

Community-Based Waste Management:

A feasibility study for a project in Siem Reap, Cambodia



Submitted by:

Kate Parizeau, for PLA 1107: Current Issues Paper
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Prepared for:

Outside Reader – Lay Chanthy
Supervisor – Virginia Maclaren
Second Reader – Joe Whitney
Course Coordinator – Philippa Campsie

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Executive Summary

Ninety-nine percent of surveyed residents in the study area characterize the Siem Reap River as either polluted or heavily polluted. The disposal of waste into this river is a major cause of its pollution. The purpose of this report is to establish the feasibility of a community-based waste management project in an area of Siem Reap, Cambodia that is not currently serviced by waste collection. This area is located in two Commune districts along both sides of the Siem Reap River. Currently, residents dispose of waste by burning, burying, or dumping it, either in public spaces or directly into the river. The convenience of these methods of disposal that bear no monetary cost to residents presents a formidable obstacle to the implementation of a fee-based collection system.

The research methodology included a literature review, an analysis of a series of household surveys (administered by, and jointly analyzed with, researchers from the Royal University of Phnom Penh), a waste characterization study, and a series of key informant interviews in the summer of 2004.

This research yielded a socioeconomic characterization of residents in the study area, a description of environmental conditions, and an understanding of waste paths and waste composition. In the report, potential barriers to effective community-based waste management identified in the literature and during fieldwork are considered in the context of the site, as are possible solutions for these issues.

I conclude that community-based waste management is potentially feasible in this study area, with the caveat that certain issues yet to be resolved will affect the success of the project. These issues include project design, project management, financing structures, and the willingness of residents to participate in the project and to pay for waste collection services.

Recommendations for the successful introduction of a community-based waste management project include: context-specific environmental awareness-raising efforts; adequate representation of local diversity in both consultations on project structure and in the make-up of the organization that will administer the project; and a detailed financial costing of the project.

1. Introduction

Waste management presents a challenge to many communities, whether they are rural or urban, industrialized or developing. In the developing world, both a lack of resources and a lack of local capacity often complicate municipal waste management service provision. In these instances, there are opportunities for the pursuit of creative alternatives. One such option is community-based waste management (CBWM) – the organization and operation of waste management systems by local community members.

The purpose of this research is to establish the feasibility of CBWM for a riverside community in Siem Reap, Cambodia. The objectives of this report are as follows:

- to identify the elements of effective community-based waste management (CBWM) projects;
- to determine the feasibility of implementing a successful CBWM project in the community;
- to make recommendations for the design and implementation of a CBWM program in the community.

This report will provide a description of the research completed in the planning study area, characterizations of the area, and a discussion of the barriers to CBWM faced by the community. Potential approaches toward overcoming these barriers and recommendations for future actions are also provided.

This research is being carried out with the support of the Waste Econ Program (a research project administered through the University of Toronto and funded by the Canadian International Development Agency), and in collaboration with research partners at the Royal University of Phnom Penh (RUPP) in Cambodia. RUPP is the client for this report, as it is responsible for overseeing research and recommendations to local community leaders regarding CBWM.

1.1 An introduction to the study area

The Town of Siem Reap is home to 85,000 residents, and services the archaeological ruins of Angkor Wat, which is a UNESCO World Heritage Site attracting one-third of Cambodia's tourist dollars (D'Monte 2005). In the parts of Siem Reap that currently receive waste collection services, the private waste hauler (MICC) collects waste left on the curbside in baskets every day for a monthly fee of 4,000 Riels (\approx \$1 USD) per household. However, many areas of the town do not receive service. The disparity in waste collection services is problematic in the areas of the town bordering on the river, as litter pollutes the water and interrupts the fishing livelihoods of those living downstream near Tonlé Sap Lake. Unsightly litter in the river is also a political concern for the City Governor of Siem Reap (and hence the Department of the Environment) because of the steady tourist presence due to the town's proximity to Angkor Wat.

The study area is situated along both sides of the Siem Reap River at the south end of Siem Reap Town (See Figures 1, 2, and 3), and includes parts of two Commune districts (Siem Reap Commune and Sala Kamraeuk Commune). Approximately one thousand households of varied socio-economic status and land tenure are included in the study area. There are also a number of businesses in the study area, including markets, restaurants, and stores. Some of these businesses are located within, or adjacent to, residents' households.

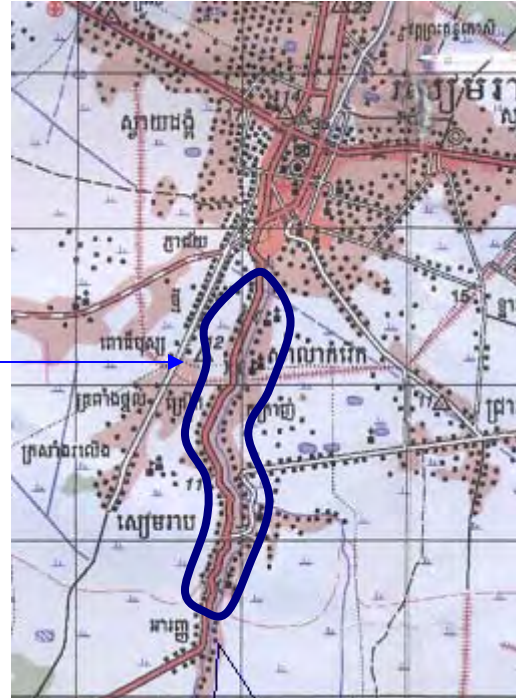
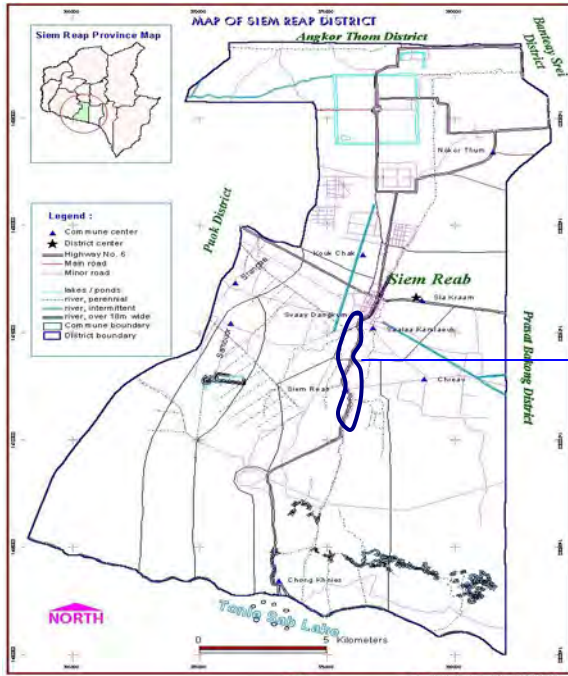


Figure 1. Map of Siem Reap District

Figure 2. Map of the study area

(Maps adapted from www.everyday.com.kh 2005)

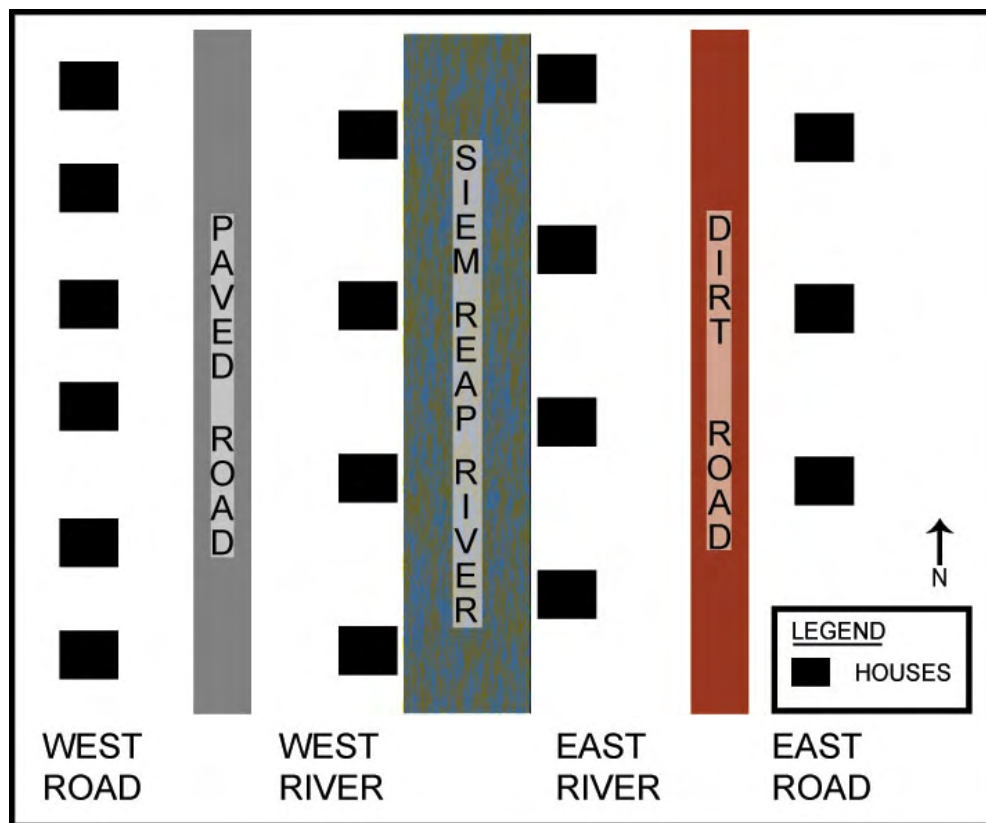


Figure 3. Schematic of household locations in the study area

The selection of this study area was based on multiple factors. The Waste Econ Steering Committee, chaired by Cambodia's Minister of Environment, recommended that RUPP locate its CBWM study in the Town of Siem Reap. In selecting a particular study area within the town, researchers at RUPP considered the following factors: a lack of waste collection services, an agreement on the study location from local government officials and the private waste collection company serving the rest of the town (MICC), the cooperation of local commune leaders, and the location of the study area along the Siem Reap River. This river has become heavily polluted partly as a result of indiscriminate solid waste and sewage disposal. Thus, this site of analysis is based around the unit of a watershed that is threatened by waste-related pollution.

