tr>
<td>Afternoon (12–5 pm)</td>
<td>12</td>
<td>13</td>
<td>10</td>
<td>.7636</td>
</tr>
<tr>
<td>Evening (5–10 pm)</td>
<td>69</td>
<td>79</td>
<td>71</td>
<td>.0380</td>
</tr>
<tr>
<td>Late night (10 pm–2 am)</td>
<td>30</td>
<td>21</td>
<td>30</td>
<td>.0541</td>
</tr>
<tr>
<td>N</td>
<td>273</td>
<td>295</td>
<td>568</td>
<td></td>
</tr>
</tbody>
</table>

### Attending Events, Participating in Activities

The Board and grantees have conducted outreach at events such as auto races and baseball games. To assess more broadly what DIYers do and the events at which they might be found, the 2001 statewide survey asked questions about their leisure activities and community involvement.

Participation in activities and attendance at events are displayed for DIYers in Table 52. These participation rates of DIYers are in the same range as most of the kinds of TV programs watched and radio stations listened to. No clear differences exist between proper and improper disposers on particular activities except volunteer work, where improper disposers do less. This indicates where improper disposers will not be found. Improper disposers participate less than proper disposers in almost every activity. Unfortunately, this means they are more difficult to reach through activities and events than are proper disposers.

### Table 52. Q170: What Activities Do You Regularly Participate In for Leisure or Community Involvement? by Used Oil Disposal

<table>
<thead>
<tr>
<th>Activities*</th>
<th>Estimated Used Oil Disposal by DIYers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proper (n = 646)</td>
<td>Improper (n = 89)</td>
<td>p of Difference</td>
</tr>
<tr>
<td>Team sports (participate)</td>
<td>38%</td>
<td>28%</td>
<td>.1550</td>
</tr>
<tr>
<td>Church, religious activities</td>
<td>29</td>
<td>30</td>
<td>.7775</td>
</tr>
<tr>
<td>Sports events (attend)</td>
<td>27</td>
<td>20</td>
<td>.2748</td>
</tr>
<tr>
<td>Fairs, markets, children’s events</td>
<td>26</td>
<td>21</td>
<td>.4065</td>
</tr>
<tr>
<td>Boating or beach recreation</td>
<td>17</td>
<td>15</td>
<td>.7408</td>
</tr>
<tr>
<td>Community events</td>
<td>10</td>
<td>4.7</td>
<td>.2182</td>
</tr>
<tr>
<td>Volunteer work</td>
<td>8.9</td>
<td>3.0</td>
<td>.0049</td>
</tr>
</tbody>
</table>

* For example, 28 percent of improper disposers participate regularly in team sports.

Of course reaching people through the media and reaching them through the sites and organizations of their activities are very different propositions. Each mode has its own problems and potentially different payoffs. See below, “Trust, Media, and Personal Contact.”

DIYers participate in team sports more than any other activity, with church and attendance at sporting events ranked second and third. DIYers probably participate in sports at higher rates than the non-DIY population, because DIYers are younger on average than non-DIYers and young people participate more in team sports.
Rates of participation in volunteer work and community events are probably lower among DIYers than among non-DIYers because young people engage in those activities less.

**Youth**

Young improper disposers (less than 40) show somewhat different participation patterns than older improper disposers:

- Younger improper disposers participate in team sports at a 41 percent rate vs. only 5 percent for older improper disposers ($p < .00005$). Even with a wide margin of sampling error (41 ± 15 percent), team sports are a likely place to find high proportions of improper disposers.

- Younger improper disposers are also more likely to attend sporting events, as spectators, than older improper disposers, 25 percent to 10 percent ($p = .17$).

- Younger improper disposers may be more likely to participate in church or other religious activities than older improper disposers, 34 percent to 25 percent (but $p = .49$).

Overall, participatory team sports, sports events, and church and other religious activities are especially likely places to find substantial fractions of DIYers and improper disposers, especially younger ones.

**Men and Women**

Male and female DIYers show about the same patterns of participation in activities. Women participated in church activities at only slightly higher rates and only slightly lower in team sports, about the same in attendance at sporting events. Note this is a population of DIYers, not the population at large. Differences in rates of participation in activities are modest, 0–7 percentage points, and not statistically significant.

Among improper disposers, however, women may be different than men, as the following observations show:

- Women are twice as likely as men to participate in team sports, 50 to 24 percent ($p = .0692$). Surprisingly, a high proportion of female improper disposers may be reachable through team sports.

- Women attend sporting events at more than twice the rate of male improper disposers, 38 to 15 percent ($p = .0861$).

- Female improper disposers are less likely to attend fairs, markets, and children’s events than men: 12 and 23 percent, respectively ($p = .2232$)—and community events as well: 0 and 6 percent ($p = .4489$).

While some of these differences are not individually statistically significant at conventional levels because we are dividing a smallish group of improper disposers into two smaller subsamples—67 men and 22 women respondents—they constitute a pattern.

In short, female improper disposers are different. The reach or coverage of team sports in which women participate, and of spectator sports, are especially high for women. These are good sites to find a fairly high proportion of female DIYers who dispose of oil improperly. The reach of community events is 0 percent for female improper disposers; of family events, 12 percent.

An estimated 24 percent of U.S.-born improper disposers are women, and 71 percent of U.S.-born female DIYers are improper disposers (vs. 54 percent of male DIYers, $p = .0585$). For women who change their own oil and participate in these various activities, estimated improper disposal
rates are highest for women who participate in team sports (80 percent) or attend sporting events (78 percent). These rates are lower for women who participate in family events such as fairs, markets, and the like (48 percent) and community events (0 percent). In other words, the audience efficiency of team sports and sporting events is relatively high for female as well as for male improper disposers; that is, most of the participants are improper disposers.

**Immigrants**

Immigrants who are improper disposers show quite different event-participation patterns than those who are U.S.-born, suggesting quite different media or other outreach strategies would be appropriate for immigrants. More than half of immigrant improper disposers have lived in the United States less than ten years; 68 percent, less than 15 years. As a group, immigrant improper disposers have the following characteristics:

- They are more likely to participate in team sports, at 39 percent compared to 24 percent of the U.S.-born ($p = .2689$).
- They are less likely to attend sporting events, at 11 percent vs. 23 percent of the U.S.-born ($p = .3022$).
- They are much less likely to participate in boating and beach recreation, at 0 percent compared to 21 percent of the U.S.-born ($p = .0459$).
- They are much less likely to participate in community events or to do volunteer work ($p = .3243, .1557$ respectively).

None of these activities have effective reach to immigrants.

Immigrants overall do **not** dispose improperly more than non-immigrants——rather, new immigrants have higher improper disposal rates. For this reason, we look at participation in activities by more recent immigrants (those in the United States less than 15 years). New immigrants who are improper disposers—almost entirely men—are most likely to be reached in team sports (42 percent) and at churches (30 percent). Community events and boating and beach recreation are not good venues for reaching this group (zero percent).

Other potentially good places to reach new immigrants not addressed in the survey include community-based organizations that deliver language and vocational instruction to immigrants. An example would be training centers for mechanics, such as the Centro Latino de Educación Popular in Los Angeles. A number of such organizations operate in California.

**Trust, Media, and Personal Contact**

Trust is a key aspect of any effort to reach improper disposers. Trust in the conveyor of messages about recycling used oil and filters was especially emphasized by a focus group conducted in Spanish with farm workers in San Marcos, California, in 2001.* Acknowledging that radio and television are possible channels for messages about recycling, they stressed that personal contact and the integrity of the author or bearer of a message are important. Typically people do not know who is behind a message, they suggested. Better that messages about recycling are delivered by someone known and trusted, and better still if in person rather than through the media. This recommendation suggests again using respected community leadership and organizations to

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convey messages about recycling in new immigrant and farm worker communities rather than or in addition to conventional media.

The San Marcos focus group also acknowledged that many people do not recycle used oil even though they know they should. Traditional beliefs stand in the way of recycling for some: “Oil comes out of the ground; it should go back into the ground.” The focus group also showed the great pride of farm workers in their skills and their deep desire to protect the natural environment, which might be an effective focus of successful messages to this group.
13. Guidance for Programs: How to Use the Data and Findings

This section draws lessons from the findings of this report and raises issues for consideration. Topics include how to make program decisions based on findings of this report; advice about curbside collection; approaches to shade-tree mechanics (STM); estimating effects of outreach; and obtaining county- and city-level estimates of DIY, STM, and disposal. See also Appendix 13, “Data Limitations and Improvements,” which includes a discussion of how and why local programs should use surveys, recommendations for future statewide and local surveys, and suggestions for improving data about residential oil collection programs.

Main Findings

This section partly pulls together information and advice to used oil programs from the entire report. The following items are new contributions of this section and Appendix 13.

1. Center-based collection programs can estimate the probability of changing an improper disposer’s behavior with a proposed outreach effort. Such estimates are based on knowledge about the probability of reaching the improper disposer and the probability of change given reach. Using the conceptual scheme explained below will improve program decision-making over time even if the first time it is applied involves guesswork.

2. Center-based programs should expect declining return on investment in efforts to market proper disposal to improper disposers. Future reductions of improper disposal are likely to be harder and harder to achieve.

3. Continuous outreach will be necessary in localities with high levels of immigration or any kind of in-migration.

4. Counties can use the oil and filter collection estimates derived in this report to assess their programs as of 2003–04. Applying appropriate multipliers, the estimates can be adjusted for growth in the number of households year by year.

5. Estimates of DIY, STM, and oil and filter volume for cities can be obtained for many cities in California. These estimates are available by combining estimates from the statewide survey with Public Use Microdata Sample (PUMS) data provided by the U.S. Census Bureau.

6. We recommend that the Used Oil Program prepare estimates of DIY, STM activity, and volume of oil and filters for cities for which this is feasible.

7. The ability to conduct meaningful surveys of DIYers and improper disposal, to use PUMS data to estimate DIY characteristics and volumes, and to assess effectiveness of used oil and filter programs are all important. These methods all depend on the extent to which a locality (city or county) “contains” its used oil disposal and collection and the extent to which it is contained within the boundaries of census-defined Public Use Microdata Areas (PUMAs). Smaller cities that are embedded in larger metropolitan areas lack containment in both senses. Many of their DIY residents dispose of used oil outside the city, and city boundaries do not coincide with PUMA boundaries. Larger cities and counties contain most of their used oil disposal and collection, and they can be defined with PUMA-based data.
Findings from Appendix 13

1. Replicating the statewide survey locally is not likely to be a good use of program resources. Limited-purpose surveys in contained communities will still be helpful.

2. If future surveys are carried out, experimentation is needed to develop and test survey methods that reach STMs, given the very large volumes of used oil they generate. Respondent-driven sampling might be fruitful.

3. Future statewide or regional surveys that attempt the detailed data collection of the 2001 statewide survey should get data from a larger sample and ask questions about additional topics. See specific recommendations in Appendix 13.

4. Surveys alone cannot reliably assess the effects of used oil marketing and collection programs. Combining estimates from a survey with data from oil collection programs, and applying the survey estimates to PUMS household data, is necessary.

5. Reporting data on the characteristics of local residential oil collection programs should be structured like a web questionnaire, with grantees answering a series of highly concrete questions about characteristics of their programs. See Appendix 13 for many specific suggestions.

How to Make Local Program Decisions that Use the Findings of this Report

- Decide on a program profile with respect to curbside vs. center collection, with STMs in mind. Curbside collection should be all or a major part of the program if you are moving quickly to collect almost all the used oil and filters in your area. Some rural areas and towns that do not require curbside collection of trash generally should consider it in order to facilitate recycling of many materials as well as oil.

- Curbside collection of used oil and filters must be implemented at multifamily dwellings as well as at single-family homes in order to capture the great majority of oil that is generated by younger DIYers.

- Work with landlords if they oppose curbside collection of used oil and filters at their properties, as they are likely to. Select or develop containers and bags to facilitate clean pickup; offer incentives if necessary. Start with a pilot program to work out the bugs. The positive results in some localities should be shared with programs statewide.

- Consider carefully how you will collect used oil from STMs, some of whom handle large quantities of oil and filters. Any effective used oil and filter collection program must facilitate collection of oil from STMs. Find out directly from them what would work for them. Consider offering no-limit regular curbside collection, or regular collection with a limit and pickup by appointment of any additional quantities.

A few STMs are really operating substantial, established repair services off the regulatory radar screen. Localities may wish to bring them into the general regulatory framework for businesses, including the framework for used oil and filters. But localities typically do not enforce the zoning and business regulations that might be used to prohibit STM work. The adverse consequences of harassing people who are working hard to make a living outweigh the possible benefits of enforcement. The need to collect their used oil should not be an excuse for a heavy-handed approach except as that is necessary to get DIYers/STMs to participate in a recycling program.
• If part of your oil collection program relies on DIYers to deliver used oil to collection centers, focus on the convenience, stability, and consistency of centers, and on the knowledge, commitment, and behavior change of DIYers. Try out methods of community-based social marketing. Develop ways of mobilizing communities, not just reaching individuals. Develop realistic estimates of the reduction in improper disposal you can achieve with a given investment in outreach.

• Consider priorities. If you conduct outreach to improve rates of collection of oil and filters at collection centers, what groups should be your highest priority? If you go by rate of improper disposal, probably recent immigrants. However, if you want to reach the groups with the greatest volume of improperly disposed oil statewide, the highest priority should be U.S.-born STMs, then other U.S.-born DIYers, then recent immigrants (Section 9, “Best Targets for Oil Collection programs”). In many cases, estimates of volumes of oil produced by different subgroups can be obtained for your city or county, using the methods developed in this report.

Curbside Pickup Is the Collection Method of Choice

In Section 6 of this report we showed that regular curbside collection reduces improper disposal of used oil much more than collection via fixed collection centers to which DIYers bring their oil. Even centers that are made very convenient for all DIYers are unlikely to reduce improper disposal very much. Almost half of DIYers already think that taking used oil to a collection facility or center is very convenient. Curbside collection, we showed, reduced improper disposal to zero. (Prior-notification programs that pick up oil on a regular pickup day may be equally effective.)

These results strongly support the conclusion that curbside collection is much more effective than collection centers at reducing improper disposal and collecting used oil from the public. Where curbside collection is feasible and cost-effective, it is the method of choice.

The CIWMB is assessing the results of projects that aim for higher levels of commitment to recycling by applying techniques of community-based social marketing (CBSM). Such methods may reduce improper disposal somewhat below 40 percent. Whether they can ever approach the effectiveness of curbside collection is doubtful.

Curbside collection is not without problems. Using the Board’s grant programs, the Used Oil Program staff, localities, and waste management firms should work to make curbside collection more feasible and cost-effective so that it can be made available in a wide range of settings.

A problem that currently keeps curbside collection from being more widely available, even in counties that have relatively extensive curbside collection, is the opposition of landlords. They typically oppose curbside collection at their properties because they want to keep oil and oil changing away from them. Some localities have developed ways of implementing curbside collection and negotiating with landlords to make curbside collection acceptable to them. A second related problem involves the choice of technology that makes curbside collection efficient, dependable, cost-effective, clean, and resistant to vandalism.

In addition to these issues, how to handle collection of oil from STMs who generate relatively large amounts of oil may be an issue for some localities.

The CIWMB, localities, and waste management firms can do much to improve equipment and procedures for handling and collecting used oil. As we showed in Section 11, more residual oil is present in used filters than previously thought. Filters should also be collected curbside where
feasible, as should empty new oil containers. A simple, effective technology for their collection should be developed as well as for oil.

Curbside collection may not be cost-effective in rural areas that do not have regular curbside pickup of trash. There, used oil programs will have to continue to rely on DIYers to bring their oil and filters to an oil collection facility at a landfill or to a collection center of some kind, and continued outreach to encourage commitment and behavior change will be necessary.*

But even with curbside collection, repeated communication of recycling procedures for used oil and the urgency of recycling will be needed, especially in localities with high rates of immigration. Where collection centers still constitute the main method of collection of used oil, the collection of large amounts of oil should be made easier.

Collection program staff members have told us of “midnight deliveries”—barrels of oil left in the middle of the night in the parking lots of auto parts stores that are certified collection centers. The stores are not equipped to handle such heavy containers, which may weigh 400–500 pounds. Their response is to put fences around parking lots and install lighting to deter such deliveries. This is an understandable response from the viewpoint of the stores.

From the perspective of oil collection, however, it demonstrates a failure of the system: the STMs who carry out such deliveries are more committed to recycling than are the officially approved collection centers! The system is creating difficulties for precisely the largest generators of used oil to recycle it. This may be a fundamental flaw of the certified collection center system. As we have seen, the largest generators, typically STMs, produce a huge proportion of the used oil and the improperly disposed used oil.

Approaches to STMs

Because shade-tree mechanics dispose of such a large proportion of the oil discarded by the public, oil collection program staff must reach this group to provide for, or require, collection of their oil. (See Section 9.) The deliveries of “midnight oil” to collection centers demonstrate that some STMs, at least, have a large quantity of oil to dispose of, want to get rid of it in an environmentally appropriate way, and are trying to get it into the recycling stream. The first problem is how to find high-volume STMs.

Finding STMs

Finding STMs looks a bit like finding needles in a haystack. Although STMs are 16.6 percent of DIY households, the figure is only 3.2 percent of all households. STMs who carry out 25 or more STM oil changes per year constitute only 0.7 percent of all households. Super-high-volume STMs are rarer still.

We know from the statewide survey that STMs are more likely to be found in low-to-moderate-income households, $25,000–$69,999, and among younger DIYers (Section 8). Just knowing this will help programs find STMs—or at least know how to conduct outreach to them. High-volume STM work is also more likely among men than among women, but not unknown among women. STMs are DIYers. If a program has effective reach to DIYers, it is likely to reach STMs too.

In addition, inquiries by project consultants and others have shown that locating STMs by word of mouth is feasible. Other informants have told us that you can drive through certain areas,*

* Alternatively, such localities should reconsider regular collection of trash, oil, and other recyclables.
typically low- to moderate-income neighborhoods, and see where people are working on cars and where oil is on the ground.

Survey methodology may be useful; “respondent-driven sampling” may enable programs to reach STMs through other STMs, or through neighbors who may know people who change oil for others outside of commercial garages or service stations. Intercept sampling outside auto parts stores or the auto parts departments of discount stores might be effective. Incentives with monetary value are likely to be useful.

The most effective ways of reaching STMs may not be the typical ways of conducting outreach via radio or TV, but they may be effective at generating a list of STMs in a locality. Such a list permits direct communication with STMs about used oil, filters, and collection, especially if an incentive is provided and if the focus appears to be supportive rather than punitive.

University-affiliated social science research institutes such as the Public Research Institute at San Francisco State University or the National Latino Research Institute at CSU-San Marcos could develop and apply methods for identifying STMs in localities using the methods cited above. Research firms such as Garcia Research Associates in Burbank, or used oil consultants such as C2C in Sonoma County, could also contribute to this effort. Most CSU campuses have such research institutes. Many localities have significant numbers of new immigrants, so looking for STMs in the languages of origin is important. Often college students who are fluent in the languages of origin are available and would make good locators with careful training.

Because of the sensitive nature of this type of effort to locate STMs, the methodology has to be developed very carefully with full regard for the safety of the locators. Asking about someone who changes oil in a neighborhood is not unsafe, but asking repeatedly might generate tension if the STM targets of the effort would rather go unnoticed.

Alternatively, efforts to reach STMs with program information and assistance could simply target neighborhoods that have the characteristics known to be associated with STM work.

**Program Alternatives for STMs**

A curbside pickup system that allows for collection of large amounts of oil, preferably on regular waste-collection and recycling days, will accommodate STMs. A well-publicized prior-notification system might also capture a large part of the used oil disposed by DIYers, including STM oil, again provided that pickup is not limited to small amounts of oil. The CIWMB can play an important role in the development, evaluation, and dissemination of effective systems.

An advantage of curbside pickup systems that will accommodate STMs is that they do not require raising questions about the outside-the-system aspect of STM activity. Prior-notification systems, however, might discourage STM participation because they may require making one’s oil-generating work known to a governmental agency. The focus should be on collecting as much used oil as possible, not on identifying STMs.

Localities have other interests as well, including maximizing revenue (business permit fees and sales tax), bringing commercial activity under regulation, and enforcing zoning ordinances. The highest-volume STM work probably approaches the size and work load of a regular small garage, generating more than 100 kilograms of oil per month, and such establishments might be brought into the system, requiring business permits and requiring them to pay to have their used oil hauled to recycling facilities. Forcing smaller, part-time STMs into the fully regulated business system would probably be counterproductive.
Estimating the Effect of Outreach to Increase Collection by Centers

Where curbside collection is not feasible, programs will still have to rely on outreach and provision of convenient collection centers. Given some number of improper disposers and the goal of reducing the rate of improper disposal, here are four main quantities to keep in mind:

- The cost of a carrying out a plan of reach.
- The probability of reaching a DIY improper disposer, given implementation of a plan of reach ($P_r$).
- The probability of changing an improper disposer’s behavior so the disposer participates in a program of proper disposal ($P_c$).
- The probability of changing an improper disposer’s behavior to proper disposal, given that the disposer was reached via the selected mode of reach ($P_{c|r}$).

This report provides information in Section 12 about $P_r$, the probability of reaching a DIYer or an improper disposer through various media and events. The data in Section 12 are statewide and must be supplemented by regional and local knowledge and by an estimate of the probability of changing behavior with a given medium. The objective is to implement a plan of reach that maximizes behavior change among improper disposers, not merely reach.

The probability $P_c$ of changing an improper disposer’s behavior is the product of the other two probabilities:

$$P_c = P_r \times P_{c|r}$$

For example, we might expect that a given plan of outreach will reach 20 percent or 0.20 of our target group of improper disposers: $P_r = 0.20$. (By “reach,” we mean here not just sending a message to an audience but having the message understood and considered.) Suppose we think we can get 10 percent of the improper disposers we have reached to participate in proper disposal; in other words, the probability of change given reach $P_{c|r} = 0.10$. Then the overall probability of change $P_c = 0.20 \times 0.10 = 0.02$.

That’s the probability of change to proper disposal among improper disposers. What’s the reduction in the rate of improper disposal overall? If improper disposers constitute, say, 40 percent of DIYers, the expected reduction in the rate of improper disposal is $P_c = 0.02 \times 40 = 0.8$ percent. We will have reduced the improper disposal rate from 40 to $40 - 0.8 = 39.2$ percent.

Given the difficulties of reach and of behavior change, even this very modest hypothetical probability of reduction might be unrealistically high. If either the probability of reach or the probability of change given reach is lower, the overall probability of change drops off rapidly.

The Problem of Declining Return to Investment

If we project successive waves of outreach in an effort to reduce improper disposal drastically, we might imagine a steady reduction in the number of improper disposers over time. But such efforts usually do not have this kind of effect, for the reason that the conversions to proper disposal already achieved are typically the easiest to get. The more DIYers we have already converted to proper disposal, the fewer remain to be converted, and they are likely to be the most difficult to convert if recycling is inconvenient but throwing oil in the trash is convenient. This could be true whether “trash” is a can that’s emptied weekly or a pile in the corner of a lot. These DIYers will
typically be harder to reach and are almost certainly more skeptical of claims of harmful impact of used oil.

It is realistic to expect declining probabilities of reach and declining probabilities of change given reach. Fewer DIYers will dispose improperly, resulting in declining probabilities of change overall and a declining return to investment in outreach. This is a reason for supposing that reducing improper disposal toward zero in a center collection system, even with more convenient centers, will be ever slower, more difficult, and more costly.

Localities that rely on collection via centers and have high levels of immigration or any kind of in-migration will have to conduct continuous outreach just to maintain existing levels of proper disposal. In such places, DIYers previously reached by used oil disposal messages are constantly being replaced by DIYers who have not received those messages.

State and local program managers should be trained in the use of the kind of estimates presented above. Using this kind of scheme for estimation of reduction in improper disposal can sharpen managers’ use of the reach and other program tools at their disposal. Over time, managers will develop skill and increasing realism in their projections of how much change they can expect for a given investment of resources. This realism will in turn lead to better investment in programs to reduce improper disposal.

How to Use County-Level Estimates to Assess and Plan Programs

Cities and counties need to know the size of the problem in their jurisdictions. They should focus on the number and proportion of improper disposers in the population of DIYers and the proportion of DIY oil that is not collected. They also may need to know the proportions and numbers of other target groups such as STMs and recent immigrants.

Identify Target Groups for Outreach or Program Focus

To start, look up your county’s figures in the big tables in Section 2. These tables estimate the proportions and the number of households in groups that programs might wish to target:

- The number of DIYers.
- The size of the important subgroup of STMs.
- The number of recent immigrants.

Special Estimation Problems of Small Counties

As noted in Appendix 2, we used census PUMS data to estimate DIY oil characteristics of counties. Twenty-four of the smallest counties in population are grouped into six groups. To obtain estimates for 22 of these counties, we distributed estimated county-group values to the individual counties in proportion to the DOF-estimated number of households in each county on January 1, 2004. The group values included number of DIY households and volume of DIY oil generated. See “Using PUMS Data to Estimate County-Level DIY” in Appendix 2, where the counties in each PUMA county group are listed.

To distribute county-group values to individual counties, first obtain the estimated number of households for each of the counties in your county’s PUMA. Calculate the proportion of the PUMA’s households that reside in your county. Estimate the number of improper disposers and the volume of improperly disposed oil as described below for the PUMA. Finally, multiply the PUMA estimate by your county’s proportion of households. Because of the added complexity of these calculations and the difficulty of staffing such work in the smaller counties, we recommend...
that the CIWMB’s Used Oil Program prepare and distribute these calculations to counties that are combined in groups for purposes of the PUMS data.

**Special Conditions of Your County**

The most common special condition is rapid population growth. If your county has experienced rapid growth since the target date of the estimates in this report—January 1, 2004—you can increment the number of DIYers and STMs estimated for your county from Section 2. Use the proportional increase in the number of households in the county estimated by the California Department of Finance (E-5 City/County Population and Housing Estimates) between January 1, 2004, and the most recent January 1 as of the time of your incremental estimate.

**The Overall Volume of Used Oil and Filters Generated by DIYers in Counties**

The total size of the used oil collection problem is the total amount of oil generated (disposed) by DIYers, including STMs. Find your county in Section 5, Table 18. Look up the same term for filters in Section 11, Table 40.

**The Effectiveness of Local Programs**

In Table 18 in Section 5, the percentage of disposed oil collected is listed. This is a measure of the effectiveness of oil collection programs countywide in 2003–04. The same term is available for filters in Section 11. The collection data are taken from the CIWMB database, which consists of entries of numbers submitted by the counties and (for oil) verified and adjusted by Used Oil Program staff. If you think the percentage for your county might be too high or too low, check the data you submitted to the CIWMB and the data in the CIWMB database. Make sure no non-DIY oil from oil-changing operations was included in the totals for oil and filters collected and that the adjusted data fairly represent actual oil collection in your county.

**The Size of the Improperly Disposed Oil and Filters Problem**

Using Table 18 of Section 5, calculate the amount of oil not collected in your county by subtracting column 4 from column 3, or column 5 from 100 for the percentage. These are measures of the size of the improper-disposal problem. The same terms are available for filters in Section 11, Table 40. These are figures you should track over time to evaluate your used oil programs. If you have had significant population growth in your county since January 1, 2004, again you may wish to increase the estimated amounts of oil and filters disposed and not collected by the estimated proportional increase in population.

**The Number of Improper Disposers—a Key Target Group**

You can calculate the approximate size of the target group of DIYers in your county who improperly dispose. First calculate the proportion of oil that was not collected: 1–(percent collected)/100. Percent collected is given in column 5 of the disposed-and-collected tables in Sections 5 and 11. Then multiply this proportion of uncollected oil times the estimated number of DIYers in your county (Section 2, or as estimated for a city following the method described above).

For example, in Section 5, Table 18, Tulare County was estimated to have collected 29.6 percent of the oil disposed by county DIYers. This corresponds to 100–29.6 = 70.4 percent of oil generated by DIYers that is uncollected oil. From Table 5 of Section 2 we find that Tulare County was estimated to have 41,596 DIY households. We multiply 70.4 percent or 0.704 × 41,596 to obtain 29,284 estimated improper disposers of used oil.
This estimate simply applies a proportion of uncollected oil to estimate a proportion of DIY households that improperly dispose. It is probably not far off because on average, improper disposers and proper disposers, including STMs, dispose of about the same amounts of oil: 10.3 gallons per year for improper disposers, and 10.6 gallons per year for proper disposers ($p = 0.9338$).

The same calculations can be carried out with filters starting with the percentage of filters collected in Section 11.

Estimates for Cities

Special problems arise with attempts to estimate the number of DIYers in particular cities and the amount of oil they dispose of, and relating oil disposed to oil collected. The first potential problem has to do with the “containment” of the population under study. The second issue is how to compute estimates employing the method used in this report.

The Problem of Containment

By containment we mean the extent to which the populations and processes involved take place within the boundaries of a city or another clearly defined geographic entity. The present effort concerns DIYers and STMs, their oil disposal, and the oil collection programs in a city or county. The feasibility and cost of limiting a survey sample to the residents of a city is also critical, as is the possibility of using census PUMS data to estimate DIY and used oil characteristics for the city.

Containment is not a problem for estimation of oil disposal and collection in counties. Most counties are sufficiently large that we can assume the following:

- That almost all oil disposed in the county is generated by residents of the county.
- That almost all oil collected in the county is collected from residents.
- That Public Use Microdata Area (PUMA) boundaries coincide with county boundaries.
- That if we conduct a survey, it will be easy to limit our sample to residents of the county.*

These assumptions can also be accurate for cities if they are large enough or if they are independent of other cities—not embedded in a continuous metropolitan region—and if PUMA boundaries coincide sufficiently well with city boundaries. Oakland, for example, is embedded in a continuous metropolitan region on its northern and southern borders, but it is large enough that we can still assume that almost all oil disposed and collected in Oakland is disposed and collected from residents, and it will be easy to limit a sample to residents of Oakland. We can tolerate minor deviations from these conditions.

For example, we can ask people where they dispose of their used oil, and the number who dispose outside the city limits of Oakland will be small compared to the whole sample of DIYers. The same is likely to be true for independent cities. In these instances, oil disposed, oil collected, PUMS data, and a survey sample are relatively contained within the cities.

But these conditions may not be true for cities that are smaller in area and are either embedded in continuous metropolitan regions or serve the needs of many people outside the city. Suppose we want to find out how many of the DIYers in our city know about certified collection centers.

* See Appendix 2 for information on county/PUMA groups.
located within the city and about the city’s HHW facility. We decide to conduct an “intercept” survey in which interviewers stand outside auto parts and discount stores and attempt to interview DIYers on their way in or out. In a relatively contained city almost all of the persons who agree to be interviewed will be residents of the city.

In an embedded city or a city with a large clientele that resides outside city limits, many DIYers successfully contacted and identified will reside in other cities. Suppose half reside in other cities. Then, in order to get the desired sample size of residents of your city, you have to interview twice as many respondents, and your survey would be much more expensive than a similar survey in a contained city. With a limited budget and unrealistic expectations about interviewer productivity, this is a recipe for failure.

These considerations lead in three possible directions:

1. You may decide to do your survey anyhow; at least you will have a more realistic idea of the cost of achieving a desired sample size of your city’s residents. Many cities will decide that a more costly survey is not feasible.

2. You may partner with adjoining cities to conduct a joint survey, or a group of contiguous cities may partner with each other or with their county or counties. In effect, they will turn their area into a relatively contained entity. You will still have the problem of obtaining a large enough sample in any one city, but almost all the interviews will be applicable to one city or another.

3. Whether or not you do a survey, alone or with partners, you should use the estimates and methods of this report to get as much information as possible about the DIYers in your city, including the STMs.

Getting City-Level Estimates of DIY, STM, and Disposed Oil and Filters

If you are a city within a county and you want an estimate of the number of DIYers in the city and the amount of oil they dispose of, what can you do? To get the county-level estimates of DIY in Section 2, we estimated the probability of DIY for every household in the statewide PUMS data. We set a prediction cutoff that yielded the statewide survey proportion of DIY of all households, then counted the number of predicted DIY households in each county. This count can be repeated from our data for any city in the state that is already identified or that can be identified in the PUMS data. Employing weights, the count of DIYers in the sample data is appropriately expanded to an estimate of the number of DIYers in the city’s population (and STMs, etc.).

Cities Explicitly Identified in PUMS Data

In the 5 percent PUMS the threshold for identifying places is 100,000 or more persons. Because of the way the Public Use Microdata Area (PUMA) boundaries were drawn, not all cities that meet the population threshold are identified. The PUMS identifies cities in which at least 99 percent of the residents resided within PUMA boundaries and no more than 1 percent of the population in those PUMAs lived outside of the city limits. The following California cities are explicitly identified in the PUMS data:
Anaheim | Irvine | Riverside
Bakersfield | Lancaster | Sacramento
Burbank | Long Beach | Salinas
Corona | Los Angeles | San Bernardino
Costa Mesa | Modesto | San Buenaventura
Downey | Moreno Valley | San Francisco
El Monte | Norwalk | Santa Ana
Fontana | Ontario | Santa Clarita
Fresno | Orange | Simi Valley
Fullerton | Oxnard | Stockton
Garden Grove | Palmdale | Thousand Oaks
Glendale | Pasadena | Torrance
Huntington Beach | Pomona | West Covina
Inglewood | Rancho Cucamonga

For example, in the 5 percent sample for Los Angeles, 0.02 percent of the identified individuals are not city residents. In Orange, Calif., 0.08 percent of identified individuals are not city residents. In other words, the cities identified in the 5 percent PUMS include households and persons that are almost 100 percent residents of those cities.* The PUMS data set a 99 percent standard, but much lower correspondence between PUMAs and city boundaries can be tolerated and the data will still be useful. Many other cities are paired in the PUMAs in ways that do give us usable data.

For example, Berkeley and Albany are paired in Alameda County as PUMA 02401. Oakland, Emeryville, and Piedmont are combined in PUMAs 02402-02404, which could be used to provide estimates for different parts of the city of Oakland. For practical purposes PUMA 02405 is San Leandro, just south of Oakland, though it contains a small number of Oakland residents. This information about the makeup of PUMAs can be obtained at http://ftp2.census.gov/census_2000/datasets/PUMS/FivePercent/California/PUMEQ5-CA.TXT.

Estimates generated for such groups of cities will be most useful to the larger or largest city in the group. Any estimates for a pair or group of cities will reflect mainly the characteristics of the largest city’s population. If a smaller city is similar to the larger city, the proportions of DIY households and STMs in the smaller city are probably about equal to the proportions for the larger city. Values for Albany, for instance, are probably not much different from values for Berkeley. On the other hand, upscale Piedmont is probably more like San Francisco or Marin County with respect to oil changing than it is like Oakland, with which it is grouped in a PUMA, because Piedmont’s population is in many ways more like San Francisco’s or Marin’s than like Oakland’s.

Estimates of number of DIYers and STMs and volume of oil can be obtained from the data developed in this report for any PUMA or combination of PUMAs. Similarly, the number of filters predicted disposed by each PUMS household (both STM and other DIY) can be summed over the PUMS households in any uniquely identified city. The same method is applicable for any pair or group of cities in a PUMA or groups of PUMAs, or groups of counties.

* http://www.ipums.org/usa-vars.html (Select “C,” then “City.”)
Smaller cities that are combined in PUMAs with larger cities that are substantially different in significant ways will not be able to use this method to develop estimates of DIY, STM, and volume of oil and filters generated. However, often such cities are not sufficiently separate from their larger neighbors to permit assessment of oil disposal programs. Containment is about the creation and use of data, but it also has to do with the extent to which separate programs really serve separate populations.

Again, because of the complexity of the data and calculations involved, we recommend that the Used Oil Program prepare estimates of DIY, STM, volume of oil and filters, and improper disposal for cities to the extent feasible, using the estimated PUMS data from this study.
Glossary of Terms

ABOP
A facility that collects antifreeze, batteries, oil, and paint.

Confidence interval (CI)
The confidence interval is a way of taking possible sampling error into account. It is an interval around an estimate from sample data within which you can be more or less confident that the corresponding characteristic of the population lies. The confidence interval is a technical term for the “margin of error” or “margin of sampling error” in conventional journalistic usage.

Suppose we have a sample estimate of something—for example, we estimate from the sample that 15.9 percent of DIYers in the population of the most urban counties are shade-tree mechanics. This is not an exact estimate because of the possibility of random sampling error. To say something meaningful and accurate about the population, we can say that the 95 percent confidence interval for this estimate is 11.9 percent to 21.0 percent. This is true. We could also say that the margin of error is ±4.6 percent. This would not be quite accurate for this estimate, though such a statement would be accurate for an estimate nearer to 50 percent.

The upper bound of the 95 percent CI is not 4.6 percent above the estimate but 5.1 percent higher, while the lower bound is only 4.0 percent below the estimate. Journalists conventionally give just such a single “margin of error” figure in order to simplify presentation.

By that method, the margin of error would be 11.3 percent to 20.5 percent—slightly different. As estimates get closer to 0 or 100 percent, their confidence intervals become more and more asymmetrical—shorter on the side of the estimate closest to the limits of 0 or 100 percent, longer on the side toward less extreme values. This is because the estimates are mathematically constrained by those limits.

In any case, the 95 percent confidence interval for an estimate is the interval in which we could expect to find the actual value for the population from which the sample was drawn 95 percent of the time, if we repeated the sampling and estimation procedure many times. So we are 95 percent confident that the percentage of shade-tree mechanics in the population of DIYers who reside in the most urban counties lies within the interval 11.9 percent to 21.0 percent. In this report, margins of sampling error are 95 percent confidence intervals, and they are given in terms of the lower and upper bounds, which are frequently somewhat asymmetric around the estimate.

Wide confidence intervals. Some of the confidence intervals shown in this report are quite wide. This occurs either because an estimate is based on a relatively small number of respondents (for example, on 111 STMs) or because there is great variation in the quantity being estimated (for example, total oil disposed by DIYers and by STMs in particular).

A wide confidence interval means only what it says: we are 95 percent confident that the value of the population characteristic being estimated lies within the interval. A population characteristic is more likely to be close to the specific estimated value than to
the boundaries of its confidence interval. A wide confidence interval does not mean that
the estimate is wrong.
We believe that the oil volume estimates in this report are better than their confidence
intervals. See also the discussion of wide and asymmetric confidence intervals and “Why
These Estimates Are Better Than Their Margin of Error” on the first page of Appendix 3.

Constant
In a regression analysis, the estimated value of a variable when all the predictors are zero.

Disproportionate sampling
Sampling from one group at a higher rate than from another group. In this study,
households in rural counties were sampled at a higher rate than households in urban
counties to ensure that the sample would contain enough households in rural counties to
support statistical comparisons of rural and urban households.

DIYer—Do-It-Yourselfer
An automotive DIYer changes oil for vehicles in his or her household; a “home
mechanic.” “Other DIYer” in this report refers to a DIYer who is not also a “shade-tree
mechanic” (see STM).

DOF
California Department of Finance, which estimates California population between
censuses.

Effectiveness
Program effectiveness is the extent to which a program achieves its objectives. In the
context of used oil disposal, effectiveness refers to the reduction in the rate or volume of
improper disposal of used oil or filters that programs achieve.

Estimate
A sample statistic we use to estimate a characteristic of a population. For example, we
estimate the proportion of DIYers in the population of California households with the
proportion of DIYers in the sample.

Estimated total potential reduction
For each predictor in a regression model, the estimated reduction in improperly disposed
oil that could theoretically be achieved if the effect of the variable could be moved all the
way toward reduction of improper disposal. An example would be if all DIYers who do
not listen to the radio daily could be reached and their improper disposal brought down to
the level of DIYers who do listen daily. Or, if curbside collection of used oil were
instituted in all California counties at the current highest level of any county, the
reduction in improper disposal that could theoretically be achieved. Actual reductions
might be smaller or greater than these estimates.

FMC
Filter Manufacturers Council

HD, LD
Heavy duty, light duty, referring to oil filters. Passenger cars and light pickup trucks
typically use light duty filters, which are smaller on average. Larger vehicles or vehicles
for more demanding uses are typically fitted with heavy duty filters.

Household
This report focuses on the oil-disposal behavior of households. To estimate total oil
consumed and disposed in California, statewide, and in counties requires accurate counts
or estimates of the number of households. The Demographic Research Unit of the California Department of Finance (DOF) estimates the number of households in each county as of January 1 of each year, starting from the benchmark of corrected U.S. census counts as of April 1, 2000. This report uses the DOF estimates for counties as of January 1, 2004, the midpoint of the year July 1, 2003, to June 30, 2004. This is the period covered by the oil collection data submitted by block grantees to the CIWMB and used in this report. The DOF estimates are available at http://www.dof.ca.gov/HTML/DEMOGRAP/E-5a.xls.

The count of households is the count of housing units occupied as the usual place of residence of the occupants. A vacation home is not counted as a household since it is not the usual place of residence. For more information, see definitions at http://factfinder.census.gov/home/en/epss/glossary_h.html and links from U.S. Census Bureau, Table QT-P10 Households and Families, 2000, or other tables containing data about households, available through http://factfinder.census.gov/.

Logarithm to base 10
A logarithm is an exponent, or a power to which a base number is raised. A logarithm of X to the base 10 is the power to which 10 must be raised to equal X.

<table>
<thead>
<tr>
<th>X</th>
<th>log_{10}(X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>1,000</td>
<td>3</td>
</tr>
<tr>
<td>10,000</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>0.1</td>
<td>-1</td>
</tr>
<tr>
<td>0.01</td>
<td>-2</td>
</tr>
</tbody>
</table>

X^0 is defined as 1.

A negative exponent of X is a power to which 1/X is raised.

Logarithmic scale
Logarithmic scales to the base 10 are used in graphs in this report for ease of reading. On this scale each increment of 1.0 represents a ten-fold increase in the quantity at hand. In multivariate statistical analyses, we use the so-called “natural” logarithm (to the base e) for its superior characteristics in statistical inference.

Logistic regression
A method of multivariate analysis that permits us to assess the effect of one or more variables on a variable of interest that takes the values 0 or 1, such as whether a DIYer is a shade-tree mechanic. The score would be 0 if no, 1 if yes.

Margin of sampling error
See confidence interval and sampling error, and Appendix 3, “Why These Estimates Are Better than Their Margins of Error.”

N or n
The number of interview responses on which an estimate is based.

Odds ratio
In logistic regression, a measure of the change in the odds of an event associated with a 1.0 change in a predictor. For example, suppose we want to predict the probability that a DIYer is an improper disposer, and we find that the odds ratio for STM is 2.0, where STM is coded (0,1). This means that the odds of being an improper disposer are twice as large for an STM as they are for another DIYer who is not an STM.
Oil, collected
Oil collected from the DIY/STM public (not from businesses). Based on block grantees’ reports as compiled and extensively verified and re-estimated by Used Oil Program staff. See Section 3 and Appendix 3.

Oil, consumed
Total oil consumed by the DIY/STM public in 2003–04. Estimated from the statewide survey as the sum of oil put into motor vehicles at oil changes and oil replaced between changes. See Section 3.

Oil, disposed
Estimated volumes of oil DIYers—including STMs—get rid of, store, or reuse; and the places, channels, and modes of disposal they use. Total oil disposed by the public is estimated as oil consumed minus estimated oil lost in driving. See Section 3.

Oil, illegally or improperly disposed
In this report, “improper disposal” means illegal disposal. This includes oil that is drained or poured onto the ground or buried, drained or poured into a drain or gutter, put in the trash, or burned. Estimated rates and volumes of oil illegally disposed are based on survey responses and on the difference between oil disposed by the DIY/STM public and oil collected from the public, excluding oil that is reused, stored, or disposed at workplaces. See Section 3 and Appendix 3.

Oil, properly disposed
Properly disposed oil is oil taken by the DIY/STM public to a site that receives oil from the public, such as a certified or noncertified collection center, a HHW facility, an ABOP site, a landfill that receives and recycles oil, or a mobile or special oil collection event; oil left at the curb or door for pickup; and oil stored, reused, or disposed into a tank at a workplace. Estimated from survey responses; see Section 3.

p-value or simply p of an estimate
Probability that an estimate, such as a regression coefficient, could have arisen by chance if there were no difference or no relationship in the population from which the sample was drawn. Low values (near zero) strengthen the conclusion that the observed difference signifies a real difference in the population, on the grounds that if the probability that a difference could have occurred by chance is very low, then we should be more willing to conclude that the difference is “real.” By this we mean the difference truly characterizes the population from which we sampled.

\( p = .05 \) is a conventional threshold. Researchers often want the probability that a relationship or difference could have arisen by sampling error to be .05 or less before they are willing to consider that there might be any relationship. This is a mistake in studies of this kind, where some subsamples are rather small. An important relationship can characterize the population of interest but not produce a \( p \) value of .05 in a small subsample. In this report we sometimes take seriously differences and coefficients with somewhat higher values of \( p \).

PUMA Public Use Microdata Area—an area defined by the U.S. Census identified in PUMS data. PUMAs are large enough to prevent identifiability of the detail in PUMS data. A very populous county is divided into many PUMAs; sparsely populated counties are combined with other such counties to form a single PUMA.
PUMS  Public Use Microdata Sample—1 percent and 5 percent samples of households and persons from which the U.S. Census Bureau collects and supplies detailed data on many individual and household characteristics for individual and household-level analysis.

$R^2$  R-squared—proportion of variance in a variable accounted for by predictor variables in regression analysis.

Regression coefficient  
Estimated average change in the amount of a variable, such as the amount of improperly disposed oil, associated with a one-unit change in a predictor.

Sampling error  
Estimation from surveys that involve random selection of respondents always involves a chance of sampling error. We do not know exactly how much sampling error occurs for a given survey, but we can attach a “margin of sampling error” to any estimate to express our confidence that the population parameter that we are estimating lies within a certain range around the estimate. That range is called a confidence interval (see entry on page 135) or a margin of sampling error. Margins of sampling error can be very large if the sample is small and/or if variation in the sample on the measure of interest is very large.

Shade-tree mechanic or STM  
A DIYer who also changes oil and may do repairs on other people’s vehicles, outside of his or her household and outside of an established service station, garage, dealership, or repair shop. Most DIYers change oil in only a few vehicles, but a few change oil in many vehicles.