Typical CBWM project areas are structured around units of community organization for ease of administration and increased socioeconomic uniformity. In some ways, this project would be less complex if the study area, as in other projects, consisted of one community unit instead of parts of two communes. A Cambodian commune district comprises a series of villages, which are made up of multiple-family groups of 100 to 150 people. As this project does not conform to any of these levels of community boundaries, it will be referred to as a study area rather than as a community in this report.

Clearly, a major barrier to implementing a CBWM system in this area is the convenience of disposing of waste in the river (see Figure 4). Other methods of waste disposal include burning it (Figure 5), burying it, or disposing of it in public spaces, all at no monetary cost to residents.



Figure 4. Houses encroaching on the riverbank; waste along the riverbank



Figure 5. Smoke from burning as a method of waste disposal

1.1 Overview of Community-based Waste Management

CBWM is a form of waste management that relies heavily on the participation and co-operation of community members to perform such roles as identifying waste-related concerns, providing active leadership in CBWM projects, participating in the collection and transport of waste, and more.

CBWM may be an appropriate solution when municipalities are either unable or unwilling to handle the waste management needs of a community. For example, a municipality may not be capable of waste collection for financial reasons. Alternatively, inadequate infrastructure (such as narrow or poor quality streets) in dense low-income areas or peri-urban areas may prevent municipal collectors from gaining physical access to the community. This is the case in the study area, where the road bordering the west side of the river is paved, but the road on the east of the river is dirt, becoming muddy and almost impassable in the rainy season, thus presenting physical obstacles to waste services in this area. Furthermore, if the community is an illegal settlement, the municipality may choose to withhold services to deny the settlement legitimacy. This is important for residents living directly on the river in the study area since they do not have legal tenure on their land, and government eviction of these residents presents an occasional threat.

CBWM may also offer opportunities for empowerment and self-improvement in developing communities. In these areas, excessive garbage is connected to both health and aesthetic problems.

Generally speaking, a CBWM system collects household wastes from individual residences (“primary collection”) and deposits them at a central location for municipal pick-up (“secondary collection”). The collection system often involves the use of hired waste collectors, or may entail householders bringing their trash to a central location. CBWM can include garbage collection, community-level diversion of recyclables and/or organic materials, and street cleaning. This report focuses on the feasibility of waste collection in the study area.

While the structure of CBWM projects varies with the situation, certain elements seem to be consistent. For example, these projects often involve community-based organizations (CBOs), non-governmental organizations (NGOs), government partners, and/or local entrepreneurs. At a household level, women and children tend to play an important role in organizing and carrying out

waste management. An extended discussion of the role of other key players in CBWM can be found in Appendix A.

In the study area, the two local commune leaders have accepted responsibility for the organization of the joint CBWM project. A CBO will be established to administer the project, and representatives from the commune associations (and potentially the commune leaders themselves) will serve on this organization. Researchers from RUPP and government partners from the Department of the Environment (and particularly the Office for Pollution Control) have been active in the CBWM project research and design to date. Because of the prohibitive costs of obtaining a license to tip waste at the Siem Reap landfill, the community organization will have to contract the local waste hauler (MICC) to carry out the secondary removal of waste from the CBWM project area to the landfill.

2. Methods

To assess the feasibility of CBWM in the study area, it is necessary to understand residents' waste-related attitudes and behaviours, and to evaluate accounts of other CBWM projects. My research consisted of a literature review, an analysis of a household survey conducted by researchers at the Royal University of Phnom Penh, a waste characterization study (including an evaluation of waste generation and composition), and a series of key informant interviews.

The household survey (n = 300) assessed socioeconomic factors and waste-related attitudes and behaviours in the study area. RUPP researchers and myself analyzed the results. The participants in the waste characterization study (n = 50) are a subset of the interviewed households. These residents were asked to collect their household waste (that is, any materials they would normally burn, bury, or throw in the river or other public spaces) each day for a week. The collected waste was weighed at each household, and then taken to a sorting area where it was separated into its component parts and weighed again.

More details on the household survey and the waste characterization study are described in Appendix B. A copy of the household survey and the key informant interview schedule are found in Appendices C and D.

3. An analysis of the study area

3.1 Socio-demographic characteristics

The average family size in the study area is 6.7 persons. The average number of children under the age of six is 0.8 per household; the average number of children from age six to seventeen is 1.9. Males head 76% of households, and females head 24%. Most of the households headed by women are those where the household head is relatively older (56% of female heads of households are over fifty years old, compared to 30% of male heads of households, $p = 0.001$), implying that these women may be widows. The average age of the household head is 45.7 years.

The average monthly household income in the study area was found to be \$434 USD, and average monthly expenditures were found to be \$224 USD. However, the validity of these amounts is questionable, since this income figure is very high for this region. The unreliability of the income data in this case may be due to a reluctance of respondents to answer survey questions (in the case of income), and to provide accurate data (with respect to both income and expenditures). Additionally, we learned that the survey was conducted shortly after the crocodile harvest in the study area; these animals are raised for resale and are sold on an annual basis. The coincidence of the crocodile harvest and income reporting for the survey may have inflated households' regular monthly income. To give context to the income values, the average per capita Gross Domestic Product in Cambodia was \$297 USD in 2002, or \$24.75 USD per month (UNDP 2003). With an average 6.5 people per household, the average monthly per capita income reported in the study area is \$68.77 USD, implying that the values reported in the survey are high. The median monthly household income in the survey area was found to be \$225 USD; this value is much lower than the mean, supporting the conclusion that the reported income data was inflated.

In the absence of income or expenditure data, housing material can be indicative of socio-economic status. When a family's wealth increases, improvements to housing are one of the first changes that they make (for example upgrading from thatch or bamboo to wood, or from wood to brick or cement). Conversely, some residents choose to maintain cheaper housing even when they come into wealth in order to give the appearance of poverty. In the study area, this most often occurs in plots directly on the river, where residents do not have legal ownership of their land and are trying to avoid government

eviction. Therefore, this proxy measure also has its limitations. In the study area, 71% of houses are made of mostly wood; 11% are made of mostly brick or cement; and 18% are made of thatch or bamboo.

Other variables also give some indication of the socio-economic status of residents. Eighty-nine percent of households have two or fewer rooms in their homes. Ninety-seven percent “own” their homes (although they may not hold legal title to the land), and 3% rent. One percent of residents receive piped water service, while 91% have access to ground water services. Eighty-seven percent of residents have electrical services, and 8% have cable television services.

Eighteen percent of household heads have no formal education, 59% have primary or secondary (pre-high school) education, and 23% have high school education or higher. The person with the highest level of education in the household was not necessarily the household head. Of those with the highest level of education in the household, 2% have no education, 48% have primary or secondary education, and 50% have high school education or higher.

Table 1 below shows household occupation, as either a primary or supplementary wage-earning activity. Each household was asked to list up to six occupations held by members of the household. As most households include people employed in multiple occupations, the total for the table is greater than 100%. This information was not collected in connection to any other identifiers (such as whether or not the occupation is held by the household head, age of the person employed, or length of time with this occupation), and so it is difficult to disaggregate this information according to its importance within the household.

Table 1. Occupation in study area households

<i>Occupation</i>	<i>Percentage of households</i>
Seller	45%
Service Provider	33%
Government staff	28%
Farmer	28%
Animal Feeder	24%
Worker/labourer	20%
Fish Seller	14%
Company staff	12%
Guide	7%
Tradesperson	7%
Support from Children	6%
Businessman	3%
Artist	3%
NGO staff	1%

To summarize, despite the lack of reliable income data, it is apparent that there is socio-economic diversity in the study area.

3.2 Location specific characteristics

The study area has socioeconomic diversity based on location of residents' households. People who live on the west side of the river, for example, tend to be more affluent than those who live on the east side, and those who live directly on the banks of either side of the river do not have land rights and tend to have lower socio-economic status (according to researchers at RUPP).

A chi-squared analysis of the results of the household survey indicates that there is a statistically significant ($p < 0.05$) relationship between certain environmental attitudes and behaviours based on location of residence relative to the river. Some of these relationships between behaviour or attitude and location are intuitive, such as the percentage of residents disposing of "all" waste in the river. In the entire sample, only 5% of residents engage in this behaviour (see Figure 6), but the rates are highest among those who live along the river, $p = 0.047$ (see Figure 7).