Skew, skewed distribution  
Asymmetry in a distribution. A batch of data that is asymmetrical, with a cluster of observations and a long tail.

Standard error  
A measure of the sampling variability of an estimate. In most instances, a 95 percent confidence interval is defined by the estimate plus or minus 2 standard errors.

Statistical power  
Statistical power is the probability of detecting, based on sample data, an effect in the population under study when there is one.

Statistical significance  
Statistical significance is the probability of deciding, based on sample data, that there is an effect in the population under study when there is not.

Weights, weighted sample  
The sample for this study was constructed with a greater proportion of households in rural counties than are in the population of California. (See disproportionate sampling.) In analysis of the sample data, respondents from urban and rural counties are weighted appropriately in order to yield accurate estimates of population characteristics. Comparisons of urban and rural households from disproportionate sampling and weighted data are more reliable than comparisons from a simple random sample of California households of the same size. The sample was also post-weighted for gender. For estimation of improper disposal, the DIY sample was additionally post-weighted to replicate the rate of improper disposal necessary to produce the volume of oil not collected in California in 2003–04.
Appendices

Note: appendix numbers correspond with section numbers in this report. Sections 7 and 12 do not have appendices, so appendix numbers skip from 6 to 8 and from 11 to 13.
Appendix 1:
Changes in Data and Measurement

**Improvements to the Survey Data**
We improved the statewide survey data. We deleted three interviews altogether because internal inconsistencies led us to conclude they were not valid. Therefore, the number of completed interviews of DIYers and non-DIYers is 1,203 for this report, including 785 DIYers, instead of 1,206 interviews and 786 DIYers for the 2002 CIWMB report *Initial Results.* In addition, we went through all of the many responses about used oil that we recorded in the survey, then we reassigned some DIYers to different disposal categories. Because of missing and unclassifiable responses to some questions, almost all DIY analyses in this report are based on 761 DIYers. Although slightly reduced in size from the data set employed in *Initial Results,* the present data are higher in quality. None of these changes affect the conclusions reached in *Initial Results.*

**A Change in the Measurement of Improper Disposal**
We modified the indicator of improper disposal of used oil that we introduced in *Initial Results.* The main difference is that we now do not classify “take to dump” as improper disposal. A detailed analysis of the “take to dump” DIYers indicated that these are not improper disposers.

The survey data now yield an unadjusted estimate of 12.2 percent improper disposers with the “take to dump” responses removed. In *Initial Results* we estimated 19.5 percent. Both the 19.5 percent and the 12.2 percent estimates are underestimates because they have not been adjusted for response bias. The unadjusted classification of DIYers as improper disposers from the survey data will always underestimate actual improper disposal rates.

With the revised data and using the method described in Appendix 3 to adjust the weights of various observations, we obtain an adjusted estimate of 64.1 percent improper disposers, with a margin of sampling error plus or minus 6.2 percent.

Our modified and adjusted indicator still classifies DIYers as improper disposers based on two kinds of responses in the survey: “certainly improper disposal” and “probably improper disposal.” Respondents were classified “certainly improper disposal” if they admitted that they drained or poured oil onto the ground or buried it, drained or poured it into a gutter or drain, burned it, or threw it in the trash.

Respondents classified as “probably improper disposal” said they took their used oil to a collection center but were unwilling or unable to say its name or its street location, and there was no other evidence in any of their responses to indicate proper disposal. (We gave respondents many opportunities to say exactly what they did with their used oil.) In almost all analyses in this report, what we call “improper disposal” combines these two categories.

**Households and Individuals**
DIY oil-changing is a household activity, and the statewide telephone survey was a survey of households. Our key screening question was “Is there a person I can talk to who takes care of changing the oil in your household vehicles?” We spoke with that person. This survey did not investigate whether two or more members of a household change oil. The sampling unit was households, and we can legitimately estimate characteristics of (a) all California households and (b) all DIY households.
Appendix 2: Estimating DIYers in Counties

This appendix provides explanations and results that back up Section 2, “Where Are the DIYers?” In this appendix and in the body of the report we use “proportion rural” and “percentage rural” interchangeably. The proportion ranges between 0 and 1; the percentage is simply 100 times the proportion.

Proportion Rural

This is a census measure: the proportion of a county’s occupied housing units that lay outside census-defined urban areas and urban clusters in 2000. The following excerpt from the U.S. Census Bureau’s web documentation at [www.census.gov/geo/www/ua/ua_w8.html](http://www.census.gov/geo/www/ua/ua_w8.html) gives the definitions of urban and rural areas:

<table>
<thead>
<tr>
<th>URBAN AND RURAL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Census 2000, the Census Bureau classified as “urban” all territory, population, and housing units located within an urbanized area (UA) or an urban cluster (UC). It delineates UA and UC boundaries to encompass densely settled territory, which consists of:</td>
</tr>
<tr>
<td>- Core census block groups or blocks that have a population density of at least 1,000 people per square mile and</td>
</tr>
<tr>
<td>- Surrounding census blocks that have an overall density of at least 500 people per square mile.</td>
</tr>
<tr>
<td>In addition, under certain conditions, less densely settled territory may be part of each UA or UC.</td>
</tr>
<tr>
<td>The Census Bureau’s classification of “rural” consists of all territory, population, and housing units located outside of UAs and UCs. The rural component contains both place and nonplace territory. Geographic entities, such as census tracts, counties, metropolitan areas, and the territory outside metropolitan areas, often are “split” between urban and rural territory, and the population and housing units they contain often are classified partly as urban and partly as rural.</td>
</tr>
</tbody>
</table>

The measure reflects the extent to which people live in rural areas—not the amount of rural space in counties. It’s a measure of the dispersal of residents outside of the urban areas where population is concentrated.

We do not have data on cities within counties, but it is plausible that the clear relationship between DIY oil changing and proportion rural applies also to cities and towns compared to the rural areas in the same counties. The DIY rate is likely to be higher in the outlying rural areas of a county than in the urban areas of the same county.
### DIY Oil Changing by Region and County Percent Rural

#### Table 53. Margins of Sampling Error and Sample Frequencies for Section 2, Table 2

<table>
<thead>
<tr>
<th>Region</th>
<th>0–9%</th>
<th>10–29%</th>
<th>30–100%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>.155 to .217</td>
<td>.136 to .351</td>
<td>--</td>
<td>.157 to .218</td>
</tr>
<tr>
<td></td>
<td>391</td>
<td>56</td>
<td></td>
<td>447</td>
</tr>
<tr>
<td>North &amp; central</td>
<td>.123 to .200</td>
<td>.188 to .296</td>
<td>.232 to .389</td>
<td>.171 to .232</td>
</tr>
<tr>
<td></td>
<td>216</td>
<td>308</td>
<td>208</td>
<td>732</td>
</tr>
<tr>
<td>Total</td>
<td>.153 to .202</td>
<td>.193 to .292</td>
<td>.232 to .389</td>
<td>.172 to .216</td>
</tr>
<tr>
<td></td>
<td>607</td>
<td>364</td>
<td>208</td>
<td>1,179</td>
</tr>
</tbody>
</table>

#### Table 54. Margins of Sampling Error for Estimated Numbers of DIY Households by Region and County Percent Rural: Section 2, Table 3

<table>
<thead>
<tr>
<th>Region</th>
<th>0–9%</th>
<th>10–29%</th>
<th>30–100%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>940,000 to 1,172,000*</td>
<td>28,000 to 52,000</td>
<td>--</td>
<td>980,000 to 1,213,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North &amp; central</td>
<td>406,000 to 583,000</td>
<td>241,000 to 333,000</td>
<td>152,000 to 211,000</td>
<td>865,000 to 1,061,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,429,000 to 1,672,000</td>
<td>281,000 to 373,000</td>
<td>152,000 to 211,000</td>
<td>1,937,000 to 2,181,000</td>
</tr>
</tbody>
</table>

* Rounded to nearest 1,000.

### Using PUMS Data to Estimate County-Level DIY

We estimated the following county-level characteristics:

- Number of DIY and STM households and proportion DIY of all households.
- Number of DIY and STM oil changes in order to estimate the proportion of used oil filters collected.
- Gallons of used oil disposed in order to estimate the proportion of used oil collected.

The estimations for counties were carried out by first estimating the target characteristics in the survey data, employing multivariate methods and models to account for the characteristics of interest as well as we could. We took the coefficients from these estimates and applied them to households represented in the U.S. Census Bureau’s 5-percent sample of California households. This is the 5-percent Public Use Microdata Sample, downloaded from the International PUMS Web site at the University of Minnesota, [www.ipums.umn.edu](http://www.ipums.umn.edu). This sample contains data on selected characteristics of 575,143 of the 11,502,870 households in California in 2000. Every county or county group is also represented by an approximately 5 percent sample. These are probability-weighted data; weights range from 0 to 98.

The smallest county sample of households in the PUMS data is 1,866 (Kings); the largest, Los Angeles with 154,430. To protect confidentiality, smaller counties are not identified in the PUMS data. Instead, small-population counties are grouped with similar small, contiguous counties in census-designated Public Use Microdata Areas (PUMAs).
Thirty-four counties are in unique PUMAs or (the largest counties) contain groups of PUMAs. Twenty-four counties with smaller populations are grouped into seven PUMAs and not separately identified. The groups are (1) Del Norte, Lassen, Modoc, and Siskiyou; (2) Mendocino and Lake; (3) Colusa, Glenn, Tehama, and Trinity; (4) Plumas, Sierrra, and Nevada; (5) Alpine, Amador, Calaveras, Inyo, Mariposa, Mono, and Tuolumne; (6) Yuba and Sutter; and (7) Monterey and San Benito counties. The Yuba/Sutter group matches our use of their combined values corresponding to their Regional Waste Management Agency. To obtain estimates for the other grouped counties, we distributed estimated county-group values to individual counties in proportion to the number of households in each county on January 1, 2004.

**Estimating County-Level DIY and STM for Section 2, Table 5**

The logistic regression results below were obtained from the statewide survey data to describe the relationship in households with vehicles between DIY (coded 0,1) and the other factors listed, accounting for all of them simultaneously. The model as a whole is statistically significant ($p < .00005$).

Two transformations of age and of household income are necessary to capture the marked curvilinearity of those key relationships. While the second transformation of age is not individually statistically significant, it is needed to account for the curved shape of the relationship.

Figure 13 shows the relationship of predicted DIY with age; Figure 14, the relationship with household income. The decline of DIY oil changing among high-income households is probably a direct income effect, but the relatively low rates of DIY at the lowest income levels are probably the result not of income but of age. (People at lower household income levels are twice or three times as likely to be 65 or older, on the average.) The low levels are also probably due to gender: women are more likely to be at the lowest household income levels than men are.

The results support the conclusion that rates of DIY oil changing are higher in rural counties even after we account for individual characteristics that are associated with DIY oil changing: the odds ratio for proportion rural is large and the $p$-value is less than .0005.

The “Change min->max” column may provide the most comprehensible measure of the possible effect of each factor on the probability of DIY oil changing. It measures the change in probability associated with going from the smallest value of the factor to the largest value, holding the other factors at their means. For example, for proportion rural, 0 is the smallest and 1.0 is the largest value. Going from 0 proportion rural to 1.0 increases the probability of DIY oil changing 0.41, or 41 percentage points. This is a large difference. Going from one vehicle to seven in a household, holding other factors at their means, increases the probability of DIY oil changing 0.50—also a large change.

For each household with vehicles in the PUMS data, we applied the regression coefficients from the logistic regression to the household’s characteristics on the factors of age, proportion rural, income, number of vehicles, and occupations of adult members of the household. We employed the same transformations as in the estimation from the survey data.

We did not use gender to explain DIY and STM in this model, and we adopted special rules to determine what age should be used in a household-based estimation. Gender and age are, after all, individual characteristics, and the survey sampled households, not individuals. The survey did not include questions about household structure, but we reasoned as follows. In households that include a young or middle-aged able-bodied male, the youngest male will change the oil in household vehicles if anyone does so.

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If a household does not include such a male, a female will change oil in household vehicles if anyone does so. In other words, the sex of DIYers is a function of gender roles and household structure, and in both cases, the age of the youngest adult is, we propose, a determinant of DIY oil changing, along with income, number of vehicles, and proportion rural. “Age,” then, was determined for each household in the PUMS data as the age of the youngest adult male younger than 65, if any; or if none, the age of the youngest adult female.

| diyer | Odds Ratio | Robust Std. Err. | z | P>|z| | [95% Conf. Interval] | Change min->max |
|-------|------------|------------------|---|------|----------------------|----------------|
| ageest1 | 18.16398 | 28.48511 | 1.85 | 0.064 | 8401168 | 392.7192 | 0.1745 |
| ageest2 | .999269 | .000621 | -1.18 | 0.239 | .9980527 | 1.000487 | -0.1110 |
| prural | 6.897111 | 3.496077 | 3.81 | 0.000 | 2.553886 | 18.62657 | 0.4273 |
| incpute | 1.379453 | .2074055 | 3.81 | 0.000 | 1.027368 | 1.852201 | 0.2904 |
| incpucu | .989536 | .0032408 | -3.21 | 0.001 | .9832045 | .9959083 | -0.3166 |
| nvehicle | 1.459683 | .1146013 | 4.82 | 0.000 | 1.251497 | 1.7025 | 0.4944 |
| mechanic | 37.44569 | 42.34891 | 3.20 | 0.001 | 4.080772 | 343.6065 | 0.6933 |
| tools | 3.947136 | .7166078 | 7.56 | 0.000 | 2.765319 | 5.634026 | 0.2756 |

**Logistic regression**  
Number of obs = 1143  
Wald chi2(8) = 112.07  
Prob > chi2 = 0.0000  
Log pseudolikelihood = -487.45179  
Pseudo R2 = 0.1273

The two age variables are transformations of age in years that best fit the DIY data. Proportion rural is a decimal number between 0 and 1. Household income cubed was added, as with the transforms of age, to capture the strong curvilinearity in the relationship of DIY to income. -mechanic- and -tools- are coded (0,1: No, Yes).
With respect to occupation, we coded “mechanic” 1 if any member of the household was a mechanic of any kind—not only automotive—otherwise zero. Similarly, we coded the “tools“ attribute 1 if any member of the household was listed in the PUMS file as engaged in an occupation that was not mechanic but involved working directly with tools, vehicles, or machinery, or working outdoors. These attributes were strongly related to DIY oil changing in the statewide survey, where an estimated 4 percent of DIYers are mechanics (any kind) but less than 1/10 of 1 percent of non-DIYers. Forty-three percent of DIYers are people in the “tools” occupations, but only 18 percent of non-DIYers are in those occupations.
Estimated probabilities of DIY oil changing for individual households in the PUMS data ranged from 0.019 to 0.998. Among DIY households, probabilities of STM ranged from 0.0007 to 0.975. Starting with the households with the highest probabilities, we marked households as DIY until we had reproduced the survey-estimated proportion of DIYers in California: 19.4 percent of households with one or more vehicles (margin of error 17.3 to 21.6 percent). We followed the same procedure to mark households as STM, reproducing the survey estimate of 3.2 percent of households with vehicles (margin of error 2.5 to 4.0 percent).

We counted the marked DIY and DIY/STM households in each PUMA subsample: counties or groups of contiguous counties. We distributed the DIY and DIY/STM households in county groups according to county proportions of households in the group. This implicitly assumes that DIY and STM rates are at least roughly the same in the counties of a county group. While this is a plausible assumption, it is a potential source of error in the estimates for the smaller counties that are grouped in the PUMS data.

Finally, we incremented all county-level counts by the proportional increase in county households from April 1, 2000 (the census) to January 1, 2004 (the DOF estimate). This process yields the estimated numbers of DIY and STM households by county in Section 2, Table 5. We then calculated the proportion DIY of county households by dividing the estimated number of DIY households by DOF-estimated total households in each county as of January 1, 2004.

The relatively low proportions DIY of the most urban counties reflect obvious urban-rural differences such as much smaller distance to oil-changing facilities. They also reflect the influence of higher household income in urban areas, fewer vehicles per household, and fewer people employed in occupations involving tools, machinery, or working outdoors. These are conditions associated with less DIY oil changing. San Francisco’s especially low proportion DIY is uniquely attributable also to its relatively small proportion of households with one or more vehicles: 71.4 percent in 2000. In other California counties, the percentage of households with at least one vehicle ranged from 87 to 95 percent.

**Potential Sampling, Prediction, and Non-Sampling Error**

**Sampling error** stems from our use of the statewide sample survey to make the original estimates and from our use of the Census Bureau’s 5-percent PUM sample. Because the PUM sample is very large, its contribution to sampling errors for county and county-group estimates of the probability of DIY is small. Average predicted probabilities and their margins of sampling error for counties and county groups vary depending on subsample sizes; they range from 0.1989 ± 0.0010 for Los Angeles County (sample size 134,979) to 0.3912 ± 0.0120 for Madera County (sample size 1,747), at the 95 percent confidence level. It would be prudent to allow ± 0.01 as the contribution of the PUMS component to the sampling errors of the proportions DIY in Figure 1 and Table 5.

The share of possible sampling error around predicted probabilities of DIY attributable to the statewide sample survey is much greater. (The predictions are carried out in the full sample of DIYers and non-DIYers, N = 1,143.) It stems from possible sampling error in all of the terms involved in the estimating equation for DIY that stem from the statewide survey: the DIY characteristic itself, age, household income, number of vehicles available to the household, and occupation, and from unexplained or “random” variation in DIY.

For the survey sample as a whole the average margin of error of the predicted probability that a household is DIY is ± 0.06, but it is higher for smaller counties. For the 24 counties that are more than 30 percent rural, the average margin of error is ± 0.095. Thirteen of the most rural and sparsely populated counties show margins of error ranging between 0.10 and 0.23: Amador,
Calaveras, Glenn, Lassen, Mariposa, Modoc, Mono, Plumas, Sierra, Siskiyou, Tehama, and Tuolumne.

The total margin of error of the predicted probabilities DIY can be approximated by the margin from the statewide survey plus an allowance of 0.01 for application to the PUMS data.

Non-sampling error can stem from various sources, including error in survey measurement of the DIY characteristic, of age, of household income, and of occupation. Income especially is likely to be subject to measurement error.

The procedures and assumptions we made above about the role of age, gender, and household structure in the estimation of the proportion DIY might also introduce non-sampling error.

Population change since the 2000 census is a potential source of non-sampling error for some counties. We have incremented the estimated numbers of DIY and STM households to account for population growth to January 1, 2004, but we are not able to account for changes in the characteristics of county populations: the PUMS data are from 2000. Counties that have experienced shifts toward higher incomes, toward increasing age of the adult population, toward white-collar occupations, and toward an increasingly urbanized population are likely to have somewhat smaller proportions DIY and smaller volumes of DIY/STM oil disposed now than we estimated in Sections 2 and 3. Counties that have experienced changes in the opposite direction are likely to have somewhat larger proportions DIY than estimated.

An additional possible source of error involves county groups in the PUMS data. To the extent that the counties in a county group differ substantially from each other with respect to the estimation variables or other factors that affect the estimates, the proportional allocation of estimated quantities to counties will introduce error for those counties beyond the possible sampling error involved in estimation from the survey data and use of the PUMS data.

The overall DIY rate may have declined since July 2001, when we estimated DIYers are present in 19.4 percent of households with vehicles and 17.6 percent of all households, both ± 2.2 percent. If the overall DIY rate has declined, that would reduce all estimates of DIY proportions a little. The rate decline would also reduce estimates of used oil and filters available for collection. However, because of the recession of 2001–03, the marked decline in the stock market, and slow recovery in some areas of the state, we doubt that the DIY rate declined in the state as a whole between 2001 and 2004. For counties that have become significantly more urban and suburban or more prosperous since 2000, our estimates of DIY proportions and oil volumes are likely to be somewhat high.

Appendix 3:
Estimating Oil Consumed and Disposed

Improving Accuracy and Overcoming Bias

This appendix describes a method of weighting survey data to adjust for the social desirability bias that arises in the statewide used oil survey and in any survey on a sensitive topic. The basic idea of the method is to compute the improper disposal rate that must correspond to the volume of oil that was not collected and not disposed in other ways.

Estimates of improper disposal rates and volumes of improperly disposed oil in this report are based on this additional weighting to fit what we know about oil collected from DIYers in California from the annual reports of CIWMB block grantees for 2003–04, as adjusted by Used
Oil Program staff. The new weighting has the advantage of yielding much more accurate estimates of improper disposal rates and of oil improperly disposed. A disadvantage is that some margins of sampling error are larger than they would be otherwise; however, others are smaller. See “confidence interval” in the Glossary of Terms.

Wide and Asymmetric Margins of Error for Estimates from Survey Data

Sometimes margins of error are wide, for reasons we explain below. They may also be asymmetric. Margins of error are usually presented as if they were always symmetric. Many of us will have heard something like the following: “Forty percent said they approved of the policy; the margin of error was plus or minus 3 percent.” The plus or minus 3 percent is symmetrical around the 40 percent estimate. In the used oil context we might say that 31.41 million gallons of oil were disposed as drained liquid oil ± 9.16 million gallons. This is a symmetric margin of error—the same on both sides of the estimate.

Symmetrical margins of error are, in fact, only approximations presented for simplicity. Usually they are good approximations. However, margins of error for some of the estimates in this report are markedly asymmetric. For example, the estimate of total DIY oil consumption for 2003–04 is 31.41 million gallons with a confidence interval that actually extends from 23.47 to 42.04 million gallons; that is, from 31.41-7.94 to 31.41+10.63. Note the asymmetry: the margin of error is greater above the estimate than it is below. This arises because the distribution of oil consumed by DIYers is extremely skewed, with a very large number of low values and a small number of extremely high values.

The laws of probability tell us that estimates at the upper end, based on a small number of extreme values, will be less reliable than estimates at the lower end, based on many values that are not so widely dispersed. In addition, all oil-volume measures are absolutely constrained at the lower end—the volume of oil cannot go below zero—but volume measures are not constrained in this way at the upper end. For these reasons, the margin of error is greater on the upper side of the estimate than it is on the lower side. For some estimates, it is much greater on the upper side.

Why These Estimates Are Better Than Their Margins of Error

Some of the margins of error reported here will seem very wide to readers. Again, the estimate of total consumption: Is a margin of error that extends 19 million gallons helpful? Is it really useful to know that you can be 95 percent confident that the “real” total consumption of oil by the population of DIY households was between 23 and 42 million gallons?

The oil volume estimates in this report are much more accurate and reliable than their sometimes wide margins of error imply. We know this because key survey estimates are close to estimates by other methods. In the example of total oil consumption, CIWMB staff estimated 2000–01 consumption of motor oil by the DIY public at 33 million gallons from sales data. The three figures are all similar: 33 million gallons, the 30.71 million gallons we estimate consumed in 2000–01, and the 31.41 million gallons for 2003–04.

The modest difference between the sales and survey estimates for 2000–01 is easily explained by missing data from respondents about oil capacity and oil changes for vehicles they said they had. The closeness of the estimates from the survey and an estimate from sales data supports the proposition that the survey-based estimates of oil consumed and disposed are much more accurate than their margins of error might imply.

When we turn to modes of disposal of used oil, bias is a significant problem. The survey estimates of the amounts of oil properly disposed are biased upward. But the percentage distribution of the amounts to three modes of proper disposal is reasonably close to the
distribution of amounts of oil collected by each mode, from grantee reports, as we show in Section 3, Table 8. An upward bias is present in the reporting of proper disposal overall, but that bias is roughly evenly distributed over modes of proper disposal.

Rates and volumes of improper disposal are of course especially important. Here we know that estimates are biased downward. Improper disposal is seriously underreported and probably improper disposers are underrepresented in the survey. Unlike proper disposal, we are unable to compare survey estimates of improper disposal by mode to another source of data. Here, we have adjusted the survey data to remove all or most of the bias, as we explain below.

The reported margins of error are a probabilistic indication of a range within which we expect a population parameter to lie. We expect a certain level of confidence based only on survey sampling and the laws of probability. Comparisons with both sales and collection data, however, indicate that key survey estimates are actually quite accurate. Nevertheless, in the interest of full methodological disclosure, we present a great many margins of sampling error, mainly in appendices.

First we describe our procedures for estimating oil consumption and disposal from survey responses, including margins of sampling error for estimates reported in Section 3.

**Measurement of Oil Consumed**

**Consumption by DIYers**

The survey asked DIYers about the number of household vehicles for which they changed oil, the number of oil changes for each vehicle in the survey reference year (2000–01), and the amount of new oil they placed in the vehicle at oil changes. We summed the number of DIY oil changes over all vehicles and, weighting the data to project to the January 2004 population, estimated the number of DIY changes statewide in 2003–04: 14.22 million (13.27, 15.23 is the margin of sampling error). The number of oil changes per DIY household ranged from 0 to 60 in the sample. Statewide, DIYers changed oil on average 6.75 times in 2003–04 (6.30, 7.23).

We multiplied the number of changes for each vehicle times the amount of new oil placed in the vehicle when oil is changed to obtain total oil consumed at changes for each vehicle. Then we summed these quantities over vehicles to obtain DIY oil consumption at changes for each respondent.

We did the same for oil added between changes. We multiplied what DIYers said they typically added between oil changes to each vehicle times the number of changes they reported for that vehicle. We then summed over vehicles, yielding an estimate of 1.75 million gallons added between oil changes for DIY households (1.47, 2.09). (This estimate includes only own-household oil added between changes. No oil that might have been added by STMs between changes to vehicles belonging to other people is included.)

We made corrections to the statewide survey data. We included oil changed by STMs, which was not included in the figures published in the CIWMB 2002 report *Initial Results*. We took into account oil remaining in filters and recalculated the estimates in *Initial Results*, page 22, where we had estimated consumption of 20.8 million gallons for 2000–01. As noted, the new survey-based estimate of consumption for 2000–01 is 30.71 million gallons. Projecting the estimate of total consumption in 2000–01 onto the number of households in California on January 1, 2004, yields the estimate of 31.41 million gallons (23.47, 42.04).
Consumption by STMs

The number of oil changes by STMs was computed from their reported frequency of such work, ranging from every day to once a year, and the number of vehicles they said they changed oil for on a typical oil-changing day. Most STMs in the statewide survey changed oil for only one vehicle on a typical STM day, but a few changed more, up to seven per STM day among STMs we interviewed. Multiplying the number of days times the number of vehicles changed on a typical day yields the estimated total number of oil changes carried out by STMs per year.

This figure ranged from one to 625 in the sample data. Statewide, we estimate 11.1 million STM oil changes in 2003–04 (5.7, 21.7). The margin of sampling error is wide because it is based on 111 STMS, a relatively small number, and because the number of changes carried out varies enormously among STMs. It is asymmetric because the distribution of number of STM oil changes per year is extremely skewed, with half in the range 0–7 and a few values greater than 50, into hundreds of changes per year.

We did not ask STMs whether they added oil to clients’ vehicles between changes; we assume they did not. We also did not try to get STMs to tell us directly how much oil they consumed per oil change, so we used the all-DIYer average to estimate the oil consumption of STMs. We estimated the average amount of oil consumed per DIY oil change, over all vehicles and DIYers, at 4.71 quarts. We multiplied this all-DIYer mean oil consumed per change times the estimated number of STM oil changes carried out over the preceding year by each STM to estimate the amount of oil consumed by STMs during their oil changes, then we summed across all STMs to estimate statewide total STM oil and average oil consumed per STM.

Oil Consumption, Use, and Disposal

Oil Lost During Driving and Not Recoverable

Not a great deal is known about oil recovery from motor vehicles. A study conducted for the CIWMB in 1996 referred to an earlier study, conducted in the 1970s, that estimated that 43 percent of oil placed in engines was lost “due to leakage or combustion.” Because of improvements in vehicles, this figure is probably too high for the current DIY vehicle fleet.

The CIWMB study provides collected data about oil recovery from rental car agencies. According to this report, “approximately 80 percent ± 14 percent of the crankcase oil added to a rental car is recovered for recycle.” In other words, an estimated 20 percent of oil ± 14 percent was lost for one reason or another. This confidence interval includes both the 18.8 percent estimated lost during use and the total 31 percent not available for collection estimated from the survey. The DIYer fleet includes vehicles that are older and larger than a rental car fleet, so we would expect more oil to be lost from the DIYer fleet than from a rental fleet.

Neither of these studies appears to have taken into account the surprisingly large amount of oil that remains in used oil filters or the oil that remains in new oil bottles.

We assumed that on average, at the time of an oil change, the level of oil in a vehicle’s crankcase is down 15 percent below the nominal “full.” We assume DIYers put the manufacturer’s recommended replacement volume into the vehicle when they change oil. The 15 percent is oil lost in driving—leakage and burn-off—between the last time oil was added to the vehicle and the time of the oil change.

The 15 percent assumption accounts roughly for the tendency of vehicle owners to let oil levels drop below completely full preceding an oil change. In our estimation system, this is the largest component of oil lost during driving, accounting for 70 percent of our estimate of total oil lost in...
use in Section 3. We think that 15 percent is a plausible assumption about that part of the oil-consumption process and of the estimation system. However, the estimate of total drained oil available for collection depends significantly on this assumption and is sensitive to it. That in turn affects estimates of how well the state is doing in the collection of oil and how effective local programs are in our estimates for counties in Table 18. Given the importance of this number, CIWMB needs to conduct research to provide a basis for future estimation.

**Other Adjustments to Oil Consumed**

As described in Section 3, we assumed that oil in a new oil container was left in the container at the rate of 1 oz. per quart. This is a plausible assumption that needs additional research. The more oil left in containers, the less oil is available for collection as drained oil, and the greater the importance of collecting the new containers. To be sure, even at 1 oz. per quart, about 1 million gallons of new oil is left in containers per year, so ample incentive to collect the containers is present.

We also reduced the amount of oil that DIYers dispose of at oil changes by 8.4 percent to account for oil remaining in oil filters even after filters are drained. From separate survey questions about oil filters, we estimated the total amount of oil remaining in filters at the time of disposal (see Section 11 and Appendix 11). We adjusted STM oil in the same way. Combining drained oil and residual filter oil yields an estimate of total oil disposed at oil changes by DIYers, including STMs, in 2003–04: 24.44 million gallons (17.95, 33.28).

Of this, 2.22 million gallons (1.63, 3.02) remained in filters; 22.22 million gallons (16.32, 30.26) were disposed as drained oil.

The overall 8.4 percent figure for oil remaining in oil filters is based on laboratory research that systematically examined the amount of oil left in filters. Our choice of a particular rate of residual oil is subject to examination and needs further research in the field. The field tests should measure the amount of oil left in filters actually in use by DIYers and STMs under their actual conditions.

As with other percentages in the estimation system, if more oil is really left in filters, then more oil can be recovered from filters. Less drained oil is potentially collectable, and the existing systems for collection of drained, liquid oil will look better—they will seem to be collecting more of the available drained oil. We discuss the dependence of estimates on assumptions below.

**Other Margins of Sampling Error**

Margins of sampling error for other estimated quantities of oil in Section 3, Table 7:

<table>
<thead>
<tr>
<th>Estimated Gallons and Margins of Sampling Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reused oil</td>
</tr>
<tr>
<td>Oil taken to work</td>
</tr>
<tr>
<td>Oil available for collection</td>
</tr>
<tr>
<td>Oil not collected</td>
</tr>
</tbody>
</table>

The margin of error for the 5.3 percent who dispose of oil by reuse or taking to work is 3.8 to 7.5 percent, while the margin of error for the estimated 540,000 gallons they disposed is 333,000 to 876,000 gallons. Again, this margin of error is wide because of the relatively small number of DIYers who dispose in these ways as well as great variation in the amounts of oil they disposed.
of. The figure is asymmetrical because the distribution of gallons of oil reused or taken to work is skewed.

**Asking About Mode of Disposal**

We asked many specific questions about oil disposal and offered DIYers numerous opportunities to mention other ways of disposal not covered by our predetermined response options. The largest number of attributions of disposal methods came from responses to the following questions:

Q81. Does the oil drain directly onto the street or onto the ground?  
IF YES PROBE: So it doesn’t drain into a container, right?  
1) YES, ON THE STREET  
2) YES, ON THE GROUND (YARD/DIRT)  
3) NO, IT DRAINS INTO A CONTAINER

Q86. I’m going to read you a list of the most common things people do with used oil in your area. You reported changing the oil in household vehicles XX times in the past year [from Q38]. How many of those times have you  
1) filtered or reused it,  
2) kept it in storage,  
3) taken it to the public dump,  
4) buried or poured it on the ground,  
5) poured it into the storm drain,  
6) taken it to a gas station, oil change service, or other collection site,  
7) put it out for curbside pickup, or  
8) taken it to a household hazardous waste facility?  
AT THE END OF THE LIST ASK IF THERE ARE OTHER WAYS AND SPECIFY.

If respondents chose option 6, they were asked to name the collection facility or at least to say what street it was on.

Combining responses about disposal from many questions yields the estimates in Section 3 of disposal of drained oil by various modes used by California DIYers in 2003–04.

**Assumptions, Accuracy of County-Level Estimates, and the Constraint of Reality**

The dependence of State and county-level estimates of oil disposal on the assumptions we had to make about the components of oil consumption raises questions about the accuracy of the estimates. Three major quantities in our estimates depend partly on assumptions: oil lost in driving, oil remaining in new oil containers, and oil remaining in filters.

If our assumptions of the amounts of oil in these channels are too high, the estimated amount of oil disposed in liquid form as drained oil by DIYers will be too low. We will overestimate the effectiveness of oil collection efforts in the state and in counties, and the effectiveness estimates for numbers of counties will be greater than 100 percent—but that is not possible.

If our assumptions about the amounts of oil in these channels are too low, the estimated volume of oil disposed in liquid form will be too high, and we will underestimate the effectiveness of oil collection efforts in the state and in counties. And indeed, some program people think our estimates that 64.1 percent of DIYers dispose improperly or that 63 percent of drained oil available for collection is disposed improperly are indeed too low (Section 3 and this appendix).
Our estimates are constrained by more or less known quantities—total oil consumed by the DIY public and oil collected from the public statewide and in counties. Accurate data from local programs on oil collected in their jurisdictions provides a partial constraint on free-floating assumptions. If the collection effectiveness percentage for a county is greater than 100 percent (we would suggest greater than 90 percent), either DIY disposal of oil was underestimated or collection of oil from DIYers was overestimated.

In Table 18 (Section 5), Sierra county has a collection effectiveness percentage of 99.7. Is this likely? Probably not. There are three main possibilities:

- Our estimation system might have underestimated the probability of DIY or STM or the oil they disposed in some counties, perhaps by systematically overestimating volumes of oil that went into other channels, as above. If that were the case, however, then total improper disposal would be even higher than we have estimated.

- Our estimation system might have produced inaccurate estimates for some counties because of sampling error. (See Appendix 2, “Potential Sampling and Non-Sampling Error”.) The average margin of error for Sierra County is $±0.105$ or 10.5 percent. Sampling error could easily explain Sierra County’s improbably high value.

- In counties with small populations and commercial centers frequently used by residents of adjacent rural counties, oil collection from DIYers might sometimes run higher than oil disposed by county residents.

- The collection estimations carried out by the Board’s Used Oil Program, starting with block grantee reports, might have overestimated collection by one or more collection sites in these counties.

Estimates of oil collected are very tricky. Errors can crop up in many places; our top candidate for systematic overestimation of oil collected from the DIY public is the fast lube industry. The current rule of thumb of the Used Oil Program allows 5 percent of oil reported by fast lube outfits to be counted as oil received from DIYers. We suspect it is much closer to 1 percent, and this disparity alone could add thousands of gallons to a county’s oil collection estimates.

From the statewide survey, we estimated that 3.48 percent of DIYers who take oil to a collection center (including workplaces) take it to a fast lube outfit (Table 11). But because DIYers who dispose at fast lubes dispose of considerably less oil on average than DIYers who take their oil elsewhere, they dispose of only 1.94 percent of total properly disposed (collected) DIY/STM oil. This is probably because, as Table 11 also shows, high-volume STMs are much less likely to dispose of oil at fast lube establishments than at other kinds of centers. The percentages are different in urban and rural counties: 1.4 percent in counties 0-9.9 percent rural, 6.1 percent in counties 10–100 percent rural.

These percentages from the survey can not give us direct estimates of how much oil is actually collected from DIYers by fast lube operations compared to the total amount of oil such operations collect. But the numbers do indicate how much oil is collected from DIYers by fast lubes as a component of total oil collected in a county or in the state. If the statewide collection data show that more than, say, 2 percent of oil collected from the public is collected by fast lube outfits, that is probably too high.

The Used Oil Program’s data-cleaning effort could check the fast lube percentage of each county’s collected oil. If the fast lube percentage of total oil collected is much greater than 1.4 percent in urban counties, say greater than 3 percent, or much greater than 6.1 percent in rural
counties, it is probably too high. Statewide, the fast lube percentage of total oil collected is 1.94 percent and should be that in the database.

A Way to Correct for the Underestimation of Improper Disposal

In order to overcome the substantial underestimation inherent in surveys on sensitive topics, we build a mathematical estimation model that leverages the relationship between the survey data and the data on oil collected from DIYers provided in CIWMB block grantees’ annual reports.

Contributions of Survey and Collection Data

The survey data give us, uniquely, an estimate of how much oil is lost in driving or changing, how much is drained and disposed by DIYers, how much is improperly disposed, and the distribution of improperly disposed oil across modes of improper disposal. The data also provide an estimate of how much oil is diverted from the stream of collection from the public to other uses, storage, or other modes of disposal (reused as a lubricant or disposed of at workplaces).

CIWMB data on volumes of oil collected give us an accounting of how much oil is collected from DIYers overall. From a disposal perspective, this is oil that has been properly disposed. We subtract collected oil from the survey estimate of total oil drained and disposed by DIYers to obtain an estimate of how much disposed oil is uncollected. Uncollected disposed oil that cannot be accounted for in any other way must have been improperly disposed. In this way we obtain an estimate of total improperly disposed oil that is not biased downward by respondents’ unwillingness to reveal their improper disposal.*

Both survey and reports data give us estimates of the distribution of properly disposed (collected) oil over the various modes and facilities. We can compare these two distributions. If they are similar, that bolsters our confidence in the survey data on proper modes of disposal. This comparison is carried out in Section 3, Table 8. The survey and reports data on proper disposal are indeed very close in their percentage distributions over three main modes of disposal or kinds of facilities for collection.

A few DIYers, probably less than one-half of one percent, burn some of their used oil—just to get rid of it or to burn it in a modified space heater or start fires with it. They may dispose of 40,000 or so gallons in this way, but there are far too few of them for reliable estimation; therefore, we omit them from further analysis. Like other reusers, DIYers who burn used oil are removing it from the collection system. They have a reason for reusing it in this manner, but the reuse injects toxic oil smoke into the air, unlike other reuses for lubrication.

Estimating the Volume of Improperly Disposed Oil

With data from the survey, we begin with the estimated amount of DIY oil available for collection at oil changes. We calculate this quantity by estimating total oil disposed as drained oil at oil changes. We then subtract oil that is removed from the system of oil collection from the public by reuse or by disposing of oil at a workplace. The first set of numbers below replicates and establishes a notation for the values shown in Section 3, Table 7.

* DIYers also store oil. We estimate that 12.3 percent of DIYers stored 1.2 million gallons of used oil in 2003-2004 and still had it in storage at the time of the interview. We assumed that they stored a similar amount in 1999–2000 so that storage had no net effect on oil used in 2000–2001 (projected forward to 2003–04). DIYers who reuse or burn oil may draw on these stocks, which are also a source of the “midnight oil” dropped off at collection centers from time to time, to their consternation.
\[ A_s \] Oil available for collection, estimated from survey.

\[ D_s \] Total oil drained and disposed by DIYers at changes, estimated from survey (22.22 million gallons).

\[ U_s \] Oil reused, estimated from survey (0.18 million gallons).

\[ W_s \] Oil disposed of at a workplace, estimated from survey (0.36 million gallons)

\[ (1) \quad A_s = D_s - U_s - W_s = 5.3671603 \text{ million gallons} \]

The second basic quantity is from CIWMB block grantees: the amount of oil they reported collected from the public in 2003–04, as adjusted by CIWMB Used Oil Program staff. (We exclude oil reported collected by marinas, airports, and agricultural programs. Such programs collect so little oil from DIY household vehicles relative to the oil they collect from other sources that including their oil would introduce significant error into this analysis of DIY oil collection.) We use this oil-collected figure together with the survey-estimated oil available for collection to estimate the amount of oil that is improperly disposed.

\[ C_r \] Oil collected by block grantees, from their reports: 7.85 million gallons.

\[ I_{rs} \] Improperly disposed oil, the difference between oil available for collection and oil actually collected.

\[ (2) \quad I_{rs} = A_s - C_r \]

\[ I_{rs} = 21.683475 - 7.845602 \]
\[ I_{rs} = 13.837873 \]

**Estimating What the Proportion of Improper Disposers Must Be to Produce the Volume of Uncollected Oil**

We know that any survey will underestimate socially undesirable behavior. Applying only the sampling weights to the statewide survey data, we obtain the estimate that 12.2 percent or 0.122 of DIYers dispose improperly, but we know that this is too low. What is a better estimate of this proportion?

A better estimate of the proportion of DIYers who dispose improperly is the proportion \( P_i \) that would have to dispose improperly to generate the volume of improperly disposed/uncollected oil estimated above at (2). This proportion can be estimated by partitioning total improperly disposed oil (\( I_{rs} \)) into two parts.

The first part is the volume of oil that we estimate from the survey responses was improperly disposed, \( I_s \). We know this is an underestimate, but in any case, it constitutes part of the oil that must be attributed to improper disposers.

The second part of total improperly disposed oil is some portion of the volume of oil that is alleged by survey respondents to be properly disposed (\( R_s \)). What portion? The proportion in addition to the survey-estimated proportion of improper disposers necessary to bring total improperly disposed oil up to the total improperly disposed oil estimated at (2) above. This proportion must be the difference between the actual proportion of improper disposers in the
population of DIYers ($P_i$) and the survey-estimated proportion of improper disposers ($p_{is}$). This reasoning yields equation (3).

$$P_i$$ Proportion of improper disposers in the population of DIY households.

$$I_s$$ Improperly disposed oil, estimated from survey.

$$R_s$$ Properly disposed oil, estimated from survey.

$$p_{is}$$ Proportion improper disposers, estimated from unreweighted survey data.

(3) $$I_{rs} = I_s + (P_i - p_{is})R_s$$

In words, the total amount of improperly disposed oil equals the amount of improperly disposed oil admitted by DIYers plus a fraction of the oil they claimed was properly disposed. The fraction is the difference between the proportion of improper disposers in the DIYer population and the survey-estimated (that is, admitted) proportion of improper disposers. Because we have already estimated $I_{rs}$ at (2), we can solve (3) for $P_i$, the desired estimate of the population proportion of DIYers who are improper disposers.

Subtract $I_s$ from both sides:

$$I_{rs} - I_s = (P_i - p_{is})R_s$$

Divide both sides by $R_s$:

$$\frac{I_{rs} - I_s}{R_s} = P_i - p_{is}$$

Add $p_{is}$ to both sides:

(4) $$\frac{I_{rs} - I_s}{R_s} + p_{is} = P_i$$

In other words, the desired estimate of the population proportion of improper disposers is the survey estimated proportion plus a fraction defined by the ratio of the difference between total and survey-estimated improperly disposed oil to survey-estimated properly disposed oil. All of the needed quantities are available except $I_s$.

We know that $I_s$ estimated directly from the survey responses will be underestimated, so instead we obtain $I_s$ by subtraction. $D_s$ (total oil drained and disposed as liquid oil at oil changes) must equal $I_s + R_s + U_s + W_s$. Therefore

(5) $$I_s = D_s - R_s - U_s - W_s$$

In other words, we subtract oil that is properly disposed, reused, or taken to work from total drained and disposed oil $D_s$ to obtain an estimate of total oil improperly disposed from the survey. From the unreweighted survey responses we estimate that properly disposed oil $R_s = 16.316315$ million gallons.

So:

$$I_s = 22.223448 - 16.316315 - .18492301 - .35504973$$

$$I_s = 5.3671603$$ million gallons

From the survey responses we estimate $p_{is} = 0.12170795$. 

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Finally, inserting values in equation (4),

\[ P_i = \frac{(13.837873 - 5.3671603)}{16.316315} + 0.12170795 \]

\[ P_i = 0.64086396 \text{ or } 64.1 \text{ percent} \]

We estimate that 64.1 percent of DIYers were improper disposers in 2003–04, ± 6.2 percent.

**Weighting Observations to Reproduce the Estimated Proportion of Improper Disposers**

With a much more accurate estimated proportion \( P_i \) of improper disposers, we can reweight the survey data in order to replicate \( P_i \) and related quantities such as the volume of oil improperly disposed directly from it. Specifically, following standard practice, we reweight survey-classified improper disposers by multiplying their sampling weights by the inverse of the sampling ratio of the population they represent to the population they should represent according to \( P_i \). We reweight survey-classified proper disposers by multiplying their sampling weights by the inverse of the sampling ratio of the population they represent to the population they should represent according to \( 1 - P_i \).

Definitions and calculations:

- \( n_{is} \) Number of improper disposers estimated from the statewide survey.
  \( = p_{is} \times \) estimated number of DIY households in California on January 1, 2004
  \( = 0.12170795 \times 2,106,040 \)
  \( = 256,322 \)

- \( N_i \) Number of improper disposers in the population of DIY households.
  \( = P_i \times \) estimated number of DIY households in California
  \( = 0.64086396 \times 2,106,040 \)
  \( = 1,349,685 \)

- \( \text{InvSR}_i \) Inverse of sampling ratio of \( n_{is} \) to \( N_i \).
  \( = \frac{N_i}{n_{is}} \)
  \( = \frac{1,349,685}{256,322} \)
  \( = 5.2655839 \)

- \( n_{ps} \) Number of proper disposers estimated from survey.
  \( = (1 - p_{is}) \times \) estimated number of DIY households in California
  \( = 0.87829205 \times 2,106,040 \)
  \( = 1,849,718 \)

- \( N_p \) Number of proper disposers in population of DIY households
  \( = (1 - P_i) \times \) estimated number of DIY households in California
  \( = 0.35913604 \times 2,106,040 \)
  \( = 756,355 \)

- \( \text{InvSR}_p \) inverse of sampling ratio of \( n_{ps} \) to \( N_p \)
  \( = \frac{N_p}{n_{ps}} \)
If a DIYer was classified in the survey as an improper disposer, we adjusted that respondent’s sampling weight by multiplying by $\text{InvSR}_i = 5.2655839$.