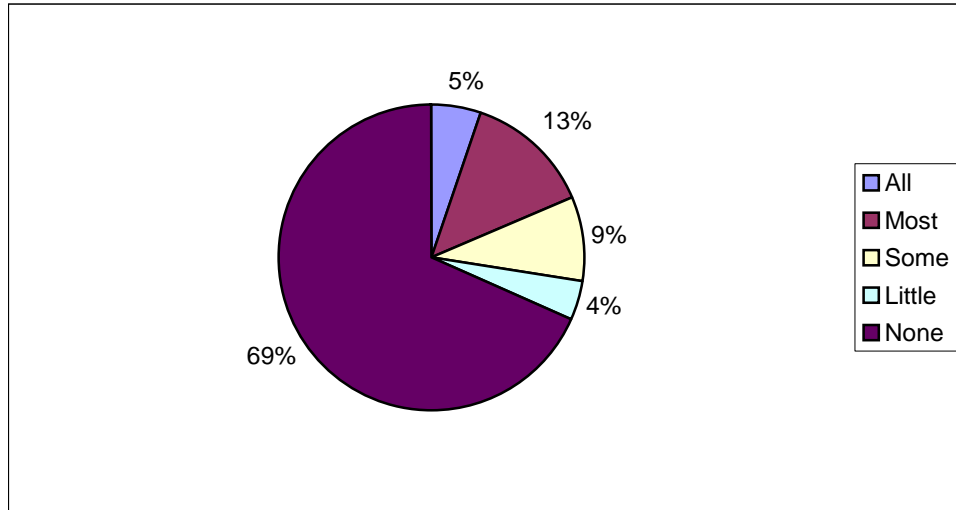


Figure 6. Amount of waste thrown in the river

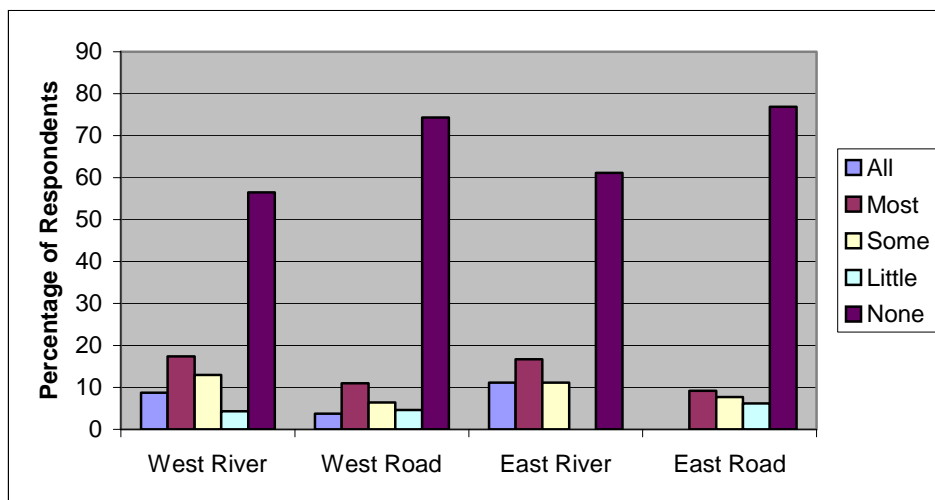


Figure 7. Amount of waste thrown in the river, by location of residence

Location is also related to residents' attitudes toward waste and the need for waste collection. Seventeen percent of residents in the study area desire waste collection services (see Figure 8). Interestingly, those who live on the East and West River are those who most desire a waste collection service ($p = 0.000$, see Figure 9). These are the same groups of residents who are more likely to throw their waste in the river. Perhaps an awareness of the environmental impacts of their practice of throwing waste in the river is what drives the

respondents living on the East River and West River to desire an alternative form of waste disposal.

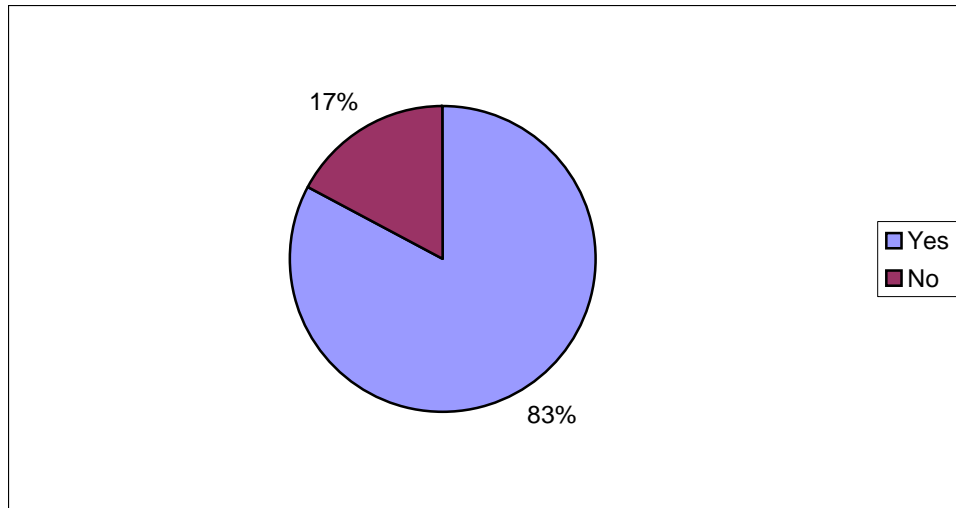


Figure 8. Desire for a waste collection service

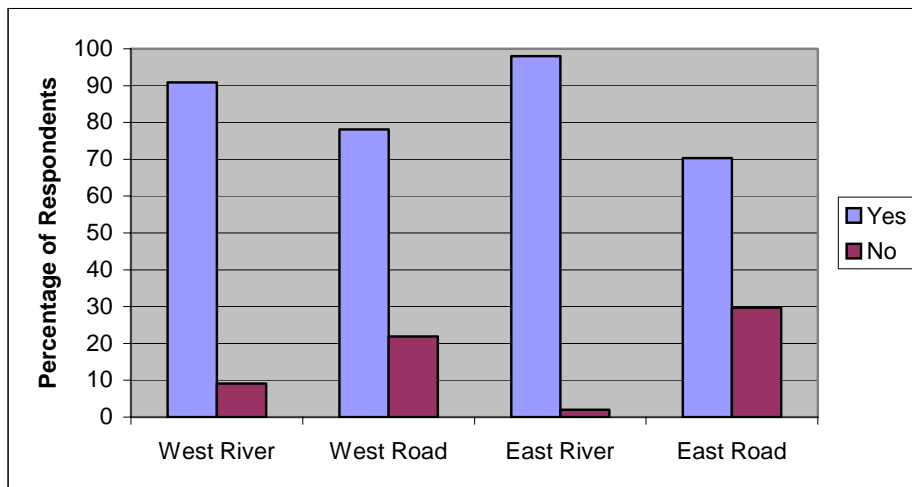


Figure 9. Desire for a waste collection service, by location of residence

Figure 10 shows the perception of waste collection in the study area. West River and West Road residents are most polarized in their ranking of environmental issues, particularly in assessing the lack of waste collection services; many see this issue as either a big problem or as no problem at all (Figure 11, $p = 0.000$). The majority of East River and East Road residents feel

that this issue is a small problem. However, Figure 9 shows that East River residents are more desirous of waste collection services. This contradiction indicates a complex relationship between environmental awareness and the desire for waste collection services in the study area.

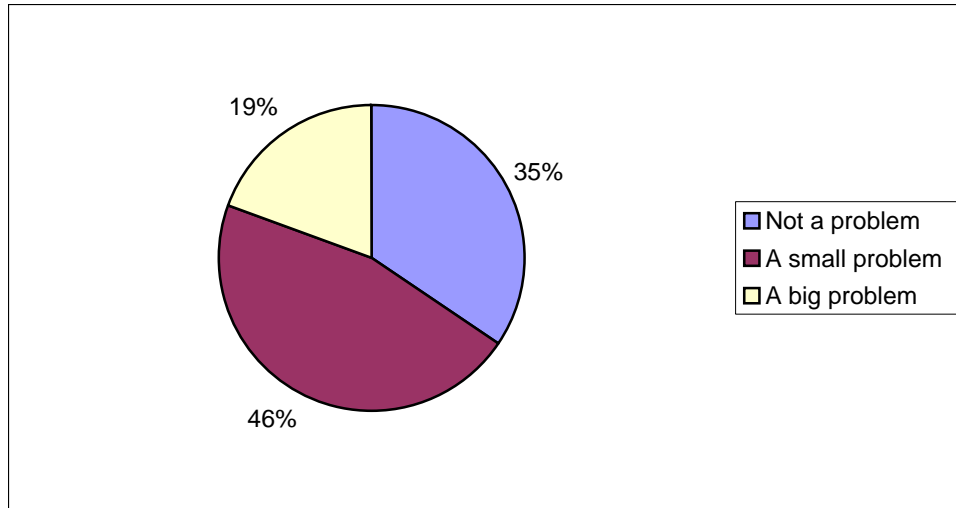


Figure 10. Perception of lack of waste collection as a problem

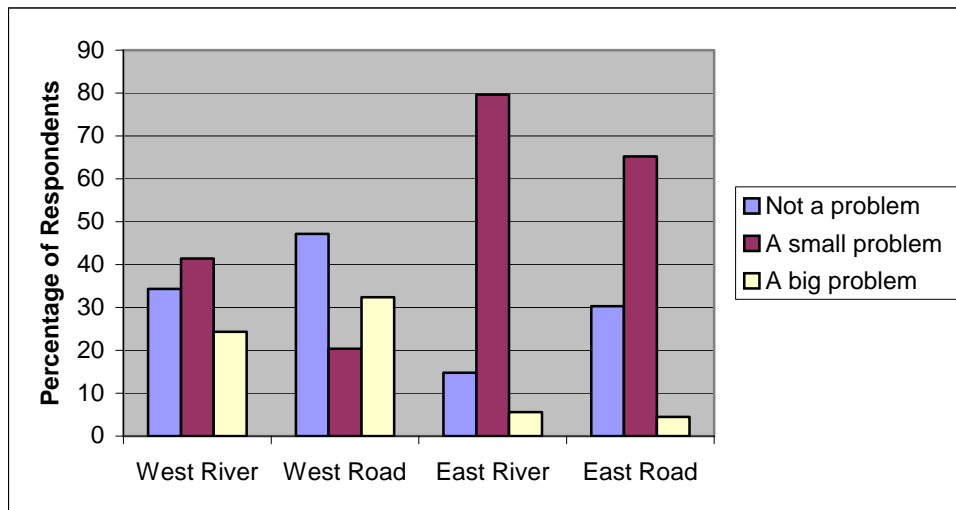


Figure 11. Perception of lack of waste collection as a problem, by location

Figure 12 indicates that 12% of residents perceive air pollution as a problem. Those who live on the East Road and East River perceive air pollution from burning waste to be less of a problem than do those who live on the West

Road and West River ($p = 0.001$, see Figure 13). Interestingly, the practice of burning all household waste is also more common on the East Road and East River ($p = 0.001$, see Figures 14 and 15), implying that engaging in a practice regularly and habitually may prevent one from perceiving the effects as being negative. However, this reasoning directly contradicts our reasoning regarding the previous relationship for river residents between their practice of throwing waste in the river and a desire for a waste collection service.