If a DIYer was not classified in the survey as an improper disposer and the classification was not missing, we adjusted the respondent’s sampling weight by multiplying by the inverse of $\text{SR}_p = 0.40890287$.

In effect, we increase the weights of the 12.2 percent improper disposers estimated directly from the survey responses so that they stand for the 64.1 percent improper disposers estimated by linking survey and reports data, and we decrease the weights of the 87.8 percent survey-estimated proper disposers to make them stand for the more accurate estimate of 35.9 percent proper disposers.

The new weights reproduce the estimated proportion of improper disposers $P_i = 0.641$ directly from the survey data, adjusting for survey nonparticipation, nonresponse, and response bias among improper disposers. Then we use the new weight to estimate other quantities that are affected by these biases, in particular volumes of improperly disposed oil and probability of improper disposal.

### Proportional Allocation of Oil to Modes of Improper Disposal

In Section 3, Table 9, we want to report volumes of oil disposed improperly by each of three modes of improper disposal—on the ground, to drains, and to the trash—more accurately than we can directly from the survey responses because the latter severely underestimate actual volumes of improperly disposed oil. To do this we allocate total improperly disposed oil $I_{rs}$ to these three modes in proportion to their shares of the improperly disposed oil estimated by the survey responses.

We calculate that the proportion each of these volumes constitutes of the sum of the volumes; these (multiplied by 100) are the percentages given in Section 3, Table 9. Then we multiply the proportions times the estimated total improperly disposed oil $I_{rs}$ to obtain the estimated oil disposed volumes in Section 3, Table 9 and Table 10.

- $I_{gs}$ Volume of improperly disposed oil disposed to ground, estimated from survey responses.
- $I_{ds}$ Volume of improperly disposed oil disposed to drains, estimated from survey responses.
- $I_{ts}$ Volume of improperly disposed oil disposed to trash, estimated from survey responses.
- $p_{gs}$ Proportion of the sum of the improperly disposed oil volumes disposed to ground, estimated from survey responses.

$$p_{gs} = \frac{I_{gs}}{I_{gs} + I_{ds} + I_{ts}}$$

and similarly for $p_{ds}$: Proportion of the sum of the improperly disposed oil volumes disposed to drains, estimated from survey responses.
Proportion of the sum of the improperly disposed oil volumes disposed in trash, estimated from survey responses.

Then we multiply the estimated proportion disposed by each mode times the previously estimated improperly disposed oil total (uncollected oil) $I_{rs}$, to obtain new estimates of the volumes of oil disposed in each improper mode. For example:

$V_{grs} = P_{gs} I_{rs}$

and so on for oil disposed in drains and in trash.

---

**Appendix 4:**

**Estimating High-Volume Oil Changing and STM Share of Improperly Disposed Oil**

This appendix provides additional data analysis and detailed information about estimates in Section 4.

**Total Oil Disposed at Oil Changes by STMs and Other DIYers**

The percentage of shade-tree mechanics (STM) among all do-it-yourselfers (DIY) is 16.6; the margin of sampling error for this percentage is 13.5 to 20.3 percent. (Margins of sampling error for percentages this close to zero are typically somewhat asymmetric unless sample size is very large.)*

Of the STMs, 10.7 percent are also employed as mechanics, with a margin of sampling error from 5.5 to 20.1 percent. They were classified as STMs because they do “side jobs” outside of their employment. STMs employed as mechanics include some who are also high-volume STMs. Their identification as STMs is not, from the survey responses, the result of their regular employment as mechanics.

Section 4 includes Table 13, Estimated Oil Disposed at Oil Changes by STMs and Other DIYers. Because STMs vary so much in the amount of oil they dispose of and the sample contains relatively few STMs, the estimates of total oil disposed by STMs and all DIYers have large margins of sampling error. The estimate for other DIYers is reasonably precise (column 4).

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* Margins of error in this report are 95 percent confidence intervals, also known as margins of sampling error. Taking into account only sampling error, we can be 95 percent confident that the true population value of the statistic lies within the interval. See Glossary of Terms and Appendix 3 for further discussion of error, reliability, and overall quality of estimates from the statewide survey.
Very-High-Volume DIY Oil Changing

Large Volumes of DIY Oil Are Disposed by Small Numbers of High-Volume DIYers

We can see the rarity of the very-high-volume DIYers in the whole sample distribution of oil disposed during oil changes (filter oil plus drained oil) in Figure 15. The distribution is extremely skewed. Eighty percent of DIYers are in the first, highest bar of Figure 15. The width of each bar is 10 gallons: this 80 percent disposed of 0–10 gallons of oil in 2003–04. The other 20 percent of DIYers are spread out with ever greater rarity into the range of dozens and hundreds of oil changes and gallons of oil disposed.

Skewed data like those in Figure 15 are often transformed mathematically in order to see relationships and facilitate analysis. Figure 16 shows the same data, transformed into logarithms to the base 10 (see Glossary of Terms). In this display, each labeled point on the horizontal axis represents a ten-fold increase in oil consumed. This distribution gives us more detail at the lower values and is much more symmetrical, and therefore better suited for some statistical analyses.

The middle half of DIYers dispose of between 3.1 and 10.1 gallons. The typical DIYer (the middle or median one) disposes of 5.8 gallons. Mean disposal is 11.6 gallons, pulled up by the few STMs at the high end of the scale who dispose of dozens or hundreds of gallons per year.

Figure 15. Total Oil Disposed by DIYers in Oil Changes, 2003–04

Width of bars = 10 gallons. One observation with more than 600 gallons omitted.
High-Volume Oil Changing—Relation to Income

With reference to Section 4, Table 14, Average Number of STM Oil Changes and Disposed Oil, by Income: 17.7 percent of respondents refused to disclose their household income. So as not to lose so many observations when we looked at relationships with income, we imputed household income for the missing observations. We did this by computing the linear regression of income category (1 for less than $15,000; up to 7 for $100,000 or more) as a function of female, U.S.-born, proportion rural of county of residence, years lived in U.S., level of education, Hispanic, African-American, Asian, age less than 30, and age 65 or more. These variables accounted for 28 percent of the variance in reported income ($R^2 = .28$). Then, using the estimated regression coefficients, we computed predicted values of income from these characteristics for the respondents whose income data were missing. The imputed values were used to classify the missing-data respondents by income in Table 14.

Estimating Improper Disposal Volumes of STMs and Other DIYers

As we did in Section 3, we combine in Section 4 survey estimates and data on oil collected from block grantees’ annual reports to obtain more accurate estimates of rates of improper disposal and, in Table 17, volumes of improperly disposed drained oil.

We have too few interviews with non-U.S.-born STMs for reliable estimation (only 12), and patterns of item nonresponse in those interviews suggested especially high levels of unwillingness to divulge secrets of used oil volume and disposal. Therefore, we assumed that the rate of STM activity and the volume of oil improperly disposed is the same for U.S.-born and non-U.S.-born STMs, and we calculated the volume of oil improperly disposed by non-U.S.-born STMs and other DIYers under those assumptions, as follows.
Re-Estimate Numbers of Non-U.S.-Born STMs and Other DIYers

1. We increased the proportion STM of non-U.S.-born DIYers to the U.S.-born level, from .09 to .19, and calculated the number of households that would imply. In the same way, we decreased the number of households classified as non-U.S.-born non-STMs (“other DIYers”).

Estimate Oil Improperly Disposed by Each Group from Survey

2. We multiplied mean improperly disposed gallons of U.S.-born STMs directly estimated from the survey (24.42 gallons) times the newly estimated number of non-U.S.-born STM households to obtain the estimated total gallons of improperly disposed oil for non-U.S.-born STMs.

3. For other non-U.S. born DIYers (non-STMs), we estimated total gallons of improperly disposed oil by multiplying average gallons, estimated directly from the survey, times the newly estimated number of non-U.S.-born non-STMs.

4. For U.S.-born DIYers—STMs and non-STMs—we estimated total gallons of improperly disposed oil directly from survey responses to questions about disposal. We multiplied the survey-estimated mean improperly disposed oil times the estimated total populations of these groups in order to avoid losing information because of missing data on improper disposal.

Calculate Percentage of Improperly Disposed Oil Accounted for by Each Group

5. For each group, we calculated the percentage the group’s oil constituted of the sum of the total oil improperly disposed by all four groups. These are the percentages in Section 4, Table 17, column 3.

Re-Estimate Total Oil Improperly Disposed by Each Group, Adjusted by Known Total Improperly Disposed Oil

6. Direct survey estimates of improperly disposed oil are underestimates. We estimated in Section 3 that 13.84 million gallons of oil were improperly disposed in 2003–04. We re-estimated oil improperly disposed by each group by apportioning 13.84 million gallons over the groups in proportion to the survey-estimated group percentages, multiplying the group percentages (item 5 above) times 13.84. This yields estimated millions of gallons of oil for each group in Section 4, Table 17, column 2.

Estimate Average Oil Improperly Disposed by Each Group

7. We estimated average oil improperly disposed by each group by dividing the group’s total improperly disposed oil (item 6) by the group’s estimated population (item 1 above for non-U.S.-born; estimated directly from the survey for U.S.-born). This yields the averages shown in Section 4, Table 17, column 4.

Assumptions

The accuracy of these estimates rests on several assumptions: (1) non-U.S.-born DIYers are STMs at the same rate as U.S.-born DIYers; (2) on average, non-U.S.-born STMs dispose of the same amount of oil improperly as U.S.-born STMs; (3) other than non-U.S.-born STMs, whom we have accounted for by assumption, the groups participated in the survey to the same extent and biased their improper-disposal responses downward to the same degree.

These assumptions are probably not precisely true, but they may be close enough. What makes the resulting estimates in Section 4, Table 17, at least plausible is that they have been adjusted in a reasonable way for the underestimation of improperly disposed oil in the survey. We know from
Section 3 the total volume of oil improperly disposed in 2003–04. That known total permits us to correct for systematic underparticipation by improper disposers and underreporting of improper disposal by those who did participate in the survey. These components of downward bias are by far the biggest sources of error in the estimation of oil improperly disposed by each group.

Appendix 5:
Estimating Total Oil Disposed and Oil Collected Curbside, by County

This appendix explains and validates ways of estimating curbside collection and collection through collection centers. It also considers error in survey estimation and in block grantees’ reporting of used oil collection data. Most section headings follow similar section headings in Section 5.

Estimating How Much Oil Is Disposed by DIYers in Counties

We estimated the number of DIY households and STMs in each county as a function of many variables, applying coefficients estimated from the survey data to the 5-percent sample of the 2000 census, as explained in Section 2, “Where Are the DIYers?”, and Appendix 2. The percentage who are STMs does not change much from urban to rural counties, whether taken as a percentage of DIYers (13-17 percent) or as a percentage of all households (3-4 percent). It does change depending on many other characteristics of county populations.

Oil Changes

We estimated the number of oil changes carried out by DIY households as a function of household income, age in years, and number of vehicles available; \( R^2 = .2908 \).

```
Linear regression

Number of obs = 730
F( 3, 726) = 47.46
Prob > F = 0.0000
R-squared = 0.2908
Root MSE = 4.488

------------------------------------------------------------------------------
|        Robust
nchanges | Coef.   Std. Err.  t    P>|t|   Beta
-------------+----------------------------------------------------------------
incpute |  0.2298111   0.1751319   1.31  0.190  .056516
age1 |  -0.0531746   0.0123206  -4.32  0.000  -.1493809
nvehicle |  2.138196   0.2127726  10.05  0.000  .5033956
_cons |  3.11927   0.6954059   4.49  0.000

------------------------------------------------------------------------------
```

Next we estimated the number of STM oil changes undertaken by STMs in each county. The mean number of STM oil changes per STM declines rapidly with proportion rural—STMs in urban counties do more STM oil changing than STMs in rural counties:

- 39.4 STM oil changes per year, on the average, in counties that are 0–9.9 percent rural (N = 52)
- 9.7 in counties that are 10–29.9 percent rural (N=40); and
- 6.8 in counties that are 30–100 percent rural (N=19).
We estimated the logarithm of the mean number of STM oil changes undertaken by a STM as a function of household income (reciprocal squared); proportion rural of the county; and whether the household included a mechanic (of any type) or a person with an occupation that involved working outdoors or with machinery or tools; \( R^2 = .1929. \)

**Linear regression**

|                     | Coef. | Std. Err. | t       | P>|t| | Beta |
|---------------------|-------|-----------|---------|-----|------|
| incrscsq            | 2.504611 | .794298  | 3.15    | 0.002 | .3154401 |
| prural              | -1.321328 | .7119282 | -1.86   | 0.066 | -.1195676 |
| mechanic            | 1.427008 | .3689803 | 3.87    | 0.000 | .2691979 |
| tools               | 0.4484943 | .3607531 | 1.24    | 0.217 | .1488763 |
| _cons               | 1.55095 | .2205318 | 7.03    | 0.000 | . |

- **Number of obs = 108**
- \( F(4, 103) = 8.13 \)
- \( \text{Prob > } F = 0.0000 \)
- \( R^2 = 0.1929 \)
- \( \text{Root MSE} = 1.3167 \)

---

**Amount of Oil Per Change**

We estimated average gallons of oil drained and disposed per oil change by DIY households as a function of proportion rural of county of residence, age, income, and whether the household included a mechanic. Other variables for which we might have expected a clear relationship, such as truck ownership, were not clearly related to average gallons per oil change, probably because variables related to truck ownership such as proportion rural are also in the model.

**Linear regression**

|                     | Coef. | Std. Err. | t       | P>|t| | Beta |
|---------------------|-------|-----------|---------|-----|------|
| prural              | 0.1428215 | .0508479 | 2.81    | 0.005 | .0998256 |
| age1                | 0.0027373 | .0006626 | 4.13    | 0.000 | .1882043 |
| incpute             | 0.0190664 | .0062694 | 3.04    | 0.002 | .1147578 |
| mechanic            | 0.157782 | .051117 | 3.09    | 0.002 | .1414266 |
| _cons               | 0.6733722 | .0380671 | 17.69   | 0.000 | . |

- **Number of obs = 730**
- \( F(4, 725) = 9.69 \)
- \( \text{Prob > } F = 0.0000 \)
- \( R^2 = 0.0792 \)
- \( \text{Root MSE} = 0.20909 \)

---

Estimating average gallons drained and disposed per STM oil change poses a special problem because the statewide survey did not attempt to get data from STMs about the amount of oil per change in their STM work. The estimate of DIY household oil changing above is not applicable because there is no reason to expect the characteristics of DIY households to affect the amount of oil per STM oil change.

It is plausible that the amount of oil disposed per STM oil change increases in rural counties, where truck ownership is more common. Therefore, we re-estimated average household gallons per oil change as a function simply of proportion rural (for households without motorcycles, because motorcycle owners are, we reasoned, more likely to change their cycle oil themselves than have a STM do it). This model (below) produces an estimate that ranges from 3.5 quarts in the most urban counties to a little over 1 gallon per change in the most rural counties. The \( R^2 \) for this model is low (.0111). The effect of this is to make estimates of average volume per oil change for STMs closer to the mean with less variability than there should be. Average volume
disposed per oil change for a high-average-volume STM—say, someone who works only on trucks—will be somewhat underestimated; for low-average-volume STMs, average volume per change will be overestimated. However, when the estimates of total oil changed are summed for STMs and DIYers for a whole county, this is not likely to make an appreciable difference.

We used the estimated values from this model to stand in for the amount of oil per STM oil change, depending on the urban-rural makeup of a STM’s county of residence.

Linear regression
(households with no motorcycles)

|                | Coef. | Std. Err. | t     | P>|t| | Beta   |
|----------------|-------|-----------|-------|------|--------|
| avhhgal        | 0.1526126 | 0.0524097 | 2.91  | 0.004 | 0.1053311 |
| _cons          | 0.8630156 | 0.0115784 | 74.54 | 0.000 | 0.000   |

Computing Total Oil Disposed

Households in the 5-percent PUMS data had already been estimated and marked as DIY and STM, or not, in the process described in Appendix 2. For each estimated DIY household and STM in the PUMS data we estimated the number of oil changes they undertook, applying the coefficients from the survey regression equations above, and the amount of oil per change of both types. For DIY households in the PUMS data, the estimated total number of oil changes—13.4 million—is close to the number estimated from survey data—14.2 million. For STMs in the PUMS data, the estimated total number of oil changes was only about 40 percent of the 11.0 million estimated from the survey, so a correction factor was applied to make the PUMS estimate approximately equal the survey estimate. This is the least reliable link of these estimates, relying as it does on a relatively small number of interviews with STMs and a weak model of STM oil per change.

We multiplied estimated numbers of STM and DIY oil changes times the appropriate mean gallons disposed per change, then summed DIY and STM oil to estimate total oil disposed by each household in 2000–01. To estimate the amount of oil disposed per county, we added the total oil disposed by all the sample households in each county. Finally, we incremented each county’s disposed oil by the increase in number of households in the county from 2000 to January 1, 2004.

Oil Collected and Disposed, by County

Here we check our estimation methods by showing the relationship between estimated oil disposed by DIYers and the estimated number of DIY households, by county.

Figure 17 shows that the survey-plus-PUMS estimates of total oil disposed by DIYers in 2003–04 on the vertical axis are very closely related to the survey-plus-PUMS estimates of the number of DIY and STM households per county, on the horizontal ($R^2 = .9939$). Deviations of counties from the best-fitting line reflect variation between counties in the estimated volume of oil disposed by their DIY/STM households; this variation is a function of the income, age, vehicles available, and other relevant characteristics of county populations. In its upper range the vertical axis involves thousands and millions of gallons of oil, so deviations from the best-fitting line that look small can involve large differences in the amounts of oil generated and disposed.
Other potential predictors of disposed oil such as total number of households and total population in counties yield less accurate predictions of the number of DIY households and STMs or the amount of oil they dispose of.

The line in Figure 17, estimated by linear regression, represents the predicted average gallons of oil collected per year in counties, for any given number of DIY households, including STMs. The slope of this line is 1.03: on average over the counties, we find 1.03 percent increase in oil disposed by DIYers for every 1 percent increase in number of DIY households. The fact that the slope is significantly greater than 1.0 ($p < .0005$) means that more oil is disposed per DIY household in the largest counties, on average. This is because STM oil changing occurs at higher volumes in the largest and most urban counties and because household income is higher in urban counties and income affects number of vehicles, number of oil changes, and volume of oil disposed.

**Figure 17. Oil Disposed by Estimated DIY and STM Households in California Counties, 2003–04**

*Notes to Figure 17:*
1) Estimated gallons of oil disposed and number of DIY households are presented as logarithmic transformations of the raw numbers to make it easier to see the relationship. This is a standard transformation for data that are highly skewed, with many small values and a few large ones, such as these data for California counties. Increments of 1.0 on a logarithmic scale represent ten-fold increases in the variables.
2) Circles are drawn in proportion to the number of DIY vehicles, with Los Angeles County at the upper right and Alpine County at the lower left.
3) The best-fitting line was estimated by linear regression. Est $Y = .7195 + 1.0298X$, $R^2 = .9939$.

The very good fit of the counties to the line helps to validate both estimation methods and suggests that this relationship is approximately constant over the whole range of the estimated number of DIY households by county, from fewer than 10,000 in 19 mountain and northern valley counties (and Marin) to 437,000 in Los Angeles (Section 2, Table 5).
As a further check on our disposed-oil estimates from survey and census data, we obtained a database of motor vehicle registration data prepared from DMV records by the California Energy Commission and the California Air Resources Board.* These data, which included ownership information, were used to estimate the number of registered DIY vehicles in each county. Trailers and vehicles owned by businesses and government were excluded. Estimated disposed oil was also fairly closely related to the number of DIY vehicles per county estimated in this manner, but it is more closely related to the estimates of DIY households developed in this report and displayed in Figure 17.

**Error and Error Correction in Estimation and Reporting**

Errors can enter the estimation process in many ways—sampling error in the statewide survey; biases introduced by the estimation method; and reporting and adjustment errors by grantees and the Used Oil Program. Estimates for individual counties may not be accurate. Estimation of DIY, STM, and oil disposal and collection by county are still in development.

With respect to sampling error, another statewide survey with a larger sample, special sampling of STMs, and improved methodology as recommended in Appendix 13 would provide more accurate estimates.

Unknown but probably minor error may result from the use of estimation components from different years. The statewide survey was undertaken in July 2001; respondents’ reports of their oil changing and disposal referred to the year 2000–01. Estimates project the 2000–01 survey data onto the estimated population on January 1, 2004, and combine them with 2003–04 grantee reports and 2000 census data (for example, proportion rural). Because the year-to-year change in the components of estimation is typically not great, we judge this error to be acceptable.

**Updating Estimates for Future Years**

For counties that make rapid progress in used oil collection from year to year, block grantee reports from 2003–04 and the percentage estimates based on them will become increasingly inaccurate as assessments of program performance as time goes on. However, the estimation models, including the coefficients for the various factors involved, may not change greatly over several years.

Predictions of numbers of DIYers and STMs in counties and the amounts of oil they generate may be replicated for future years using the same methods employed in this report—extending estimates for future years by incrementing the DOF-estimated number of households in counties for those years. In this report we already incremented 2000 census counts of number of households to the DOF estimates for January 1, 2004. The estimates of DIY, STM, and volumes of oil and filters can be updated from year to year with the most current collection figures by county and with estimates of number of households for the January 1 falling in the middle of the reporting periods for collection (July 1–June 30). We recommend that the Used Oil Program carry out this updating.

Updating for population change will not account for rapid changes in the makeup of populations that some counties experience. Proportion rural is an important predictor in our estimation system, and it can change fairly rapidly in rural and semirural counties undergoing rapid urbanization and suburbanization. Household income is also important and can change fairly rapidly over several years—enough to change the DIY and STM behavior of households a bit. For example, the percentage DIY of county households and the volume of oil generated by the

* The help and advice of Gary Occhiuzzo of the CEC were indispensable, and we are grateful for it.
DIY/STM public might both decline several percentage points over a period of 4–6 years. Adjustments of the estimates presented in this report are feasible and might be appropriate.

**Grantees’ Reports**

No doubt most block grantees’ reports are accurate. However, during estimates of filter collection (Section 11) we encountered a county with apparently very high levels of collection. Subsequent checking with a cooperative county used oil specialist revealed inadvertent errors in the number of filters reported collected. Some filters collected by fast lube installers, not from DIYers, were mistakenly attributed to DIYers.

The used oil collection estimates in Section 5, Table 18, imply that Sierra County collected 99.7 percent of the oil disposed in the county. This is probably an instance of unintended error in reporting or attributing too much oil to fast lube outfits or other sources, or of sampling error.

Board staff members presently check the face validity of block grantee reports—for example, comparing amounts collected over time to see if a sudden jump or dip appears in the data. This is good even though it will not catch all errors. In addition, counties that rank especially high or especially low in column 5 of Table 18 and column 4 of Table 19 might be targeted for spot auditing or, at a minimum, asked to review their reports.