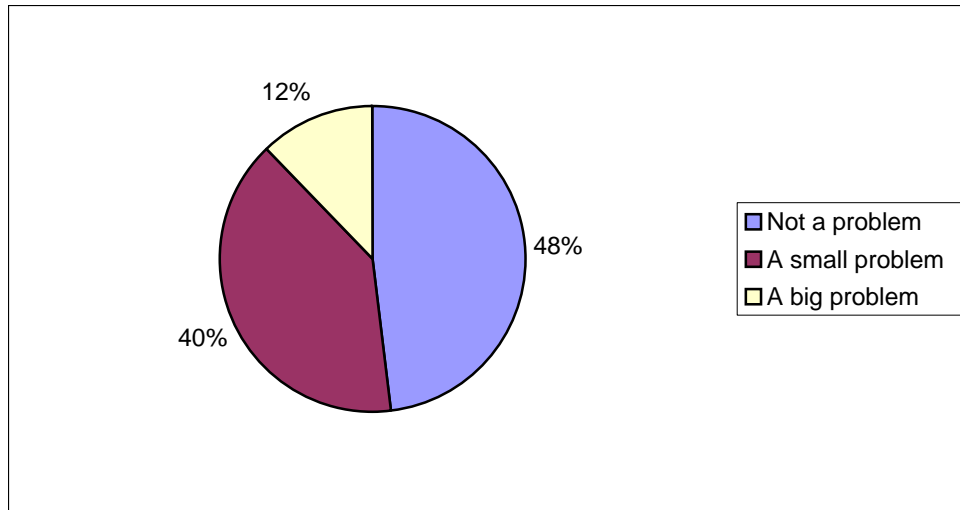


Figure 12. Perception of air pollution as a problem

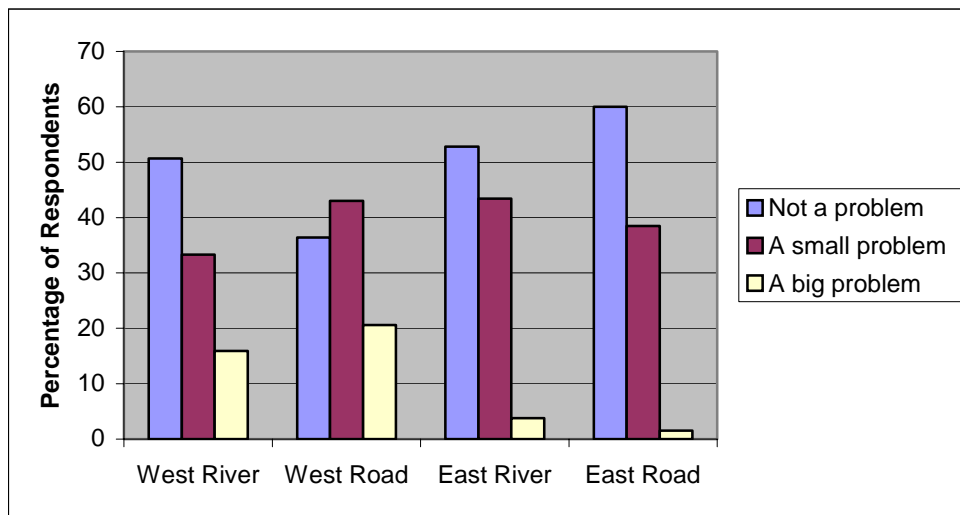


Figure 13. Perception of air pollution as a problem, by location of residence

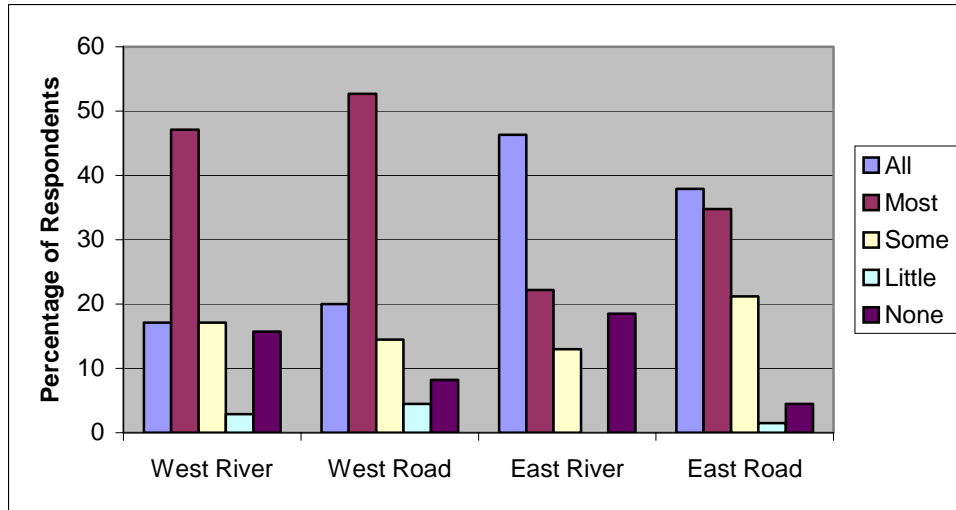


Figure 14. Amount of waste burned

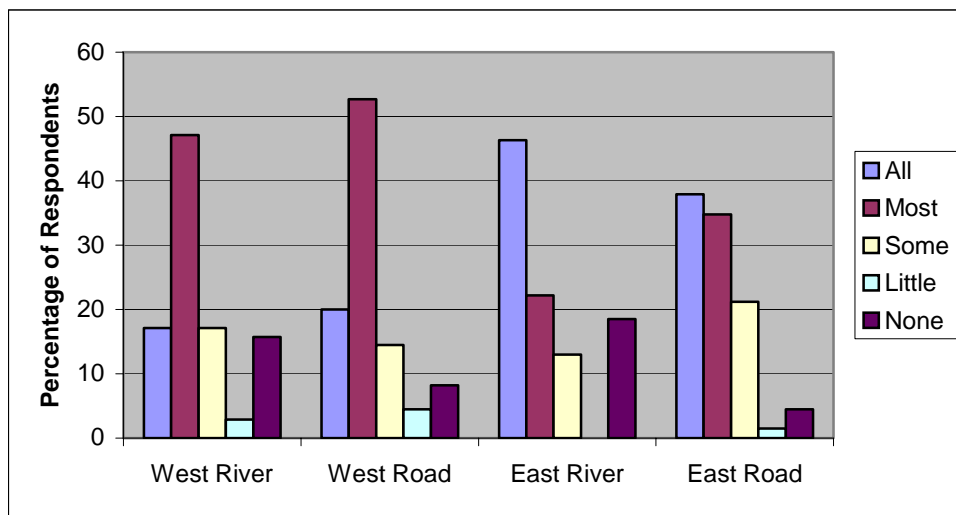


Figure 15. Amount of waste burned, by location

Some of the other statistically significant relationships are not as clear as those examined above, and it is difficult to interpret the results. A discussion of these results can be found in Appendix E.

Regardless of the availability of explanations, all of the statistically significant differences indicate that there is a substantial amount of diversity in residents' attitudes and behaviours that must be considered when designing and implementing a CBWM system. The design of educational programs and the community-based organization will need to reflect this diversity.

3.3 Gender specific issues

Another dimension of diversity in the study area was found along gender lines. Waste-related attitudes and behaviours of women were found to differ from those of men, particularly around the issue of responsibility for waste management.

Residents were asked who in the household has responsibility for waste management issues. Multiple responses were allowed, and so the total of these figures is greater than 100% (see Table 2).

Table 2. Responsibility for household waste management tasks

<i>Person Responsible for Waste Management</i>	<i>Percentage of Respondents (n = 291)</i>
Wife	43%
Not specified	30%
Female child	21%
Other female	8%
Husband	6%
Male child	6%
Other male	2%
Maid	2%

It is apparent that women bear a greater responsibility for waste management in the study area than do men. Female children also have a prominent role in household waste management. These observations are relevant to the targeting of educational information about CBWM in the study area, and indicate the need to examine the potential roles of women and youth in the community-based organization administering the project.

3.4 Environmental conditions

Community leaders in both communes have expressed concern over environmental conditions related to waste. The Siem Reap Commune Leader noted that people used to use the water from the river for drinking, cleaning, and so on. Currently residents know they can only rely on well water as a source of clean water, due to pollution in the river. The Sala Kamraeuk Commune Leader also characterized the river as polluted.

The Secretary Director of a local school noted that excessive waste makes the community appear unclean and smell bad. The Siem Reap Commune Leader said that waste in the river accumulates and makes the river narrower,

interrupting its flow. The Sala Kamraeuk Commune Leader agreed, saying that waste builds up in sewage and drainage areas, impeding the flow of wastewater away from residential areas.

The survey was designed to assess these concerns. Household survey respondents were asked to identify the severity of eight issues associated with uncollected waste in their community (see Table 3). Most residents identified water or river pollution as the biggest problem followed by flies and mosquitoes, visual pollution and odours. It is clear that residents are aware of many of the problems created by uncollected waste, but their understanding of the severity of these issues varies.