Grantees’ reports of DIY oil collected are valuable to used oil personnel in the counties—they might be part of their personal performance evaluations, for example. The structure of the situation, the lack of monitoring, the complexity and ambiguity of these data, the inherently difficult task of separating DIY from non-DIY oil, and in many counties the relatively low priority of data submittals to the state, are likely to lead occasionally to reporting of greater volumes of oil and filter collection from DIYers than is actually the case. Such errors are less likely to be detected if they seem to indicate progress than if they seem to indicate failure.

Counties that rank highest in oil collected as a percent of disposed oil, and counties that indicate the most rapid increases in oil collected, year to year, should be asked to recheck their reports against the raw data. Programs in counties that rank lowest should also recheck their data to ascertain that they did not make mistakes in the opposite direction. All of the block grantees should be made aware of the importance of submitting accurate data.

To secure their attention to data accuracy, the Board might consider conducting occasional problem-oriented spot audits of their reports. They could check the submitted data against the documents on which the data were based, especially for grantees whose submitted data show collection of very high percentages of disposed oil.

Accuracy in these data is essential if the Board and county, city, and regional programs are to make rational use of them to assess the performance of the used oil and filter collection system at all levels. Increased attentiveness to accuracy should go along with increased use of the data.

We have no doubt that the vast majority of the numbers submitted by block grantees to the Used Oil Program are accurate. But data collection is intrinsically subject to error, and reporting must be monitored if a reporting system as a whole is to have integrity.
Appendix 6: Determining Which Collection Method Is Superior

This appendix provides methodology and detailed statistics for Section 6, “Improper Disposal—Which Collection Method Is Superior?”

Impact of Curbside and Center Collection on Improper Disposal

Figure 18 below replicates Figure 9 of Section 6. The graphs are the same except for the margins of sampling error shown here. We repeat Figure 9 to show an example of margins of sampling error for predicted probabilities of improper disposal.

Convenience of taking oil to centers is measured on the horizontal axis from survey responses as 0 = somewhat or very inconvenient, 0.5 = neither convenient nor inconvenient or somewhat convenient, and 1.0 = very convenient. Availability is measured, also on the horizontal axis, as oil collected curbside as a proportion of total oil collected in counties.

The solid line within the shaded area in the graph below estimates the probability of improper disposal for users of collection centers of all types, given the DIYer’s perception of the convenience of taking oil to centers. The shaded area represents the 95 percent confidence interval for the estimated probabilities—that is, their margin of sampling error.

Figure 18. Predicted Probabilities of Improper Disposal and Confidence Intervals for Center Collection and Curbside Collection

The estimated probabilities and the shaded margin of sampling error are obtained from the logistic regression of improper disposal (0,1) on DIYers’ perception of the convenience of
centers, for DIYers who do not use curbside collection—almost always, these are DIYers who do not have curbside collection available to them:

| Imp Disposal | Odds Ratio | Std. Err. | z    | P>|z| | [95% Conf. Interval] |
|--------------|------------|-----------|------|------|----------------------|
| Convenience* | 0.2598114  | 0.0973024 | -3.60| 0.000| .124072 .543065      |

* Of taking oil to a collection center, coded 0=not at all, .5=somewhat, 1=very.

The dashed line estimates the probability of improper disposal, and the outlined area around it indicates the margin of error of the probability estimates, for DIYers who do not take their used oil to collection centers. The probability estimates of the dashed line and its margin or error are computed from the logistic regression of improper disposal on the availability of curbside collection, measured by the proportion of oil collected curbside of all oil collected from the public in a county:

Logistic regression

| Imp Disposal | Odds Ratio | Std. Err. | z    | P>|z| | [95% Conf. Interval] |
|--------------|------------|-----------|------|------|----------------------|
| Availability* | 0.0002958 | 0.0007882 | -3.05| 0.002| .000000159 .0548719 |

* Of curbside collection.

The margin of sampling error is wider for the lower of the two trends on the graph, because it is based on the relatively small number of DIYers who do not use centers (158), while the predictions and sampling error from the first analysis are based on 663 DIYers. In spite of wide margins of error, the difference between the curbside and center predictions of improper disposal is great; the predicted probabilities and their trends are most definitely very different for the two groups in the population of DIYers.

**Prior-Notification Programs**

In a graph not shown here we also plotted estimated probabilities of improper disposal given increasing availability of prior-notification programs. The line for prior-notification programs roughly parallels the line for regular curbside programs in Figure 9 and Figure 18 and drops to zero, as the line for curbside does, but the underlying coefficient is not significantly greater than zero ($p = 0.226$). So in appearance, the effect of prior-notification programs on improper disposal looks the same as the effect of regular curbside collection—but the appearance is not sufficiently anchored in the data for us to be confident that it is really similar to the effect of regular curbside collection, and certainly not sufficiently anchored in the data to detect the difference between the two methods, if any.

Only one county (San Luis Obispo, at 59.3 percent) collected more than 10 percent of its DIY used oil through prior-notification programs. In contrast, 11 counties collected more than 10 percent of their DIY oil with regular curbside pickup. A larger survey and a closer specification
of the kinds of used oil programs available to respondents would be necessary to fully test a hypothesis about difference between the programs. In the meantime, the effect of prior-notification programs appears to be about equal to that of curbside pickup without prior notification.

**The Connection Between Single-Family Dwelling and Age**

Figure 19 shows the predicted probability of living in a single-family dwelling by age in California, estimated from the 2000 census 5 percent PUMS data. The rate of residence in single-family dwellings is much higher among residents 40 and over than among those under 40. This supports the argument in Section 5 that curbside collection is much more likely to be available to older DIYers than to younger ones, because curbside collection is typically available only to residents of single-family dwellings. Age is a good indicator of residence in a single-family dwelling.

**Curbside Pickup and Age**

The rate of use of curbside collection increases steadily from 5.6 percent among DIYers age 18 to 29 to 17.9 percent among DIYers 50 and over (p = .0126). Older DIYers are more than three times as likely to report using curbside collection.

![Figure 19. Probability of Single-Family Dwelling by Age](image)

We trace the predicted use of curbside pickup for used oil by age in Figure 20. The trajectory of curbside pickup by age in urban counties is very similar to that of residence in single-family dwellings. This supports the proposition that curbside collection is available mainly to older DIYers because it is available only to single-family dwellings.

The trajectory of curbside pickup by age for the more rural counties in Figure 20 is essentially the same but at much lower probabilities of curbside collection: curbside pickup is simply much less available in rural counties.
Appendix 8: Technical Detail on Selected Statistics

In Section 8, \( p \)-values in some tables were calculated with various statistical procedures, listed here. If a \( p \)-value is not listed here, it was obtained directly from the crosstabulations presented in Section 8.

Table 21, column 7: \( p = .002 \) via a generalized linear model with Newton-Raphson optimization, of improperly disposed oil (gallons) on age in years, employing the -glm- module in STATA SE 8.2 (StataCorp 2005) with a log link.

Table 24: \( p = .008 \) from logistic regression of improper disposal (0,1) on income (0,1—less than $25,000, $25,000 and over) rather than directly from the crosstabulation shown.

Table 26, column 6: \( p = .0135 \) via linear regression of income on improper disposal.

Table 26, column 7: \( p = .002 \) via a generalized linear model with Newton-Raphson optimization, of improperly disposed oil (gallons) on income (categorical, values 1-6), employing the -glm- module in STATA SE 8.2 (StataCorp 2005) with a log link.

Table 28, column 4: \( p = .1706 \) from crosstabulation of the STM attribute (0,1) and a two-value classification of percent rural of county of residence (0–29 percent, 30–100 percent).

Table 28, column 7: \( p = .040 \) via a generalized linear model with Newton-Raphson optimization, of improperly disposed oil (gallons) on proportion rural of county of residence, using the -glm- module in STATA SE 8.2 (StataCorp 2005) with a log link and gamma distribution.
Appendix 9: Statistical Detail for Best Target Groups

We provide the number of survey respondents for each cell in tables 30–33.

Table 55, Cell Frequencies for Tables 30–33

<table>
<thead>
<tr>
<th>Immigration</th>
<th>18–39</th>
<th>Age</th>
<th>40 and Older</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>STM</td>
<td>Other DIYer</td>
<td>STM</td>
</tr>
<tr>
<td>Not Born in U.S.</td>
<td>78</td>
<td>7</td>
<td>54</td>
<td>5</td>
</tr>
<tr>
<td>Born in U.S.</td>
<td>208</td>
<td>73</td>
<td>282</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>286</td>
<td>80</td>
<td>336</td>
<td>27</td>
</tr>
</tbody>
</table>

In important tables of Section 9, it may be useful to know whether we can be confident that particular differences in percentages used to prioritize target groups for oil collection programs really characterize the populations. Here we present p-values for selected pairs of percentages of improper disposers. Pairs of percentages not evaluated are far from statistical significance. As always, these p-values are probabilities that the data could give rise to the observed difference in percentages due to sampling error alone. See Glossary of Terms.

**p-Values for Differences in Rate of Improper Disposal by Age, STM, and Immigration in Table 30**

**Age 18–39**

**STM effect among DIYers born in the U.S.:** difference between STMs and other DIYers in percentage improperly disposing—78 percent vs. 60 percent, \( p = .0585 \).

**New immigrant effect among other DIYers:** difference between born in U.S., 60 percent, and not born in U.S., 75 percent, \( p = .0993 \). This difference is due to the high improper disposal rate of new immigrants (in U.S. less than 10 years: 80 percent) vs. immigrants in U.S. 15 years or more (65 percent) and U.S.-born (60 percent). For the logistic regression of improper disposal \((0,1)\) on this set of categories (scaled 1, 2, 3), the odds ratio is 0.62, \( p = .0503 \), \( N = 284 \).

**STM effect among all DIYers:** Total row for age 18–39, difference between STM and other DIYer total improper disposal rates, 66 vs. 76 percent, \( p = .2401 \). In this comparison, the STM effect is confounded with the new immigrant effect, which works against detection of the effect of STM work on improper disposal. To detect the STM effect, the analysis has to control for immigrant status (U.S.- and non-U.S.-born), as above.

**Age 40 and older**

**STM effect among DIYers born in U.S.:** difference between STMs and other DIYers, 68 percent to 54 percent, \( p = .4346 \) because of the small \( N = 22 \) older STMs.

**STM effect among all DIYers:** total row, difference between other DIYer and STM total improper disposal rates, 54 vs. 63 percent, \( p = .6459 \).
The p-values in this age group do not in themselves establish that STMs have higher improper
disposal rates than other DIYers because there are too few STMs in the 40-and-older subsample.
Nevertheless, because of the observed higher rates (63 vs. 54 percent for all DIYers, 68 vs. 54
percent for DIYers born in the U.S.) and because of the strong evidence of higher improper
disposal rates among STMs in the younger age group, it is highly likely that STMs in the 40-plus
age group dispose improperly at higher rates than other DIYers as well.

Because the two age groups are independent subsamples, we can combine the p-values for the
STM comparisons by multiplying them: \(0.0585 \times 0.6459 = 0.0378\). Overall, the STM effect is clearly
statistically significant.

**STMs**

**Age effect among U.S.-born STMs**, the difference between younger and older STMs, 78 to 68
percent, \(p = 0.5706\).

**Age effect for all STMs**, difference between 76 percent and 63 percent improper disposal, \(p=
0.6459\).

**Summary—Clearly Supported Differences**

1. Younger immigrants (that is, new immigrants) dispose improperly at a higher rate than
younger non-immigrants (born in U.S.).
2. Younger STMs dispose improperly at a higher rate than other younger DIYers.
3. STMs regardless of age dispose improperly at a higher rate than other DIYers.

**p-Values for Differences in Average Oil Improperly Disposed by Age, STM, and Immigration in Table 32**

**Age 18–39**

**STM effect among U.S.-born:** difference between STMs average 24.9 gallons improperly
disposed oil and other DIYers 1.9: \(p = 0.0397\).

**STM effect among all DIYers** (total row): difference between STMs 24.2 and other DIYers 2.2
average gallons: \(p = 0.0428\).

**Immigrant (mainly new immigrant) effect among other DIYers:** difference between 2.7 and
1.9 mean gallons, \(p = 0.3475\).

**Age 40 and Older**

**STM effect among U.S.-born:** difference between 14.4 and 2.9 mean gallons, \(p = 0.0035\).

**STM effect among all DIYers** (total row): difference between 13.2 and 2.7 mean gallons, \(p =
0.0089\).

**New) immigrant effect among other DIYers:** difference between 1.8 and 2.9 mean gallons, \(p =
0.2062\).

**Born in U.S.**

**Age effect among U.S.-born STMs:** difference between 24.9 and 14.4 mean gallons, \(p = 0.3777\).

In spite of the magnitude of the estimated difference, the small number of 40-plus STMs (22) and
the enormous variation in their volume of used oil make the difference fall short of conventional statistical significance.

**Age effect among U.S.-born other DIYers**: difference between 1.9 and 2.9 mean gallons, \( p = .1692 \).

**Age effect among immigrant other DIYers**: difference between 2.7 and 1.8 mean gallons, \( p = .3688 \). Note that this effect, if any, is in the direction opposite that among U.S.-born other DIYers.

**Summary—Clearly Supported Difference**

Among U.S.-born and among all DIYers, STMs dispose of more oil on average than other DIYers.

**p-Values for Differences in Total Oil Improperly Disposed by Age, STM, and Immigration in Table 33**

**Age 18–39**

**STM effect among younger U.S.-born DIYers**, difference between STMs, 8.1, and other DIYers, 0.9 million gallons, \( p = .1024 \). STMs probably produce more improperly disposed used oil in total than younger U.S.-born other DIYers even though there are far fewer of them.

**STM effect among all younger DIYers**, difference between 8.1 and 0.9 million gallons, \( p = 1411 \).

**Age 40 and Older**

**Immigrant effect?**—among other older DIYers, difference between not born in U.S., 0.2, and born in U.S., 1.5 million gallons, \( p = .0084 \). Older DIY immigrants, not STMs, do not produce more improperly disposed used oil than other older DIYers who are U.S.-born; instead, the latter generate more improperly disposed used oil than the former—partly because other U.S.-born DIYers are far more numerous (estimated 1,095,000 to 492,000), but also because they dispose of more oil on average (Table 32).

**STMs**

**Age effect** among U.S.-born STMs, difference between 18–39, 8.1 million gallons, and 40-and-older, 1.2 million gallons, \( p = .1217 \).

**Summary—Supported Differences**

1. Among U.S. born DIYers, STMs probably dispose of more oil improperly in total than other DIYers do, in spite of being far less numerous.

2. Younger U.S.-born STMs probably dispose of more oil improperly than older STMs.

3. Older U.S.-born other DIYers (non-STMs) dispose of more oil improperly than older other DIYers who are immigrants, partly because they are more numerous, partly because they dispose of more oil on average.
Appendix 10: Testing Findings and Estimating Net Effects on Improper Disposal

Here we use multivariate methods to test findings about groups of DIYers and rate of improper disposal. The analyses support the findings summarized in Section 10.

**What Factors Are Likely to Affect Improper Disposal?**

The method employed below is logistic regression. Logistic regression provides measurement and a test of the effects, considered all at once, of one or more factors on the probability of improper disposal, measured as a (0,1) variable. By accounting for all the main factors simultaneously, we are able to determine which factors exert independent, substantial, and statistically significant effects on improper disposal, net of other factors. The method helps us sort out which factors are determinants of improper disposal and which factors are merely confounded with the real determinants.

Except for years lived in the United States, these potential influences on improper disposal are the same for immigrants and for native-born DIYers. The main factors and our expectations for them are as follows:

<table>
<thead>
<tr>
<th>FACTORS</th>
<th>EXPECTED EFFECT ON IMPROPER DISPOSAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Collection program characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Curbside collection</td>
<td>Reduce improper disposal among older DIYers only</td>
</tr>
<tr>
<td>Prior-notification residential collection</td>
<td>Reduce improper disposal but less than curbside collection</td>
</tr>
<tr>
<td>Convenience of taking oil to a center</td>
<td>Reduce improper disposal</td>
</tr>
<tr>
<td><strong>Media use and information about used oil</strong></td>
<td></td>
</tr>
<tr>
<td>Listen to radio daily</td>
<td>Reduce improper disposal</td>
</tr>
<tr>
<td>Sometimes watch TV (vs. never)</td>
<td>Reduce improper disposal</td>
</tr>
<tr>
<td>Heard of any specific impacts on environment</td>
<td>Reduce improper disposal</td>
</tr>
<tr>
<td><strong>Years of exposure to learning about recycling</strong></td>
<td></td>
</tr>
<tr>
<td>Years lived in United States</td>
<td>Reduce improper disposal</td>
</tr>
<tr>
<td>Age</td>
<td>Reduce improper disposal (but age is confounded with years in U.S., which is probably more important among immigrants)</td>
</tr>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>Uncertain</td>
</tr>
<tr>
<td>Gender</td>
<td>Women more improper disposal because less exposure to culture of cars and maintenance, less learning</td>
</tr>
<tr>
<td>Residence in a rural county</td>
<td>Increase improper disposal because recycling inconvenient, recycling services limited, possibly attitudes less supportive</td>
</tr>
</tbody>
</table>
Education
Reduce improper disposal (but no relationship was found in crosstabulations)

Region
Uncertain

Shade-tree mechanic/high-volume disposer
Change oil for others (STM)
Uncertain (but somewhat higher improper disposal rate in crosstabulation among U.S.-born STMs)

Volume of oil disposed
Uncertain, but important to know whether high-volume DIYers are more or less likely to dispose improperly than low-volume DIYers

We proceed by testing many combinations of factors. It is also important to note which factors do not show any consistent or statistically significant relationship with improper disposal. For both immigrants and U.S.-born DIYers, we find no evidence that the following factors are related to improper disposal across many multivariate analyses of improper disposal, accounting for other factors:

Education
Residence in a rural county
Region (north/south)

Information about specific impacts of used oil might have a modest effect on improper disposal, but it is unclear in the analysis of this section, and it has been omitted from the results presented here. We deal with information about specific impacts in Section 7.

Immigrants and Improper Disposal—Multivariate Analysis

Here we present the results of multivariate logistic regression analyses of the rate of improper disposal as a function of the many possible factors that affect it.

For immigrants, the results in Table 56 show how improper disposal is related to curbside and prior-notification collection, convenience of taking oil to a collection center, knowledge of specific impacts of used oil, years lived in the U.S., gender, watching radio every day, STM work, and amount of oil disposed, adjusting for the effects of all of these factors simultaneously. Among immigrants, all of these factors except listening to radio daily appear to affect improper disposal.

- **Curbside collection.** For immigrants as a whole, the county percentage of DIY oil collected curbside was significantly related to their probability of improper disposal in 2003–04. Over the range of the county proportion of DIY oil collected curbside (from 0 to .78), we estimate that the probability of improper disposal drops by about one-half, a very large change. As with U.S.-born DIYers, immigrant DIYers who reside in counties with robust curbside collection programs have substantially lower rates of improper disposal.

- **Residential prior-notification collection.** Over the range of the county proportion of DIY oil collected at residences with prior notification (0 to .59), the estimated probability of improper disposal drops by three-quarters, also a very large change, and the relationship is statistically significant. At least for immigrants, the reduction of improper disposal achieved with prior-notification programs is just as great as with regular curbside programs.*

* We should not read too much into the strong statistical showing for prior-notification programs, however, because it is anchored by just one county: San Luis Obispo County shows 59.3 percent of its
• **Convenience.** As convenience increases (not at all, somewhat, very), the odds of improper disposal fall. The odds of improper disposal drop by 70 percent from “not at all convenient” to “very convenient” (column 1). As a measure of effect on improper disposal, the estimated probability of improper disposal drops by 0.19 over the range from “not at all convenient” to “very convenient” (column 3), a substantial if not huge effect. The effect of convenience is probably real even though the $p$-value is slightly higher than we would like (0.152, column 2).

• **Knowledge of any specific environmental impact of used oil.** Immigrant DIYers who knew at least one specific impact of used oil were somewhat less likely to dispose improperly.

### Table 56. Improper Disposal of Used Oil—Main Factors for Immigrants

<table>
<thead>
<tr>
<th>Predictor (scale)</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of oil collected by regular curbside pickup in county (0 to .78)</td>
<td>0.029</td>
<td>0.056</td>
<td>-.53</td>
<td>Probable, very large</td>
</tr>
<tr>
<td>Proportion of oil collected by prior notification program in county (0 to .59)</td>
<td>0.000</td>
<td>0.021</td>
<td>-.76</td>
<td>Probable, very large</td>
</tr>
<tr>
<td>Convenient to take oil to a center (0 = not, .5 = somewhat, 1 = very)</td>
<td>0.30</td>
<td>0.152</td>
<td>-.19</td>
<td>Probable, some</td>
</tr>
<tr>
<td>Know any specific environmental impact of used oil</td>
<td>0.37</td>
<td>0.147</td>
<td>-.24</td>
<td>Probable, some</td>
</tr>
<tr>
<td>Years lived in United States (1 = 0–5, 2 = 5–10, 3 = 10–15, 4 = 15 or more)</td>
<td>0.56</td>
<td>0.088</td>
<td>-.37</td>
<td>Probable, large</td>
</tr>
<tr>
<td>Female</td>
<td>0.14</td>
<td>0.044</td>
<td>-.43</td>
<td>Probable, large</td>
</tr>
<tr>
<td>Listen to radio daily (0,1)</td>
<td>0.78</td>
<td>0.718</td>
<td>-.06</td>
<td>Unlikely</td>
</tr>
<tr>
<td>Shade-tree mechanic (0,1)</td>
<td>0.28</td>
<td>0.242</td>
<td>-.31</td>
<td>Possible, large</td>
</tr>
<tr>
<td>Gallons of oil disposed in 2003-2004 (0 to 25.8)</td>
<td>0.87</td>
<td>0.035</td>
<td>-.64</td>
<td>Probable, very large</td>
</tr>
</tbody>
</table>

*An odds ratio close to 1.0 (column 1) and estimated change in probability close to zero (3) with $p$ greater than .10 (column 2) suggests uncertain, negligible, or no relationship. See Glossary of Terms. Because of the small N and the plausibility of key relationships, we have relaxed our $p$ criterion. We regard all of the relationships in this table as probably real in the population of immigrant DIYers except the relationship with listening to radio daily.

Note 1. N = 139, model $p = .0003$

Note 2. Only three respondents never watch TV, so that variable is omitted from this model.

DIY oil collected by prior-notification programs in 2003–04; after that, the next highest county is Merced with 9.9 percent.
• **Years lived in the U.S.** The probability of improper disposal drops .37 over the range of the intervals of years lived in the U.S., a substantial effect. We interpret this as a result of learning.

• **Gender.** Among immigrant DIYers, women showed lower rates of improper disposal than men. On average the predicted probability of improper disposal by DIY women was 0.43 less than by DIY men.

• **Media use.** Only three immigrant DIYers said they never watch television, so any relationship with improper disposal is unreliable and is omitted. There is also insufficient evidence to support an effect of radio use on improper disposal. The odds ratio for daily listening to radio is lower than 1.0, so that predicted improper disposal is slightly lower among daily listeners. However, the p-value is 0.718, far from adequate statistical support for such a finding. Overall, we find no reliable evidence to support the notion that immigrant DIYers who use media more have lower rates of improper disposal than those who use media less.

• **Shade-tree mechanic.** Among immigrant DIYers, STMs appear to dispose improperly at a lower rate than other DIYers. Although \( p = 0.242 \), this is because we have already absorbed most of the variation attributable to STM work by including gallons of oil disposed in the model. When we take gallons disposed out of the equation, the odds ratio for STM shows greater effect and is statistically significant. Immigrant STMs clearly dispose improperly at a lower rate than other immigrant DIYers.

• **Volume of oil disposed.** First, the range of gallons disposed is much smaller among immigrant DIYers in the sample (0–25.8) than among U.S.-born DIYers (0–607), and U.S.-born DIYers are much more likely to be high-volume STMs. With their reduced range of gallons disposed, immigrants who dispose of more oil are less likely to dispose improperly. The effect on probability of improper disposal is very large (-.64). That DIYers who are high-volume disposers are less likely to dispose improperly is of course highly desirable.

Although age has no detectable effect on improper disposal once we take years in the U.S. into account, in a broader sense, age and years lived in the U.S. are probably both involved in the learning about automotive maintenance and used oil recycling. Young people and new immigrants both become vehicle owners for the first time. They both go through a great deal of learning about maintenance—and about recycling, if the Board’s programs are effective.

**U.S.-Born DIYers Under 40**

Among U.S.-born DIYers under 40, **convenience, gender, and daily listening to the radio** are the main factors that still appear to affect improper disposal even after we adjust for other factors (Table 57).

• **Curb side collection** of used oil is uncertainly related to improper disposal in this age group; as noted, younger DIYers are not likely to have curbside collection service even in localities where it is provided to single-family dwellings. The odds ratio and the average reduction in

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* However, it is also possible that these differences between immigrant and U.S.-born DIYers arise because high-volume immigrant STMs were undersampled in the statewide survey or because they were more guarded than U.S.-born STMs about revealing high levels of STM activity. Undocumented immigrants in particular have a strong incentive not to participate in surveys and to be guarded in their responses if they do participate.
The probability of improper disposal (−.34, column 3) suggests a relationship. Although the $p$-value (column 2) leaves us uncertain whether they represent a real effect, the effect probably is real—most likely it’s just that too few younger DIYers are exposed to curbside programs for their effect to register here.

- **Residential prior-notification collection.** The odds ratio and the change in probability indicators both suggest a large effect of prior-notification collection on improper disposal, but the $p$-value leaves us uncertain of any effect.

### Table 57. Improper Disposal of Used Oil—Main Factors for U.S.-Born DIYers Under 40

<table>
<thead>
<tr>
<th>Predictor (scale)</th>
<th>Odds Ratio</th>
<th>$P$</th>
<th>Estimated Change in Probability of Improper Disposal Over Range of Predictor</th>
<th>Conclusion About Effect on Improper Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of oil collected curbside in county (0 to .78)</td>
<td>0.16</td>
<td>0.263</td>
<td>−.34</td>
<td>Possible, large</td>
</tr>
<tr>
<td>Proportion of oil collected by prior notification program in county (0 to .59)</td>
<td>0.44</td>
<td>0.652</td>
<td>−.65</td>
<td>Uncertain, possibly large</td>
</tr>
<tr>
<td>Convenient to take oil to a center (0=not, .5=somewhat, 1=very)</td>
<td>0.23</td>
<td>0.019</td>
<td>−.34</td>
<td>Very probable, large</td>
</tr>
<tr>
<td>Know any specific environmental impact of used oil</td>
<td>0.47</td>
<td>0.121</td>
<td>−.19</td>
<td>Probable, some</td>
</tr>
<tr>
<td>Female (0,1)</td>
<td>3.26</td>
<td>0.018</td>
<td>+.26</td>
<td>Very probable, substantial</td>
</tr>
<tr>
<td>Shade-tree mechanic (0,1)</td>
<td>2.03</td>
<td>0.178</td>
<td>+.17</td>
<td>Possible, some</td>
</tr>
<tr>
<td>Never watch TV (0,1)</td>
<td>4.24</td>
<td>0.132</td>
<td>+.29</td>
<td>Probable, large</td>
</tr>
<tr>
<td>Listen to radio daily (0,1)</td>
<td>0.36</td>
<td>0.140</td>
<td>−.23</td>
<td>Probable, substantial</td>
</tr>
<tr>
<td>Gallons of oil disposed in 2003–04 (0 to 181)</td>
<td>1.01</td>
<td>0.141</td>
<td>+.39</td>
<td>Probable, large</td>
</tr>
</tbody>
</table>

N = 262, model $p = .0053$

- **Convenience.** The odds of improper disposal drop substantially with greater convenience of taking oil to a collection center. Convenience decreases the probability of improper disposal an estimated 0.34 from “not at all” to “very convenient” (column 3), and there is no question about the statistical significance of the result. This reconfirms the findings of Section 6 about the effects of convenience.

- **Knowledge of any specific environmental impact of used oil.** Even though the $p$-value does not meet a conventional .05 criterion, there is probably a modest effect of knowledge on improper disposal.

- **Gender.** The odds that a female DIYer in this under-40 group disposes improperly are 3.26 times the odds for a male DIYer. Taking all other factors into account, the estimated
probability that female DIYers dispose improperly is 0.26 greater than the estimated probability of improper disposal by DIY men.

- **Shade-tree mechanic.** Among these younger, U.S.-born DIYers, STMs may be somewhat more likely to dispose improperly than non-STMs, though the effect is somewhat uncertain in this model. As with immigrants, if we take gallons of oil disposed out of the model, the effect of STM status is strong and statistically significant. This suggests that the large volumes of oil disposed by younger U.S.-born STMs are a major factor in their higher improper disposal rates. That is, STMs tend to dispose of much more oil than other DIYers, and having very large amounts of oil to dispose of increases the probability that they dispose improperly.

- **Media use.** Never watching TV is associated with a higher rate of improper disposal. DIYers who never watch TV are about 30 percent more likely to dispose improperly than those who watch it at least sometimes. Listening to radio daily appears to reduce improper disposal for the under-40 group: the probability of improper disposal for a DIYer under 40 who listens to the radio daily drops nearly one-fourth compared to a DIYer who does not listen daily (column 3).

Because radio spots have been a major way of reaching DIYers, we take this relationship as evidence of a genuine effect of media use in spite of the less than conclusive p-value. Younger DIYers who use the medium that carries most of the messages about oil pollution and recycling are more likely to have learned about recycling and less likely to dispose improperly. They are more likely to have received the message. Media use is a way of learning about used oil recycling that has probably made a difference for this group.

- **Volume of oil disposed.** High-volume DIYers dispose improperly at a higher rate than lower-volume DIYers—the estimated probability of improper disposal increases 0.39 over the large range of oil disposed, and this relationship is not far from conventional statistical significance (p = .141). The difference between younger U.S.-born DIYers and immigrant DIYers in this respect is stark: high-volume immigrant DIYers are less likely to dispose improperly; high-volume U.S.-born DIYers are more likely to dispose improperly. This is another piece of evidence to suggest that high-volume U.S.-born DIYers, including the STMs who are numerous in this group, should be a particular target of efforts to reduce improper disposal.

Further analysis indicates that the relationship of higher volume and higher probability of improper disposal applies really only to U.S.-born STMs. Other U.S.-born DIYers under 40 are less likely to dispose improperly if they dispose of large volumes of oil (p = .0010).

### U.S.-Born DIYers 40 and Over

Results for U.S.-born DIYers 40 and over are given in Table 58. For comparability with the under-40 group, we include all of the same variables in the model even though many are not clearly related to improper disposal for the older group.

- **Mode of collection and convenience.** Among DIYers 40 and over, the multivariate analysis confirms that curbside collection is very strongly associated with reduced improper disposal, as we showed in Section 6. The analysis also confirms that convenience of collection centers substantially reduces improper disposal for this group; the effect of prior-notification collection programs is somewhat uncertain but might be substantial.

- **Knowledge of any specific environmental impact of used oil.** The impact of specific knowledge on improper disposal is uncertain and probably small in any case, in this group. This is not because older DIYers are generally knowledgeable—they are not.
Table 58. Improper Disposal of Used Oil—Main Factors for U.S.-Born DIYers 40 and Over

<table>
<thead>
<tr>
<th>Predictor (scale)</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds Ratio</td>
<td>p</td>
<td>Estimated Change in Probability of Improper Disposal Over Range of Predictor</td>
<td>Conclusion About Effect on Improper Disposal</td>
</tr>
<tr>
<td>Proportion of oil collected curbside in county (0 to .78)</td>
<td>0.004</td>
<td>0.023</td>
<td>-.57</td>
<td>Very probable, very large</td>
</tr>
<tr>
<td>Proportion of oil collected by prior notification program in county (0 to .59)</td>
<td>0.179</td>
<td>0.317</td>
<td>-.24</td>
<td>Uncertain, substantial</td>
</tr>
<tr>
<td>Convenient to take oil to a center (0=not, .5=somewhat, 1=very)</td>
<td>0.27</td>
<td>0.027</td>
<td>-.31</td>
<td>Very probable, large</td>
</tr>
<tr>
<td>Know any specific environmental impact of used oil</td>
<td>1.40</td>
<td>0.582</td>
<td>+.08</td>
<td>Uncertain, small</td>
</tr>
<tr>
<td>Female (0,1)</td>
<td>1.94</td>
<td>0.259</td>
<td>+.08</td>
<td>Uncertain, small</td>
</tr>
<tr>
<td>Shade-tree mechanic (0,1)</td>
<td>1.53</td>
<td>0.572</td>
<td>+.11</td>
<td>Uncertain, small</td>
</tr>
<tr>
<td>Listen to radio daily (0,1)</td>
<td>0.47</td>
<td>0.169</td>
<td>-.35</td>
<td>Probable, large</td>
</tr>
<tr>
<td>Never watch TV (0,1)</td>
<td>5.20</td>
<td>0.177</td>
<td>+.44</td>
<td>Probable, large</td>
</tr>
<tr>
<td>Gallons of oil disposed in 2003–04 (0.6 to 607)</td>
<td>0.995</td>
<td>0.247</td>
<td>-.47</td>
<td>Uncertain, perhaps large</td>
</tr>
</tbody>
</table>

N = 292, model $p = .0064$

**Volume of oil disposed.** The effect of volume of oil disposed on improper disposal in this group is uncertain. See Section 10 for further discussion and synthesis of these findings.

**Gender.** In this group, the data are not entirely clear about a difference between men and women with respect to improper disposal; perhaps there is some modest difference.

The fact that women among older DIYers are only slightly more likely to dispose of used oil improperly while they are clearly and substantially more likely to do so among younger DIYers is consistent with a learning model of used oil recycling. Younger women, by this reasoning, are more likely to dispose improperly because they are initially at a learning disadvantage: they are less likely to have been raised with knowledge about automotive maintenance, and they are less likely to pick up information about it from same-gender friends. Older women who change their own oil have learned.

**Shade-tree mechanics.** The bivariate data in Section 4, Table 15, indicated that U.S.-born STMs are more likely to dispose improperly than other DIYers. The lack of a clear relationship between improper disposal and STM work among older U.S.-born DIYers in Table 58 suggests that age rather than STM work per se is the operative factor. We know that younger DIYers are more likely to be STMs, and they are more likely to dispose improperly—it is not clear from Table 58 that STM activity in itself is associated with more improper disposal. STM activity falls off rapidly with age in any case. However, U.S.-born STMs are typically younger and more likely to
dispose improperly compared to DIYers who do not do STM work. This is an important consideration for targeting STMs.

Media use. The three-quarters of older U.S.-born DIYers who listen to the radio every day are probably less likely to dispose improperly; those who never watch TV are probably more likely to do so, though the p-values leave us less certain than we would like. Although media use shows somewhat uncertain relationships with improper disposal for each of the three groups taken separately, putting the results together across the groups suggest that the effects of media use are clear and reliable and in the predicted direction, especially for radio.

Appendix 11: Oil Filter Methodology

This appendix contains methodological detail that is not provided in Section 11. To retain continuity, however, some text in Section 11 is repeated here.

Estimating Oil Volume in Disposed Filters

The estimation of the volume of used oil attributable to filter disposal is difficult in two ways. First, oil filters in current use vary greatly in size. In addition to the need to account for the fact that filters used in motorcycles, passenger cars, and trucks hold different quantities of oil, filter designs have become smaller in recent years. Secondly, the amount of oil remaining in disposed filters also varies according to the type of filter and the method of disposal. We accounted for both of these important factors in our estimates. We first estimated the expected capacity of filters before drainage, and then adjusted for drainage and disposal methods to estimate residual oil remaining in disposed filters.

Filter Oil Capacity

In order to estimate the maximum amount of oil contained in filters before draining, we requested information from the Filter Manufacturers Council (FMC), an industry association based in Research Triangle Park, North Carolina. The FMC provided estimates from member companies concerning the sizes and approximate market distributions of filters in current use. This information suggested that the smaller, more modern filters generally contain 5–10 oz. oil before draining (capacity), and older-style light duty (LD) filters contain approximately 25 oz. oil before draining. (A full quart of used oil is 30 oz.) FMC staff characterized the market distribution as 40 percent larger filters, 35 percent medium sized, and 25 percent smaller filters.

We used the survey data on the frequency of oil changes, the amount of oil changed, and the model and year of each household vehicle to classify the likely oil capacity of each vehicle’s filter into three categories:

- Motorcycles and similar vehicles were identified and their filters were assigned the low end of the FMC estimates: 5 oz.

* We use “filter oil capacity” to refer to the maximum amount of oil contained in a filter when it is removed from a vehicle and full of oil. The expression “filter capacity” is also sometimes used in the research literature to describe a filter’s ability to absorb contaminants.

† From personal correspondence with Brent Hazelett, Executive Director of the Filter Manufacturers Council. We are grateful to Mr. Hazelett and the FMC for their assistance.
• We classified other vehicles with no more than six quarts of replaced oil, according to survey respondents, as using medium-sized LD filters. We used the FMC market distribution estimates to derive a weighted average filter oil capacity of 14.75 oz.

• Vehicles in which respondents replaced more than six quarts of oil were assumed to use heavy duty (HD) filters with estimated oil capacity of 25 oz., the high end of the FMC’s range.

We assumed that the filter capacity of vehicles for which oil was changed by STMs was equal to the estimated average for household vehicles statewide.

Recent research suggests that typical HD filters can be double the size of older-style LD filters.* However, we expect that HD filters have also become smaller in recent years. Based on review of manufacturer and interest group websites, we found a considerable range of sizes in HD filters. Additionally, the use of by-pass filtration systems for demanding applications is a potentially important factor that was not addressed in the current study. Further research concerning the use and market distribution of heavy duty and by-pass filters could substantially improve the precision of oil filter usage and filter capacity estimates.

Residual Oil in Filters

Various sources cite estimates of residual oil: the amount of oil remaining in filters at the point of disposal. At least two reports have cited figures provided by the Filter Manufacturers Council, based on a 1996 study (to our knowledge, no published report of this study is available). Using these figures, the North Carolina Department of Environment and Natural Resources† estimated filters to contain between 3.5 and 8 oz. of used oil after (1) punching a hole in the anti-siphon valve present in most modern filters, and (2) hot draining the filter. Apparently drawing on the same sources, the Minnesota Pollution Control Agency adopted a range of 2–8 oz. for DIYers.‡

However, recent research indicates that considerably more residual oil remains in used filters than previously thought.

In a surprising result, describing laboratory tests in a technical bulletin for the Missouri Department of Natural Resources, Peaslee and Roberts (1997) reported that “a typical LD used oil filter is still nearly 40 percent used oil by weight even after being hot punched and drained for

*Roberts, D.E. & Peaslee, K.D., “Analysis of the factors influencing the removal of oil from used automotive oil filters during recycling operations,” Resources, Conservation and Recycling, Vol. 22, 1998, pp. 97–113. Although HD filters were reported as 2.6 times the weight of older-style LD filters, comparison of their average dimensions suggests that a factor of 2 provides a better approximation of filter capacity.


at least 12 hours.”* In additional reports based on laboratory studies of a wide variety of filters across different methods and conditions of drainage, Peaslee and Roberts reported ranges of 25–75 percent of oil remaining in the filters even after hot punching and draining.†‡

If the anti-siphon valve is not punched as recommended by the U.S. EPA, filters were found to retain 73 percent of oil on average, regardless of temperature or oil viscosity (!), and even after extended periods of drainage. Optimal drainage also depends on filter orientation, with punched filters drained at angles of 30° and 180° from vertical obtaining the best results. Some filter orientations during drainage resulted in significantly lower amounts of recovered oil.

Anecdotal reports and the expert opinion of FMC staff suggest that very few DIYers actually punch their filters. Therefore, we adopted 70 percent as a likely figure for average residual oil in filters discarded by DIYers.

Within the mix of filters used by California DIYers, 70 percent residual oil generates an estimated average 0.3522 quarts of residual oil or 10.57 oz. per filter, substantially above the commonly cited ranges.

**Oil Attributable to Disposed DIY Filters**

After identifying the most likely filter capacity for each vehicle as described above, we multiplied the capacity of the filter by 70 percent to estimate the residual oil per filter. We then multiplied that figure by the number of oil changes reported by respondents for each vehicle to obtain the total oil attributable to disposed DIY filters, per DIYer. Finally, we multiplied the per-DIYer figure times the number of households each DIYer in the sample represents to estimate the total oil attributable to disposed DIY filters for the population of California DIY households.

Estimated residual oil per filter = 70 percent of assigned filter capacity

Total oil attributable to disposed DIY filters per DIYer =

\[
\text{Estimated residual oil per filter} \times \text{no. of changes per vehicle in 2000–01, summed over vehicles}
\]

Total oil attributable to disposed DIY filters statewide =

\[
\text{Oil attributable to disposed filters per DIYer} \times \text{no. of households each DIYer in the sample represents, summed over DIYers}
\]

About 2.22 million gallons of oil remained in filters disposed of in 2003–04 by California DIYers, by all methods.

Because a small number of STMs dispose of very large volumes of oil and filters, the margin of sampling error of the total 2.22 gallons is relatively large, 1.59 to 2.98 million gallons (Table 59).

---


There is less variation among other DIYers, so the margin of error of their estimated total residual oil of 1 million gallons is smaller, 0.93 to 1.09 million gallons.

**Table 59. Estimated Residual Oil in Filters Discarded by STMs and Other DIYers, 2003–04, and Confidence Intervals**

<table>
<thead>
<tr>
<th>California Households</th>
<th>Estimated Number of Filters</th>
<th>Estimated Total Residual Oil (Millions of Gallons)</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>24.9</td>
<td>2.18</td>
<td>1.59  2.98</td>
</tr>
<tr>
<td>STM (n=104)</td>
<td>13.4</td>
<td>1.17</td>
<td>0.67  2.04</td>
</tr>
<tr>
<td>Other DIYer (n=659)</td>
<td>11.5</td>
<td>1.00</td>
<td>0.93  1.09</td>
</tr>
</tbody>
</table>

Note: For all estimates, residual oil is estimated at 70 percent of filter capacity, with average residual oil of 10.57 oz.

**Measuring Effectiveness of County DIY Filter Collection Programs**

A measure of effectiveness that takes simply the number of filters collected per 1,000 population does not take into account many relevant factors. These factors include differences in household size and between-county differences in DIY rates, STM rates, income, age of the members of the household, and number of vehicles per household.

DIYers who have higher incomes tend to have more vehicles in their households. They tend to change oil more frequently, therefore they use more filters. STMs with the lowest incomes tend to change oil in a great many more vehicles than STMs with higher incomes; again, they use more filters. In addition, very-high-volume STM work takes place mostly in urban counties (less than 10 percent rural), and household income is also associated with urban-rural differences.

We use the estimated number of oil changes to estimate the number of filters disposed of. Estimates of oil changes are described in Appendix 5. They rest on the estimates of DIY by county described in Appendix 2, “Using PUMS Data to Estimate County-Level DIY.” About 1 percent of DIYers do not change the filter when they change oil, so number of oil changes may slightly overestimate the number of filters disposed by DIYers and STMs.

**Possible Sources of Error in Estimates of Filter Disposal**

Like the estimates of used oil disposal and collection, the filter estimates are subject to potentially large error. The numbers they depend on involve sampling and other possible sources of error, possibly including the following:

- Selective nonparticipation in the statewide survey—improper disposers being less willing to take the survey.
- Error in reporting by certified centers and block grantees, and entry into the CIWMB database.
- Error in estimating number of filters based on weight or volume.
- Error associated with use of census data from 2000.
Potential error is associated with other factors not taken into account in the county-level estimates, in particular household structure and gender.

A close check of one county’s data found errors both in the numbers of filters reported collected by the county (filters collected by two quick-lube shops were mistakenly included as DIY filters) and in the entry of reported numbers into the Board’s database (5,250 filters reported as collected curbside were entered as zero). The corrected percent of filters collected was less than half of the original estimate. Probably other errors are present in the county-level database. All of these county-level estimates are therefore first attempts and may be erroneous for some counties. The estimates are subject to adjustment upon detection and correction of errors and further research to refine the estimation methodology.

Appendix 13:
Data Limitations and Improvements

This appendix reviews data limitations and discusses whether local programs should do surveys. It summarizes topical and methodological suggestions for future statewide and local surveys of DIYers, and it lists suggestions for the improvement of data on residential oil collection programs.

Review of Data Limitations

We believe the data presented in this report are basically sound. However, readers should be aware of potential sources of error. See also “Possible Sources of Error” in Appendix 12 and “Error and Error Correction in Estimation and Reporting” in Appendix 5.

Block Grantee Reports

With respect to block grantee reports of used oil and used filter collection, measurement and estimation error are potential problems. The number of filters actually collected by certified centers may be especially difficult to ascertain accurately. The number of filters collected by commercial oil installers from DIYers and as a by-product of the installers’ work on non-DIY vehicles may be difficult to determine and may vary by grantee. Given the changing sizes of filters and the surprisingly large amount of oil remaining even after filters are drained, instructions to grantees for estimating numbers of filters from the weight of filters collected may not produce accurate estimates. Those instructions should be re-examined for accuracy. This may require research on filter weights and sizes and on oil remaining in filters.

Estimating the number of filters collected is important, because that number can be linked to estimates of the number of oil changes undertaken by DIYers. Estimating the total used oil (and its burden of pollutants) remaining in filters would also be useful, along with the total other materials collected in a typical container of used filters, especially steel.

Surveys

The most significant sources of survey measurement and estimation error for the current study are social desirability bias, recall bias, limited measurement, and the distribution of the underlying behavior.

Social desirability—the tendency to avoid reporting undesirable behavior—is the central problem of surveys on any sensitive behavior, including oil and filter disposal. The problem may be lessened with reported filter disposal because some respondents do not know that they should not put used filters in the trash. However, questions regarding filter usage were asked in the same
context as reported oil consumption. A “spillover effect” may occur, in which respondents who have erroneously reported oil recycling will do the same for filters in order to appear consistent.

We dealt with the social desirability bias by estimating the improper disposal rate that must have existed in order to generate the amount of used oil known to have been uncollected, from survey estimates of oil generated minus grantee reports of oil collected.

**Recall bias.** Although the survey-based estimates of total oil and total filter consumption are satisfactorily close to Board estimates based on sales data, all survey reports of behavior frequency, such as oil changes, are subject to *errors of recall*. Including a wide time interval is important (in the current case, one year) in order to capture the reports of infrequent DIYers, but respondents to surveys often base their reports on their most recent behavior. Although the current questionnaire was designed to add considerably more detail than previous work of this type, there is still room for improvement.