Table 3. Problems with uncollected waste

<i>Type of Problem</i>	<i>Big Problem</i>	<i>Small Problem</i>	<i>Not a Problem</i>	<i>Don't Know</i>
Pollutes the water/river (n =.257)	72%	25%	2%	2%
Attracts flies and mosquitos (n = 253)	48 %	45%	7%	0.4%
Presence of waste is unsightly (n = 255)	42%	46%	13%	0.4%
Bad smell (n = 257)	40%	37%	23%	0.4%
Causes health problems (n = 254)	35%	47%	18%	1%
Attracts rats (n = 255)	34%	50%	15%	0.4 %
Attracts dogs (n = 258)	8%	34%	57%	1%
Causes others to throw waste on their land (n =.248)	2%	10%	88%	1%

Community health is a further concern in areas with inadequate waste management. Poor health can also be an obstacle to participation in community projects. The Sala Kamraeuk Commune Leader associated waste collection services with health problems, and said that areas without collection services have more diseases. The Secretary Director of a local school associated uncollected biodegradable wastes with health effects like diarrhoea and rashes. The Chief Officer of Pollution Control noted that the poor water quality of the river also has health effects for those who use the water, and especially for those who have no choice but to use the water, such as those who live along the river, even though they know it is polluted.

In addition to household waste, raw sewage is another contaminant of the Siem Reap River. Seventy-eight percent of residents perceive wastewater as a source of river pollution. Sewage collection is beyond the scope of this report, but a feasibility study addressing wastewater management would be valuable for this study area.

3.5 Waste paths and waste composition in the study area

CBWM projects elsewhere have discovered the importance of mapping waste paths and composition. In South Jakarta, UNESCO and participating NGOs conducted an assessment of waste paths and waste composition prior to designing an appropriate CBWM system. Since 74% of the waste collected was found to be organic, the project organizers decided to add a composting component to the project. The waste stream also contained items that can be reused or recycled to generate income. The involved NGOs encouraged the creation of a CBO and the establishment of a small recycling/composting centre. Women and adolescents are directly involved in the income-generating portions of the projects, which are connected to reuse of waste in craft projects and recycling. The profits from these endeavours were used to send youth to training courses and to create a marketing cooperative for the women's handiwork. The project has contributed to a high level of environmental awareness in this community (UNESCO 2000). The success of this project demonstrates the importance of mapping waste composition prior to the design of a CBWM system.

The household survey and waste characterization study provide information on the required collection capacity for the study area, the potential for collecting and selling recyclable materials to fund the CBWM project, and the potential for the development of a composting project in the study area at a later date.

3.5.1 Waste disposal and separation practices

Respondents dispose of their wastes in a variety of ways, as shown in Table 4.

Table 4. Method of waste disposal

<i>Method of waste disposal: "most" or "all" of waste</i>	<i>Percentage of Respondents (n = 300)</i>
Burning	70%
Disposing in the river	18%
Burying in backyard	14%
Using a nearby open space / the street	11%
Giving to garbage trucks (curbside collection)	1%

Many residents are aware of the social unacceptability of environmentally detrimental waste disposal methods. Anticipating that some respondents might

conceal their true method of waste disposal, residents were also asked to describe how their neighbours dispose of their waste to gain a more complete picture of community disposal behaviours. Respondents described neighbours as disposing of their waste using the methods listed in Table 5.

Table 5. Method of waste disposal used by neighbours

<i>Neighbour's method of waste disposal</i>	<i>Percentage of Respondents (n=298)</i>
Burning	73%
Disposing in the river	41%
Dumping behind/under the house	16%
Burying in backyard	13%
Other	11%
Using a nearby open space	8%
Giving to garbage trucks (curbside collection)	1%

Many more people believe that their neighbours are more likely to throw their waste in the river (41%), rather than admitting to doing so themselves (19%). This result points to the possibility that respondents were reluctant to admit to this practice because they knew of its negative environmental impact, and that the estimate of self-reported river disposal may be low.

The Chief Officer of Pollution Control attributed the use of polluting methods of waste disposal (such as burning, burying, or throwing waste in the river) to both a low environmental awareness and a lack of waste disposal options as the private waste hauler for the city does not provide service to this community.

The Chief Officer of Pollution Control and the Siem Reap Commune Leader noted that residents used to bury their waste in order to fertilize their gardens. However, the gradual introduction of plastics and other non-biodegradable items to the waste stream has reduced the fertilizing benefit of this practice. Many continue to bury their waste (as indicated by the household survey results), but the Sala Kamraeuk Commune Leader said that most no longer separate out the non-biodegradable components of their waste before putting it in the ground.

Eighty-nine percent of residents separate materials from the waste stream to sell or give away: 14% separate all kitchen waste, 30% separate some, and 45% separate little kitchen waste. Waste generation in the study area would be

much greater if households did not separate waste, and would drive up the costs of waste collection. These figures indicate that there is a potential for greater waste diversion with the introduction of a composting program. It is important to note that some of the separated kitchen wastes may be used to feed animals in the study area, and would not necessarily go to a composting project; 75.4% of households raise and feed various animals. Table 6 shows the types of animals raised in the study area (see also Figures 16 and 17).

Table 6. Types of animal raised by the household

<i>Type of animal raised/fed</i>	<i>Percentage of respondents (n = 293)</i>
Dogs	49%
Fowl (chicken and ducks)	37%
Other	14%
Pigs	11%
Crocodiles (for resale)	8%
Cows	4%



Figure 16. Crocodiles are raised by 8% of households in the study area.



Figure 17. Pigs are raised by 11% of households in the study area.

Recycling is another method of creating value from waste. Items such as metal paper, bottles, cans, plastic, and clothing are sold to either “hetchai” itinerant buyers or local recycling depots. On average, a resident in the study area earns \$1.14 USD per month from selling items reclaimed from the waste stream. The Sala Kamraeuk Commune Leader said that many parents allow their children to take responsibility for sorting out sellable recyclables and allow them to keep the revenue for themselves. Because residents already separate recyclables for resale, they are unlikely to give these materials to a CBWM project to fund the collection services.

3.5.2 Waste generation and composition

The average weight of waste collected from the fifty houses in the waste characterization study on a daily basis was 97.0 kg. The average daily volume was 0.6m³ and the average waste density was 156 kg/m³. An extrapolation of these results from fifty households to the entire study area indicates that the total daily generation would be 1,940 kg, and the total volume for 1,000 households would be 12 m³ per day. It is important to note that these totals account for the households in the area, but do not address the wastes generated by the three markets in the study area. These extrapolations can be used to estimate the capacity of collection vehicles that will be used in the CBWM collection system.

The composition of waste in the study area is largely organic, indicating a potential for the introduction of a composting project in the area (see Table 7). Thirty-five percent of residents currently compost their organic wastes. Forty-nine percent indicate a willingness to separate organic material. Of those willing to separate their wastes, 32% said they are willing to separate all organic wastes, and 38% are willing to separate some.

Table 7. Waste composition, by weight

<i>Waste Composition</i>	<i>Proportion (by weight)</i>
High nitrogen organics (mostly kitchen wastes)	31%
High carbon organics (mostly yard wastes)	22%
Stones and dirt	14%
Non-recyclable plastic	13%
Wood and coconut	13%
Paper	3%
Metal	1%
Textiles	1%
Recyclable plastic	1%
Glass	1%
Shells and bones	0.3 %
Medical waste	0.3 %

There are also substantial amounts of plastics in the waste stream, although it is probable that the weights for plastics are a bit exaggerated as this total often included dirt and moisture from organics that could not be separated from the plastics.

The waste characterization study revealed that residents dispose of a mix of commercial and household wastes. For example, medical waste was consistently observed in the waste collected from a household that runs a pharmacy from its residence, and a large amount of wood shavings were regularly collected from a household where one man identified himself as a carpenter.

The toxicity of some commercial materials presents a danger for collectors (such as some of the pharmaceutical wastes described above). Identification of toxic wastes not suitable for CBWM-style collection will need to be included in awareness-raising programs (for both residents and collectors) prior to project implementation.

Observations during the study indicate that conceptions of “waste” varied from household to household. Although we asked for everything that people usually burn, bury, throw in the river, or discard on the ground, it was clear that we received different types of waste from different people. For example, some people cleared the leaves from their yard each day and considered this matter to be waste, while others did not give us their yard waste. A few households repeatedly claimed that they had “no waste” for us to collect, again problematizing the consistent definition of “waste.” These observations reinforce

the need to educate residents about what “waste” is, and what types of waste should be given to collectors.

On average, the per capita waste generation of this area was 0.34 kg per day. There is no statistically significant difference in average weight based on location of the households, indicating that it is reasonable to charge the same fees in all parts of the study area. Following is a histogram showing the frequency of individual waste per capita data points. Almost half of the households in the study produce between 0.10 and 0.30 kg of waste per capita per day (see Figure 18).

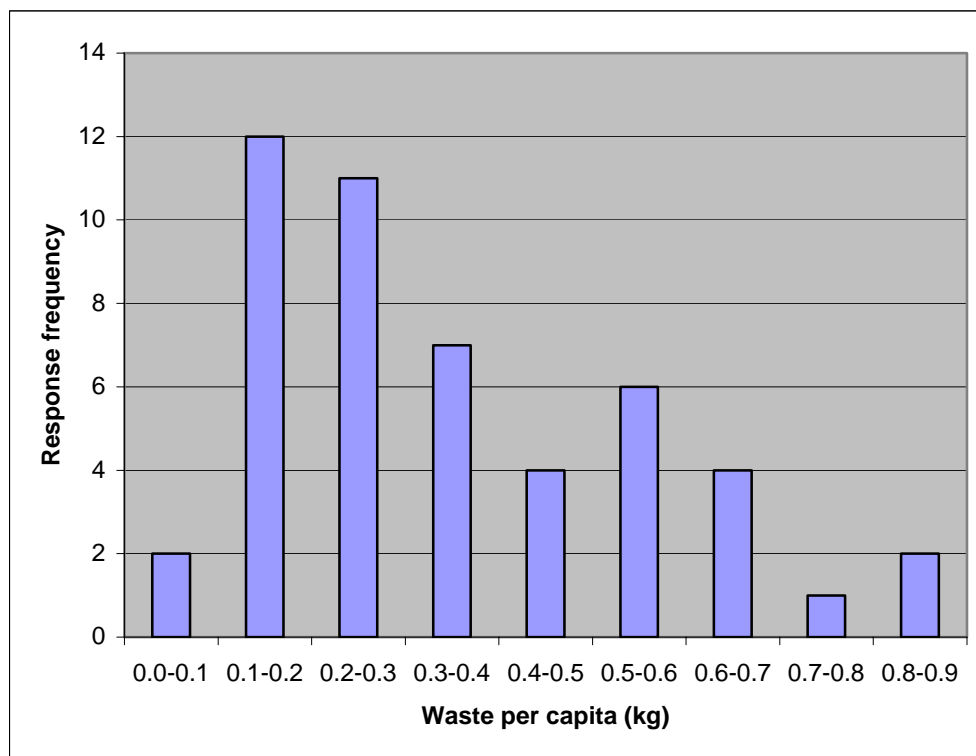


Figure 18. Histogram of waste per capita per day results

To give context to these waste generation figures, a study in the Town of Siem Reap found that residents produce 0.50 kg of waste each day on average (ECSPESC and Ministry of Environment 1997), and it has been observed that Torontonians generated approximately 0.37 tonnes of residential waste per annum in 2000, or 1.0kg of waste per day (Toronto Community Foundation 2001).