For example, a “timeline follow-back” approach could ask respondents to identify personal landmark events in the past year, which are then used as reference points for their behaviors. Another approach might focus on oil-change and recycling practices at different seasons of the year, which might improve the precision of consumption and disposal estimates.

Recall bias apparently did not have much effect on the survey estimate of total oil consumed statewide, which was reasonably close to Used Oil Program estimates from sales data. If anything, oil consumed and therefore oil disposed were slightly underestimated. If actual oil disposed was greater than we estimated, this would have increased the estimated amount of oil uncollected and therefore improperly disposed. In turn, the percentage of oil collected would be lower.

Recall bias might also have affected estimates of very-low-volume and especially very-high-volume disposal, reducing the numbers of cases at the extremes.

**Limited measurement of filter changing.** A number of important details emerged concerning filter disposal practices that had not been considered when the survey was designed. The most notable of these include (a) whether respondents punch and drain their filters while they are hot; (b) whether respondents always change the filter when they change their oil (a few volunteered that they did not); (c) exactly what sizes of filter they use in their vehicles, in particular whether users of larger vehicles use heavy duty filters and/or by-pass filtration systems.

A similar lack of detail showed up in the estimation of the amount of oil STMs typically replaced in the vehicles they serviced. We attempted to capture as much of the variation in that quantity as we could but were probably only partly successful.

These are potential sources of measurement error. Overall, an effect of measurement error is *attenuation*—relationships between variables are smaller in the data than they actually are in the population. This points up the need for investigation and reduction of measurement and reporting errors, both in block grantee reports and in future survey work.

**Limited measurement of household and individual characteristics.** DIY oil changing is a result of both household and individual characteristics. We did not understand the full extent of this fact when the statewide survey was designed. We incorporated both household and individual characteristics in our models of DIY activity, STM work, and volumes of oil disposed, but we need to understand more about the characteristics of households and of the individuals in those households that lead to DIY oil changing.
High variability and small subsample size. As previously noted, because a few DIYers, STMs especially, carry out many oil changes, total oil and filter disposal is highly concentrated in the group of high-volume STMs. A few people account for a very large number of oil changes. They are in effect running part-time, informal (and unlicensed and unregulated) businesses changing oil for others.

This result is important for oil collection programs, which need to face the requirement to obtain larger samples for valid findings. It also presents problems for data analysis. We know the high-volume generators are there. But we cannot yet be certain exactly how much oil and how many filters they generate, because their variability is so great and their numbers are so small in the statewide sample. Therefore, margins of sampling error are very large. Estimates of the volume of improperly disposed filters by high-volume STMs in particular are subject to very wide margins of error. The solution is to interview larger numbers of STMs. Future surveyors need to develop more efficient ways of finding and talking to STMs, as we argue in Section 13.

Largely missing subgroups—recent immigrants and language diversity. Resource limitations prevented the statewide survey from being conducted in languages other than English and Spanish. Therefore, groups that mainly speak languages other than these are not well represented in the survey. These groups include many relatively recent immigrants who are likely to be DIYers and improper disposers but are not likely to be well connected to recycling programs. Future surveys must find effective ways of reaching these groups and obtaining their participation.

Inadequately sampled subgroup—STMs. We have had a great deal to say about STMs in this report, and they are very important. We were able to say many things about them at satisfactory levels of statistical significance. However, we still did not have enough high-volume STMs in the sample. Future survey work has to find ways of sampling more STMs at reasonable cost. Pilot studies are needed to find the best ways of accomplishing this objective.

PUMS Data

As described in Appendix 2 and Section 13, we have to accommodate the limitations of PUMS data provided by the U.S. Census Bureau. The smallest counties are not uniquely represented in those data, and estimates of DIYers, STMs, and oil and filter volumes for smaller cities may also be difficult or impossible to obtain. These data limitations typically coincide with a lack of containment with respect to oil disposal and collection (for smaller cities embedded in metropolitan regions) or with a lack of resources to gather data about programs (for smaller counties and cities).

Should Local Programs Conduct Surveys of DIYers?

Local programs might use surveys of DIYers for various purposes. One option is to attempt a local replication of the statewide survey. A city or county might decide to conduct a simplified version of the statewide survey to determine if the levels of improper disposal, knowledge, and convenience of collection centers really apply to that county or city. The city might conduct its own survey to compare it to the results of the statewide survey prior to program decision-making. The questionnaire for the statewide survey is available in English and Spanish at http://pri.sfsu.edu/reports.html.

Reasons for Not Conducting DIYer Surveys

Replicating the statewide survey locally is not likely to be a good use of resources. Following are three reasons:
1. Estimates produced from the statewide survey for counties are already available. They can be obtained for many cities or usable groupings of cities, as explained in Section 13. These estimates already take into account many important characteristics of counties and cities, including household incomes, age, number of vehicles per household, and rural-urban makeup.

2. Most local government agencies cannot afford to conduct local surveys with comparable accuracy. Estimates from the statewide survey are more accurate because they are based on a larger number of interviews than a local study could produce.*

3. The statistical power of estimates from the statewide survey is based on very complex data and a complex analysis. To get similar statistical power from local surveys requires applying this analysis to very detailed oil-consumption data from each DIYer and STM. These requirements add substantially to the cost of any replication of the statewide survey.

4. Many localities in California have substantial populations that speak little English or, if they do speak English, they are more likely to participate in surveys in their native languages. Future surveys, local or statewide, are not complete unless they are conducted in the languages spoken by immigrants. Interviewing in multiple languages is a significant cost and complexity factor.

The Program Reason for Not Conducting DIYer Surveys

Given the findings of the statewide survey, most localities should plan to implement curbside pickup of used oil. In areas where curbside pickup is implemented, a comprehensive survey is not necessary. However, outreach will be needed to prepare local DIYers for curbside pickup and maintain their participation.

An advantage of curbside pickup is that surveys will probably not be necessary to assess knowledge, convenience, and attitudes toward recycling. These issues are important where programs require DIYers to deliver used oil to collection centers because making such deliveries requires a much higher level of commitment. Recycling becomes a matter of attitudes, knowledge, convenience, and commitment rather than simply the use of a routine municipal service.

Brief surveys to assess curbside pickup implementation might be useful.

If You Must Conduct a Survey

In localities where curbside pickup is not implemented, marketing efforts will be required. Community-based social marketing might help raise the level of commitment to recycle used oil and filters. Limited-purpose surveys might be helpful here. They could produce information about convenience, commitment to recycle, recycling needs, knowledge about recycling procedures and locations among DIYers, and problems of the collection system from the DIYer perspective.

* The statewide survey required conducting short interviews with 3,808 households in order to obtain full interviews with 418 non-DIYers and 785 DIYers. This included 114 STMs, fewer than we wanted for a highly robust analysis. The problem is the amount of screening required to locate the relatively small proportion of DIYers and the very small proportion of STMs. Rural counties would have to do less screening because more households engage in DIY oil changing, but they also have less resources to conduct such surveys.
As we have pointed out, STMs account for a very large part of used oil disposed by the public in California and an even larger part of the improperly disposed oil. Getting this group to recycle its used oil would be very beneficial. However, telephone surveys of households are not a good way to reach shade-tree mechanics (STM). STMs are in only 3.2 percent of all households statewide, and high-volume STMs—say at least 10 STM oil changes per year—are in only 1.1 percent of households. A telephone survey of households is not a cost-effective way of developing data about STMs unless you are prepared to contact thousands of households.

A better approach for local used oil programs is to find some STMs directly. Or, supplement a random sample of households with another survey technique such as respondent-driven or intercept sampling (see above, “Finding STMs”) and talk to them. Find out what would work for them. If you can’t implement curbside pickup, be open to community-based and alternative ways of collecting used oil and filters from STMs (above, “Program Alternatives for STMs”). Talking freely in a semi-structured way with some individual STMs might be useful in addition to the typical survey where all the questions and most of the responses have been pre-designed.

None of the above argues against conducting surveys among a naturally contained or defined population, or where cost or other limitations can be overcome. Surveys of boat owners at a marina, for example, or of people who put their boats into the water at a given point, or of farmers in an agricultural area, are entirely feasible and may be very useful. A brief mail survey of a sample of households in a small city might be feasible, even a city that is embedded in a larger metropolitan area. The survey would gauge the extent of DIY/STM work and the pattern of oil and filter disposal. Unfortunately, mail surveys can yield very low response rates unless funds are available to support multiple follow-up mailings.

One use of surveys in such an embedded city might be to determine the level of containment of the DIYers in the city with respect to their disposal of used oil and filters. To what extent do DIYers dispose of oil and filters within city limits? A very short survey with the objective of answering this and a few other questions might yield usable responses without triggering much social-desirability bias.

**Survey Questions and Requirements for Future Surveys**

If future statewide or local surveys are undertaken to replicate or improve on the 2001 survey to estimate DIY behavior, used oil program staff should address certain issues in more detail.

**Language**

First, future surveys must do a better job of reaching the many California households where limited or no English is spoken. This is especially important since DIY and STM oil changing practices are so much shaped by learning and household income, and recency of immigration is related to these factors. Statewide and in some regions, interviewing should be carried out in 12 languages. In other regions, fewer languages will be adequate. The statewide surveys conducted by New California Media (www.ncmonline.com) are a model in this respect.

**Determining the DIY Rate**

Between full statewide surveys, very short but large-sample surveys should be designed and conducted solely to determine the DIY and STM rate. This should take place even if a full statewide survey is not anticipated. In the oil collection business, program assessment is difficult without identifying the number of DIY households and STMs and how much oil they generate. After determining the number of such households, you may use the relationships revealed in the 2001 survey data to estimate how much oil they generate. Increasing or decreasing DIY and STM rates will sharply affect conclusions about how much of the used DIY oil generated is being
collected—and in turn, conclusions about the effectiveness of used oil programs. Alternatively, a somewhat longer questionnaire could add questions about the volume of oil generated.

An advantage of a very short survey is that participation rates are likely to be much higher and costs much lower per completed interview than for a longer survey.

**Sample Design**

If the California Integrated Waste Management Board plans a complete statewide survey that tackles the breadth of issues in the 2001 survey, the survey sample should, as in 2001, be stratified by urban-rural with disproportionate sampling. Adequate numbers of rural households should be sampled for statistical comparisons of urban and rural households and for analysis of the many aspects of DIY and STM behavior that are related to rural vs. urban residence. There should also be disproportionate sampling of minority racial and ethnic groups and of immigrant groups—especially recent immigrants—of STMs, and perhaps of female DIYers. These provisions will improve the statistical reliability of findings about these important subgroups.

Urban-rural stratification for the 2001 survey was based on a county-level measure of “urban influence” based on economic considerations.* Subsequently, county-level data on population, number of households, and the proportion of households in urban or rural areas in 2000 became available. Urban-rural residence is fairly closely related to “urban influence,” but they are not entirely the same thing. “Urban influence” is probably related to DIY oil changing independently of urban-rural residence: the DIY rate is higher in counties that are more distant from major urban centers and less in the sphere of their economic influence, such as Stanislaus County, than it is in counties that are similar in urban-rural residence but higher in “urban influence,” such as Yolo, Riverside, and San Bernardino.

Stratification for a future large-scale statewide survey should probably be carried out on proportion rural residence, which is a more important factor, rather than on “urban influence,” which might not be available in updated form in any case. Care should be taken to obtain somewhat more interviews with residents of very rural counties (30+, 50+, 70+ percent rural) so as to yield more accurate estimates of DIY and STM activity and improper disposal in the state’s more rural counties. This will reduce the margin of sampling error for those counties.

To obtain more accurate estimates generally, a future large-scale statewide survey should include a larger sample to help overcome the extreme variation among DIY households and STMs in the number of oil changes carried out and volume of oil disposed. Some margins of sampling error in the present study were too wide because of that extreme variation; increasing sample size overall and/or increasing the size of the sample of high-volume disposers is the way to make margins of error smaller.

The width of a margin of sampling error is inversely related to the square root of sample size; for example, a random sample four times as large as the 2001 statewide sample will produce margins of error that are half as wide. Planning for a future large-scale survey should include detailed consideration of sample design, especially stratification, sample size, and acceptable margins of error.

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Timing of a Full Statewide Survey

For a future large-scale statewide survey, urban-rural stratification based on 2000 census data is satisfactory because stratification on urban-rural does not have to be precisely accurate. Very little would be gained by waiting until county-level data on urban-rural residence from the 2010 census are available. Analysis of the data, however, should incorporate the 2010 census data.

For the purpose of deriving county and city level estimates, using the most current PUMS data is more important than the census counts. PUMS data for a census will not be available for two to three years after the census. Therefore, county (and perhaps city) level estimates from a future statewide survey should be conducted about 2013 or 2014, combining it with 2012–13 or 2013–14 oil and filter collection data as in the present report.

The gap in time between the 2010 household, income, and vehicles data in the PUMS and the oil and filter collection data is dealt with by adjusting the number of households in each county corresponding to the DOF-estimated change in population from 2010 to January 1 of the year for which the most recent oil and filter collection data are available.

At least 18 months of preparation, including pilot surveys, should precede the next statewide survey. The quality of a full statewide survey will be greatly enhanced if adequate time is allowed to experiment with design issues, including topics for special attention, ways of asking questions, and ways of reaching important groups such as STMs.

Household Structure

We did not attempt to obtain information about household members other than the DIYer. The age, employment status, occupation, DIY and STM work, and gender of all the adult members of a household are likely to be relevant in the explanation of both household DIY and the assignment of DIY work to an individual member or members. This data will add to the characteristics of household income and number of vehicles we studied. Knowing these characteristics of household members would permit us to build more accurately on available PUMS data on households and therefore make better estimates of the probability of DIY and STM oil changing and of volumes of oil and filters.

Our respondents always seemed comfortable with our unstated presumption that one person changed oil in household vehicles. But we know from local surveys that two or three people change oil in some households, and a statewide survey should inquire about this explicitly.

We almost always confine interviewing to persons 18 and over because parental consent is required to interview persons under 18, which greatly increases the costs of interviewing. In future surveys, interviews with persons 18 and over should also ask whether household members under 18 work on household vehicles or change oil for vehicles outside the household.

To get at the extent to which household commitments affect DIY work or interfere with proper disposal, future surveys might also inquire about the number of children under five, which has been shown to reduce other kinds of social and political participation by adults.

Housing, Residence, and Recycling Services

Because curbside collection is typically available only to single-family dwellings, future surveys should always determine whether the household resides in a single-family or multi-family dwelling. In addition, because many people believe that ownership reduces improper disposal, data on ownership or rental of housing should be obtained as well.
How long have they lived in that building? In the neighborhood? In the locality? In California? Length of residence in a place is likely to be related to proper disposal.

Where do DIY households reside—inside or outside city limits? In a rural area? This affects what services they receive and might affect who accepts their oil. What kind of refuse collection do they have where they live—regular curbside pickup of trash, or not? Who provides that service? Is used oil picked up curbside where they live? Do they have regular curbside pickup, or not? Do they think or know that prior notification is required in their locality? Is pickup on a regular waste collection day, on some other regular day, or on a day determined by appointment? What kind of container do they use? Are filters and containers collected as well? If they believe they do not have residential collection of used oil, filters, and containers, do they know where they can take these items?

An important use of these kinds of questions is to link respondents’ answers to the known collection programs in their localities. The validity of survey data on program use can be greatly improved if it is corroborated with data on actual program provision in the field. If future statewide surveys are carried out, small pilot surveys should be designed to test how such correspondence can best be determined.

**STMs**

More data are needed on STMs and on how they dispose of their oil. We did not ask STMs whether they took money or bartered for oil changing, but future surveys should do so. Asking how much of their oil changing is done for friends and relatives is insufficient—we know from focus group participants that they may be changing oil for friends and relatives for a price.

STMs should be asked whether they themselves take used oil to collection centers, and how often? Does someone else haul it away for them? What does that person do with it? Does the STM pay for that service?

**Filters**

How often do DIYers change the oil filter when they change the oil? Do they drain them before they dispose of them? Do they punch and drain them while they are hot? Exactly what sizes of filters do they use in their vehicles? In particular, do they use heavy duty filters and/or by-pass filtration systems, or standard filters?

**Variations in DIY Activity**

We assumed that DIYers either changed oil on all household vehicles or on none, and no one suggested a different practice to us. Nevertheless, DIYers should be asked explicitly about this.

To get a better sense of the dynamics of DIY, people who say they take their vehicles to a shop to have oil changed should be asked: did they change oil in household vehicles at any time in the last 12 months? How often?

Future surveys might explore starting and stopping of DIY activity. When did they start DIY oil changing? Did their household conduct DIY oil changing continuously or were there breaks?

**Collection programs**

Statewide and in localities where relevant, surveys should distinguish carefully between regular curbside collection of used oil and residential pickup programs that require appointments.

If DIYers take oil to a certified collection center, do they take it to more than one? Does the place they buy their oil also accept their used oil?
Convenience

We need to know more about convenience. What makes taking oil to a recycling center convenient? What makes it inconvenient? What part of convenience is a characteristic of the center, such as distance, hours, or waiting time? What part is a (potentially variable) characteristic of people’s lives, such as number of small children, number of hours employed, health or disability, or just the DIYer’s lack of interest in recycling?

Belief and Commitment

Used oil program staff that operate center-based programs need to assess DIYers’ belief in the urgency of recycling used oil and used filters and the strength of their commitment to recycling.

Overcoming Social Desirability Bias

Used oil program staff must make every effort to develop proper wording and place questions in an order that will reduce social desirability bias in responses to questions about proper and improper disposal. Ask about vehicles, oil changing, and oil consumption before you ask about improper disposal. After you have asked your initial disposal questions, if they say they take their oil to a collection center of some sort, ask them for corroborating information. Ask them to name the center and give its location or a street name.

If the respondent cannot or will not do so, they probably do not take their oil to a center. Ask them whether there was any time in the past year when they were not able to take it. The group that answers in the affirmative might also be improper disposers, even if they say they subsequently took that oil to a center. Ask them at a different point whether they have a place they can store used oil; if not, it is unlikely that they held oil for a while before they took it to a center. Only a fraction of the improper disposers will admit this outright. For another fraction, improper disposal must be inferred from the pattern of their responses. What constitutes evidence of improper disposal is a critical decision in this research.

We cannot reduce bias to zero—we should expect in every survey that only a fraction of improper disposers will admit that they dispose improperly. In surveys of DIYers, ten times as many DIYers will probably dispose improperly than will admit to it outright. Two to four times as many will probably dispose improperly than you infer by following the rules employed in this study (Appendix 2).

Survey Assessment of Outreach Efforts

Unfortunately, increased efforts to market proper disposal are likely to reduce improper disposal slightly, but these efforts are also likely to reduce willingness to admit improper disposal. Therefore, before-and-after surveys by themselves are not a reliable way to reveal the effects of marketing efforts on improper disposal. They may simply record increased reluctance of respondents to reveal what they actually do with their oil.

The ultimate test of effect must involve data on the amount of oil actually collected. A before-and-after survey might be helpful in assessing the effects of marketing efforts on improper disposal if the survey is carefully combined with meticulously obtained before-and-after data on the volume of oil and filters actually collected. The relation of the survey data to the oil collection data and the time intervals and method by which the oil collection data are obtained must be carefully planned with the help of a specialist in applied research design, such as an applied statistician or a knowledgeable applied social scientist. Otherwise, the data will not yield the desired determination of effect.
In communities that lack containment as discussed in Section 13, affordable research may be impossible to design that will assess the efforts of that community to reduce improper disposal. In such cases, a group of adjacent communities sufficient to achieve containment and correspondence with PUMAs should partner both to reduce improper disposal and to assess their efforts.

The lesson of the 2001 statewide survey is that estimation of the rate and volume of improper disposal is possible when survey estimates of oil consumed and disposed are combined with oil collection data and census (PUMS) data.

It is tempting to suppose that one can survey only about improper disposal and come up with useful results, saving a lot of survey time and cost. This is not the case. A used oil survey that aims for a thorough assessment of improper disposal and its correlates has to accurately estimate total oil consumption and total oil disposed as well as improper disposal, and with a survey of adequate size. The assessment of improper disposal depends on the combination of survey and oil collection data.

**Suggestions for Data on Residential Oil Collection Programs**

Analysis of the CIWMB Used Oil Program’s data-collection system was not formally within the scope of this study, but estimation of the effectiveness of curbside collection was. Because we developed a scheme for estimating effectiveness that depended on accurate reports of oil and filters actually collected by curbside programs, we learned a good deal about the system and about how its data can usefully be combined with survey data. These suggestions are the result of that learning.

The purpose of good data on residential oil collection in California is to produce good research on the effects of such programs. Good research in this context means research that is able to assess the effects of different program elements.

Among the elements that might have an impact on program effectiveness are prior notification requirements, container requirements, frequency of pickup, and inclusion of multi-family dwellings. Other elements include whether all multi-family dwellings are covered or only some, pickup at curbside or at the door, the number of households covered, and whether oil is collected on the same days as trash or on different days.

A collection program might be affected by limits on the volume of oil collected from a household, whether used filters and empty oil containers are also collected, and whether oil is picked up in a prior-notification program oil even if prior notification is not given. A research program needs to know whether notification calls are used to educate DIYers. Researchers need to know the corporate or governmental identity or affiliation of the hauler, and the year in which the present contract with a hauler (if any) expires.

In order to assess the effects of different program elements, program staff must gather and retain data on these elements and perhaps others. We can hypothesize in advance that program elements that seem to add inconvenience for DIYers and STMs will be less effective, but we cannot know that until we actually see the data.

The Used Oil Program is planning to shift block grantees to web-based reporting of the oil and filters collected in their jurisdictions. This is a good step and affords an opportunity to redesign the data-collection process and to retain more detail about programs than it is presently feasible to enter and keep.
We recommend that a redesigned data process to collect data on residential used oil programs be structured like a web questionnaire, with a series of questions that can be answered by clicking on a response. The flow of questions answered by a particular grantee should be conditioned by the responses already given, where it is logical to do so. Grantees should not face questions that are logically irrelevant once they have answered a prior question.

Of course some questions must be asked of all grantees that provide any residential oil collection. For example, grantees that provide residential oil collection will need to specify the frequency of such services whether or not they require prior notification. But only prior-notification programs will need to indicate whether the hauler will pick up used oil even if they were not notified in advance (always, almost always, sometimes, rarely, never). Only prior-notification programs will need to indicate whether they use notification telephone calls or Web visits to educate the notifying DIYer, or simply record the notification.

Focusing on concrete questions will avoid the confusing terminology in use for residential programs (“curbside” and “door-to-door”). The meaning of these terms is difficult to remember and does not capture possibly important differences.

A web-based system can also be used to obtain information from grantees on the major problems of their residential oil collection services, if any. This can be very useful to the CIWMB’s Used Oil Program as it monitors the effectiveness of used oil collection statewide and endeavors to help localities develop more effective programs.

Jurisdictions that operate more than one program or provide different services in different areas should provide data for each program they operate. After they have entered their data, grantees should be shown a check-and-correction page they can examine, store, and print out to make sure their responses are accurate. Their responses for the previous year should be available to them so they do not have to fill out every item every year but can just update any elements that have changed.
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