A Solid Waste Management Program Officer for the Community Sanitation and Recycling Organization in the capital city of Phnom Penh commented that his organization has observed less waste (in weight and in volume) during the dry season in Cambodia (May-June to October-November). This observation suggests that a comprehensive waste characterization study would need to be conducted over multiple seasons.

4. Identifying challenges to effective implementation: barriers and potential solutions

This section will address difficulties encountered in CBWM projects – both the challenges faced by others as described in the literature, and the local manifestations of these issues in the study area. The challenges to effective CBWM include the waste-related attitudes and behaviours of residents, organization and management, logistical arrangements, and finances. Potential program responses are suggested for each category of challenges. Most of these ideas have come from the literature and from other projects, but some are the author's.

4.1 Resident attitudes and behaviours

4.1.1 Level of environmental awareness

Previous research has found that there is a low priority for solid waste management in some communities because of a lack of knowledge and/or a lack of incentives (Anschtz 1996). If community members are not motivated to participate in waste management projects, success is unlikely. Ali and Snel warn, “not [to] assume willing participation from the outset; communities, waste collectors and municipal government all require strong motivation” (1999: 4). Achieving such a high level of motivation in all of the participants can be quite challenging.

The household survey results indicate that environmental awareness in the study area is complex and non-homogenous. As noted above, those who live in different parts of the community have significantly different opinions about the severity of, the causes of, and the remedies for environmental issues in the study area. Despite locational differences, there seems to be a diversity of concern with respect to local environmental topics.

Ninety-six percent of respondents characterize the Siem Reap River as being heavily polluted and an additional 3% describe it as polluted. When those who consider the river to be polluted were then asked about the causes of river pollution, a variety of opinions emerged, as shown in Table 8.

Table 8. Perception of sources of river pollution

<i>Source of river pollution</i>	<i>Percentage of respondents (n = 299)</i>
Solid waste	83%
Waste water	78%
Illegal buildings along the river	21%
Other	8%
Don't know	6%

In contrast to the high percentages of respondents who identified solid waste and waste water as sources of river pollution, a relatively low percentage of respondents believe that waste and waste water collection could improve the water quality of the river, even though multiple responses were accepted for each respondent, as shown in Table 9.

Table 9. Perception of potential approaches to improving river quality

<i>Method of improving river water quality</i>	<i>Percentage of respondents (n = 296)</i>
Improvement of law and enforcement	29%
Provision of waste collection system	21%
Provision of waste water collection	17%
Provision of education	14%
Don't know	12%
Other	8%
Government intervention	5%

Seventy-five percent of respondents stated that they believe the community has a problem with solid waste. Respondents were asked what they thought about some ideas for improving waste management in the community, and the results were overwhelmingly supportive of suggested interventions. These responses seem to be in contrast to the responses for the above question on improving river water quality (see Table 10), suggesting a complex understanding of environmental issues in the study area.

Table 10. Perception of approaches to improving waste management

<i>Method of improving waste management problem in the community</i>	<i>Percentage of respondents who strongly agree / agree (n = 300)</i>
Educate people	94%
Improve law enforcement	91%
City waste collection	86%
Community waste collection	83%

Eighty-two percent of households say that they want to have waste collection services in the community. Of those who do not want waste collection services, 58% say they can burn their waste, 31% say they do not produce much waste, and 27% say that they have space to dispose of their own waste.

The differing, and seemingly contradictory, responses to questions about environmental awareness and attitudes towards environmental improvement indicate a complicated understanding of environmental issues in the study area. There are many potential explanations for this complex pattern of community awareness.

Community leaders were able to shed some light on this diversity of attitudes. The Sala Kamrauek Commune Leader observed that residents in the centre of the city of Siem Reap have a more sophisticated environmental awareness, and so it is easier to talk to them about environmental issues. He said that the residents living farther from town (like those in the study area) have a lower level of education, and so have a lower environmental awareness and less propensity to care about where they dispose of their waste.

The Secretary Director of a local school agrees that many residents of the study area do not know much about the environment. Because they are poorer people, they are primarily concerned with their material survival and not with environmental issues.

The Siem Reap Commune leader noted that people know that the river is unclean, but they believe they cannot change this situation and so they continue to throw their garbage in the river. Also, he stated that some people do understand the environmental consequences of throwing their garbage in the river, but they have no alternative ways to dispose of their waste. Perhaps the ambivalence of responses to survey questions about environmental awareness comes from the cognitive dissonance of residents engaging in un-environmental practices for lack of options and yet knowing about the consequences of these practices.

It is also possible that the form of the questions affected the responses. For example, the above charts show quite disparate responses to questions about improving river quality and improving waste management, despite the fact that 88.3% of the survey population believes that solid waste contributes to river pollution. Appendix C contains a translation of the household survey. The question on river water quality lists the potential interventions, and asks residents to identify those that they perceive will improve water quality. The question on

waste management instead addresses each intervention in turn, asking respondents whether they strongly agree, agree, are neutral, disagree, or disagree strongly with each option. Perhaps giving more attention to each option encourages the respondent to consider each more seriously.

4.1.2 Willingness to participate/organize

A lack of awareness or social capital may inhibit a community's willingness to participate in or organize a CBWM project. Other factors, such as financial limitations or internal community politics, may also affect the willingness of community members to participate. In these situations, there may not be an adequate local capacity for appropriate action.

A study of "Social Capital, Networks and Community Environments in Bangkok, Thailand" and a similar study conducted in both Bangkok and Ho Chi Minh City found that environmental awareness predicts community participation in projects that improve access to environmental services (Daniere et al 2002; Daniere et al forthcoming).

In the study area, it was found that a desire for waste collection services (and so presumably a willingness to participate in a CBWM project) is significantly higher among those households who:

- rank "lack of waste collection service" as a big problem (22% versus 2% of those who do not want waste collection services) ($p = 0.000$);
- rank "odour" as a big problem (29% versus 18% of those who do not want waste collection services) ($p = 0.000$);
- believe that providing waste collection services will improve river water quality (22% versus 6% of those who do not want waste collection) ($p = 0.006$);
- perceive a solid waste problem in the community (82% versus 49% of those who do not want waste collection) ($p = 0.000$).

These results suggest that increasing awareness about waste issues and their connection to other environmental issues may improve willingness to participate.

All of the key informants interviewed indicated that they were very willing to participate in a CBWM project, with the possible exception of the Vice Director of the private waste service (MICC). He indicated that his participation would be contingent on the fee that his company could expect to receive for bringing waste

from the study area to the local landfill. Due to the prohibitive costs of purchasing a license to access to the landfill, the participation of MICC is central to the success of the project. This cost will be discussed further in the Finances section of the paper.

4.1.3 Willingness to pay

A common obstacle in CBWM projects is the unwillingness of residents to pay for CBWM in the form of user fees. A study of the Prodipan project in Khulna, Bangladesh identifies the following issues that affect residents' willingness to pay:

- the residents' perception of the benefits of the service;
- local customs regarding paying for services;
- ability to pay;
- the level of community involvement in the CBWM decision-making process.

Using bidding games, researchers determined that prior to the introduction of the CBWM project, more than two-thirds of the residents were not willing to pay for waste services. After a year of the project's successful operation, surveys found that the payment rate for the collection service was over 90% (Salequzzamana et al 2003), indicating that perception of reliability and relevance of the service also affect willingness to pay.

In the study area, 83% of respondents said they want to have solid waste collection services. Of those desiring waste collection services, 52% indicated a willingness to pay the same fee that people pay for city collection for daily collection service (4,000 Riels or \$1 USD per month). This means that 41% of respondents in the study area overall are willing to pay 4,000 Riels. It is important to note that some residents may be more prepared to say they will pay when the question is abstract and they are not actually being asked for money. Therefore, willingness to pay 4,000 Riels per month is currently quite low. However, the Prodipan case suggests willingness to pay may increase once the project is established.

If residents indicated that they were not willing to pay 4,000 Riels, they were then asked if they were willing to pay smaller amounts for less frequent service. Some indicated that they would pay smaller amounts if everyone else did, but even at the lowest fee of 2000 Riels (\$0.50 USD), 11% still said they were unwilling to pay.

Chi-square analyses indicate that willingness to pay is significantly related to certain variables. The subset of residents that is willing to pay 4,000 Riels per month for waste collection is more likely than those not willing to pay 4,000 Riels to:

- believe that lack of waste collection is a big problem for the area ($p = 0.001$);
- believe that having no or poor sewage collection is a problem, indicating a general awareness of river water quality as an environmental issue ($p = 0.06$);
- be located on the West Road, West River, or East River ($p = 0.000$).

These findings show that awareness of environmental issues is connected to willingness to pay in the study area. They also demonstrate the need for focused outreach efforts for residents on the East Road to increase their willingness to pay.

Another element of willingness to pay is ability to pay. I have assumed the fee of 4,000 Riels or \$1 USD per month for waste collection services to be relatively affordable as this is the fee paid by residents of Siem Reap Town. However, it is possible that those living in the peri-urban areas have less disposable income, and thus are able to pay less than their counterparts in the town. Twenty percent of surveyed households have a monthly income of less than \$100 USD per month. In these cases, the project may be asking residents to pay more than 1% of their income for waste collection services. It is recommended that the community organization assess the affordability of waste collection fees as an element of project design.

4.1.4 Willingness to separate

Participants in CBWM projects are sometimes asked to separate recyclables or compostable materials for resale as an income-generating activity for the project. CBWM projects that include a waste segregation component involve another layer of complexity in the form of residents' willingness and ability to separate materials for either recycling or composting.

Bennagen et al have found in Manila, Philippines, that willingness to separate recyclables, reusables, or compostables is more likely when the head of the household is younger, households generate more waste overall, and when the mother is not employed (and therefore spending more time on household

activities). The existence of a flat fee for waste collection in a community reduces the likelihood of segregation behaviour, whereas the existence of local ordinances that promote waste segregation and composting increase the likelihood of segregation and composting behaviours. Furthermore, the presence of a larger yard and the amount of more food waste in a household increase composting behaviour (2002).

While there is not sufficient data to determine a statistically significant relationship between waste generation and willingness to separate wastes in the study area, it is possible to assess some of Bennagen's observations using the "willingness to separate kitchen waste" variable from the household survey data.

Thirteen percent of survey respondents said they separate all of their kitchen waste from the waste stream, while 30% separate some and 45% separate a little. Overall, 49% indicate a willingness to separate all or some of their kitchen waste.

A Chi-square analysis ($p = 0.031$, $n = 264$, see Figure 19) indicates that younger households (those with household heads between 20 and 39 years old) are more likely to be willing to separate wastes, middle-age headed households wastes (40 to 49 years old) are more likely to say they may separate, and older households (60 years and above) are more likely to be unwilling to separate wastes. The anomaly is households headed by 50 to 59 year olds, who are more likely to be willing to separate wastes. Categorized ages shown in Figure 19 are as follows: category 1 = less than 20 years old, 2 = 20-29 years old, 3 = 30-39, 4 = 40-49, 5 = 50-59, 6 = 60 and up.

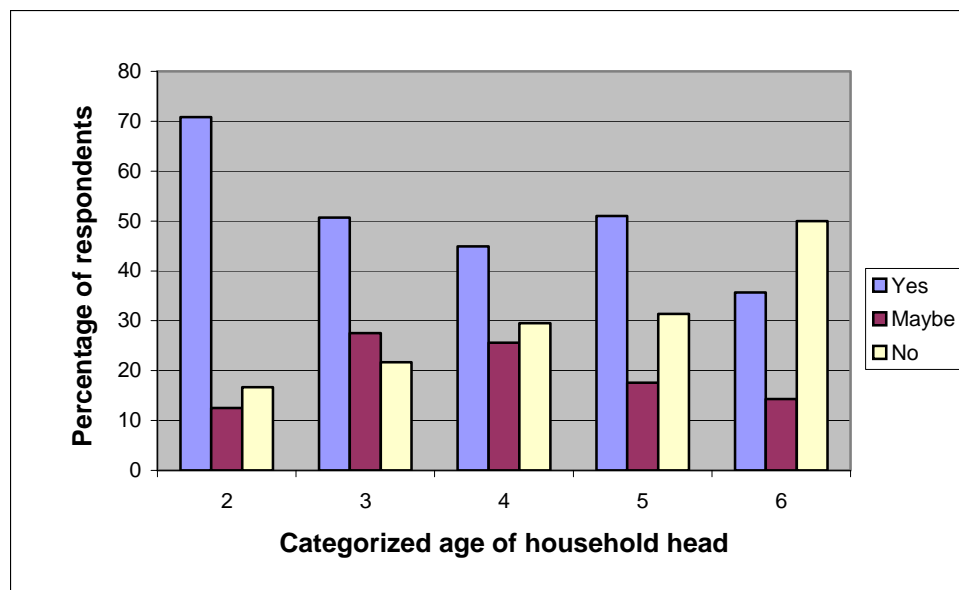


Figure 19. Willingness to separate food waste, by age of household head

Unlike Bennagen's study, size of backyard in the study area was found to be unconnected to willingness to separate.

Thirty-five percent of respondents indicated that they make compost from food/garden waste. Ninety percent of those who compost do so to improve the soil, 4% to reduce the amount of waste for disposal, 9% because of family tradition, and 1% for resale.

With respect to resellable items, 88.7% of respondents to the household survey said they currently separate wastes to sell or give away. Respondents identified the motivations listed in Table 11 for separating wastes (sample size is highly variable for these questions as multiple responses were accepted for each question, and there is a large number of missing responses).

Table 11. Reasons for separating wastes

<i>Reason why recyclables are separated</i>	<i>More important reason</i>	<i>Less important reason</i>
To earn income (n = 238)	80%	14%
Family tradition (n = 122)	66%	30%
To reduce amount of waste for disposal (n = 135)	19%	56%
Good for environment (n = 129)	11%	64%

These results indicate that people in the study area are unlikely to separate recyclables for CBWM income-generation purposes since these items

are currently separated to earn household income, along with other reasons. Additionally, attempting to engage in a competition with private entrepreneurs in the recycling industry can jeopardize the financial and organizational viability of CBWM (Anschtz 1996).

There does seem to be a potential to encourage composting in the study area, whether to generate income for the project, to reduce overall waste generation in the community, or for individual resale.

4.1.5 Potential solutions - Education

Environmental education offers an opportunity for increasing environmental awareness, community motivation, and the level of perceived project relevance (Zurbrügg and Ahmed 1999, Salequzzamana et al 2003).

A study of a CBWM project led by the non-government organization Prodipan in Khulna, Bangladesh, found that increased environmental awareness contributed greatly to the full community's participation in the new collection scheme. Previous to the educational efforts, only 38% of community residents disposed of their waste in provided dustbins. The remainder threw their waste in open spaces and drains. When the CBWM project was established, all households gave their waste to collectors (Salequzzamana et al 2003).

It is not just the existence of an educational program that defines the success or failure of a community-based project, but whether this education is appropriate in its content, methodology, and scope. Education should be gender-specific, context-specific, and benefit-focussed in order to be effective in CBWM. Generally speaking, ample funding is required for this important piece of community programming.

There are many approaches to environmental education that have proved useful in CBWM projects. Following are a selection of awareness-raising efforts used in other CBWM projects.

The Prodipan project held meetings with community members (one-on-one and in small groups), arranged environmentally-themed lectures delivered by teachers and students from Khulna University, hung posters in the project area, and held school rallies to inform residents of the need for better environmental management practices. This study also discovered that persons with a higher level of education are more inclined to accept a new waste management system than persons with less educational background (Salequzzamana et al 2003).

Zurbrügg and Ahmed (1999) describe the Inform-Educate-Motivate strategy used by the CBWM non-governmental organization Association for the Protection of the Environment (APE) in Karachi, Pakistan. In the “Inform” stage, residents are familiarized with local environmental and related health issues. They are then instructed more specifically about solid waste management using teaching materials such as videos and handouts in the “Educate” stage, and are encouraged to participate and become involved in the project during the “Motivate” stage. The project communicated with residents using informal meetings, home visits, and information sessions at schools and religious buildings. The educational efforts of this project were also targeted to religious schools. After the project was implemented, a survey indicated that there had been improvements in waste handling in the community.

A CBWM project in Bangalore, India has used a variety of methods to educate the public about environmental issues and the project itself. The project initiated door-to-door contact with residents of the community with the assistance of paid student volunteers, performed street theatre and magic shows, used other local events and local meeting places to promote project awareness, and enlisted community volunteers to monitor the daily operations of the project and give regular feedback and suggestions to the Medical Officer of Health (Iyer et al 2001).

In Mali, a CBWM program organized awareness days in order to raise subscriptions to the waste service. These days were planned in advance and the community was notified ahead of time. In order to raise awareness of the service and its relevance, community members converged on an unclean area and undertook a public clean-up (Diarre and Togola 1997).

A report on CBWM in Jakarta, Indonesia notes that the Ministry of Education and Culture has introduced environmental education to the school system. This curriculum consists of nationally consistent teachings on broad environmental issues, as well as a component on local environment that is customized to each region. In order to supplement the formal instruction provided in the schools, UNESCO has supported informal education programs such as field courses in Jakarta (UNESCO 2000).

In the project study area, the Siem Reap Commune Leader identified the need to involve commune staff, any CBOs that are formed, the Department of the Environment, and other government authorities in the educational process. The Royal University of Phnom Penh will also be involved in educational efforts.

Currently, some environmental awareness-raising events take place in the area. The Sala Kamraeuk Commune Leader said that his commune association occasionally joins with the Department of the Environment in cleaning national roads and approaching local businesses to clean up their property.

The Chief Officer of Pollution described “Environment Days” that are run by the municipal Department of Environment two or three times per year in the extended community. On these days, people are brought together to collect waste in their communities, alongside national roads, in markets, and along Tonlé Sap Lake. The commune associations are active in participating in these events. The national level Sub-Committee of the Environment holds Environment Days in November as well. Finally, bike ride days are held to raise awareness about air pollution. The government authorities organize these events, and ask community members to join in.

The Sala Kamraeuk Commune Leader suggested using different media to supplement awareness-raising events in the community. TV, radio, posters and pamphlets were options suggested for informing residents about CBWM and environmental issues in general. The Chief Officer of Pollution Control recommended using the results of the household survey to teach the community about the need for improved waste management.

Environmental education through the school system is another way to approach awareness building. The secretary Director of a local school noted that educating children is an effective way to ensure that information about the environment and CBWM reaches households, since children take the information they learn back to their homes. Currently, a provision exists for environmental education in the Grade 4 to 6 curriculum. The Department of the Environment mandates the discussion of environmental topics, but does not provide any substantive assistance with lesson plans. The Secretary Director says that teachers generally talk about air pollution and advise the children not to burn waste or throw it in the river or other public areas. The lack of official curriculum for these grades offers opportunities to develop a comprehensive set of environmental lesson plans to justify and explain CBWM.

As indicated by some of the differential attitudes and responsibilities of men and women with respect to waste management, gender-specific education and information appears essential to CBWM. Gender-segregated focus groups could be run to address differing awareness levels, and to ensure that specific concerns are heard and addressed (for example, as women are more often

responsible for waste management tasks, they may have more specific questions about the daily logistics of a CBWM project).

It is important to note that education alone is not enough; people must also be given waste management alternatives to increase their environmentally responsible behaviour. Therefore, education is particularly timely just prior to the introduction of a CBWM program.

4.1.6 Potential solutions - Tapping into social capital

The ability of a community to organize around an issue and effectively work together is affected by the amount of social capital shared by the residents. Coleman (1988) defines social capital as a community's capacity to take productive action based on internal relationships and social structures. If there is an existing degree of reciprocal interactions and a precedent for collaboration, the success of the project is much more likely. Social capital may manifest itself as previous community involvement in a community-based organization (CBO), a non-governmental organization (NGO) program, a faith-based organization, and so on.

The study of the Prodipan project in Khulna, Bangladesh, found that many people connect the idea of proper waste disposal with an Islamic belief that Allah assists those who keep themselves and their environments clean (Salequzzamana et al 2003). This finding, combined with the social capital provided through collective religious activities, supports the idea that faith-based organizations may play a role in providing social support for environmental projects.

The literature on social capital in Cambodia indicates that the Cambodian Commune system and the traditional Pagoda Associations offer a potential for organization-level mobilization and support for community projects (Pellini 2004, Romeo and Spyckerelle 2004, Bhuiyan 2004). In the study area, the Head Monk at the local wat said it is usually older people who come to regular religious services. He said he would be glad to discuss the project and general cleanliness with those who come to the wat.

The Sala Kamraek Commune Leader indicated that there are many sources of social capital in the community. There are commune associations, which are made up of 100 families within a commune. There are also even smaller associational units of groups within villages; within these groups, people are close and friendly. Every village has its own chief. The pagodas are a

meeting place for community members, and there are fishery and forestry associations in some communes. There are chiefs for each village too.

Similarly, the Siem Reap Commune Leader said that there are local organizations at the commune level that are always present (these are the commune associations). There are sometimes NGOs in the community, although they tend not to have a strong presence. He noted that most people go to wats (pagodas) and ceremonies on a regular basis. In general, he characterized his commune as a very close community.

Another option for making use of social capital is the introduction of a waste steward program that uses door-to door contact to present information about the CBWM project and about environmental knowledge in general. This interactive format of dispensing information allows for residents to ask questions and to discuss their concerns. The waste steward would bring resident feedback to the CBWM organizing committee, thereby building project accountability. The waste stewards could also receive payment for their efforts (from the fees collected for CBWM) and could receive training on waste and environmental issues from Cambodian researchers and lecturers from the Royal University of Phnom Penh. This is therefore a capacity building activity as well as an exercise of social capital.

4.1.7 Potential solutions - Enforcement

One approach to sustaining motivation is to introduce enforcement measures for non-compliance with the project. In Manila, the barangay (local authority unit) can set out regulations detailing resident participation in segregation and recycling programs. Those who do not follow the regulations are subject to a day of community service and a reprimand from local Leaders (Bennagen et al 2002).

The Siem Reap and Sala Kamraeuk Commune Leaders said that it is possible to create local commune laws to mandate participation in CBWM projects. Fines or other punishments would be issued to those who do not comply. The Siem Reap Commune Leader added that there is currently a law in the centre of Siem Reap that requires residents to give their waste to collectors. Using the enforcement abilities of commune authorities to support CBWM is another way of using social capital to encourage participation.

4.1.8 Potential solutions - Composting

High quantities of nitrogen- and carbon-rich organic materials in the waste stream indicate the potential for composting in the study area. Community-scale composting could be introduced in order to generate income for CBWM projects. However, large-scale composting projects can be capital and land intensive, and may create unpleasant side effects for nearby residents, such as odours and pest attraction.

Household-scale composting may be a more appropriate system for local residents. Barrel composting is a relatively simple endeavour that can convert the organic waste from low-income households into usable compost (Waste Concern 2004). Aside from the initial investment in the barrels, there are no operating costs to this system, and the participating households provide labour. The resulting compost could be used as fertilizer for gardens or could be sold.

Wensauer and Parsamanesh (2004) have completed an annotated bibliography on waste management in developing countries. They have noted that odour and pest problems can be moderated by using proper proportions of carbon-based materials in the compost mix, and by controlling the amount of rain that reaches and settles in the compost pile. Perla (1997) observed that composting projects in Indonesia were most effective when they had a focus on turning a profit and when the project was well connected to the local community.

In general, a project that can demonstrate a demand/market for composting products provides a good incentive for source separation (UNESCO 2000); therefore, an assessment of the feasibility of composting as a source of CBWM financing should be conducted to assess the market for composted products. I have not included a composting market analysis in this research. I recommend that composting be considered as a subsequent project in the study area in order to maintain the simplicity of the collection system and financing structures of the CBWM project, and in order to avoid contamination in the waste stream.

4.1.9 Potential solutions - Creating multi-purpose projects

To better encourage community participation, projects can be structured as multi-purpose, thereby providing more than one benefit and creating a greater priority within the community. For example, waste management could be combined with a public health and safety program (Anschtz 1996). I suggest that this idea be presented to local authorities for consideration.

4.2 Issues of Authority

4.2.1 Organization and management

Accountability within the community applies to the organization and administrative aspects of CBWM. In order to run well, these structures need to be inclusive (particularly of women, youths, and ethnic minorities), as well as transparent with regard to financing and record keeping. Community education and training can greatly contribute to these ends (Anschtz 1996).

4.2.2 Potential solutions

One way to approach meaningful and accountable CBWM project management is to create a representative community organization. Local-level administration can be an efficient method of dealing with community-specific issues. Higher-level government bodies benefit from not having to deal with the minutiae of project details, and may be willing to lend financial and logistical support to such an organization (particularly if established local leaders are involved).

Anschtz (1996) comments on methods for improving relationships with government agencies; this is particularly relevant for ensuring adequate secondary waste removal from the community. She suggests a structured communication system, including regular meetings between community and government representatives. This would be facilitated by a well-functioning community management structure.

Richardson's study of CBWM programs in Hanoi, Vietnam (2003) provides some examples of organizational structures. In the Minh Khai area, the elected leaders of the Women's Union are responsible for the oversight of daily collection, encouraging community participation in waste collection and segregation, and discussing local environmental issues with residents. The community's waste management organization is responsible for handling those complaints and issues that the Women's Union leaders are unable to resolve. This organization also organizes public meetings to make collective decisions about the waste program. Community members offer and vote on ideas; a suggestion is passed if it is supported by a vote of 70% of those present. This is an organizational arrangement of authority that may be useful in the study area.

The Nhan Chinh waste collection group in Hanoi has an organizational structure of a leader, two vice-leaders, and a team of collectors. The vice-leaders handle routine problems and are ultimately responsible to the leader.

The leader and vice-leaders hire the collectors, who are members of the Women's Union. The local People's Party selects the leader and vice-leaders from the community's voluntary citizen group. These individuals receive an honorarium of 10% of the fees collected for the waste service as payment for their efforts (Richardson 2003).

It is important to note that representative community management can prove problematic in even the best of circumstances. For example, lack of appropriate community organization can lead to an inability to collect the fees that sustain a CBWM project (Cissé 2003). A local organization taps into social capital in performing the daily administrative tasks of CBWM (such as ensuring resident fee payment). However, not all social capital is positive, and community organizations can sometimes reproduce oppressive power structures that exclude the poor and marginalized (Beall 1997). For this reason, it is important that the community-based organization in the study area reflects the diversity of the residents.

All of the key informants for the study area indicated that they are willing to participate in the CBWM project. When asked about how the project should be structured, the informants agreed that established local authority figures will play an important role in administration. Informants were not explicitly asked about the role of honorariums in the community-based organization structure; this will need to be discussed with the organization members and the community.

The Siem Reap Commune Leader said that the community organization should include the commune leaders, commune police, other commune staff, and people in the community. The Secretary Director of a local school said the organization should include the commune leaders, village chiefs, and their deputies, since these people live with the householders and understand their concerns. The Vice Director of the private waste collection company MICC said that the commune leaders should have organizational responsibilities, as MICC trusts them to know how to collect waste appropriately from this community. The Chief Officer of Pollution Control said that his Department of the Environment would choose representatives for the committee from the village chiefs and commune leaders; it is not clear whether other informants are aware of the decision-making power he purports to have.

While it is important for established local leaders to be involved in the community organization, it is equally necessary to have other community members involved to ensure that the issues and concerns of a diversity of

perspectives are represented. For example, the results cited earlier in this report indicate that it is important that the committee include people from all locations in the community, especially women and people of a variety of ages, as these factors seem to be connected to diverse waste-related attitudes and behaviours. However, it is important to note that Khmer society is inherently hierarchical and patriarchal (Ledgerwood 1996), and the incorporation of women and those of lower socioeconomic status into authoritative bodies may meet some cultural resistance.

The community should also feel that this is a responsible and accountable committee that they can trust. For this reason, the community should take part in deciding who is on the committee. Their participation could be elicited in a vote, public meetings, or focus groups.

There are many ways that the community organization could be structured. For example, it could be run as a democratic council, where each member's voice has an equal weighting, or as a tiered organization with leaders and vice leaders (as in Richardson's study), where certain members have more executive powers than other members.

4.3 Logistical issues

4.3.1 Type of collection system

A number of collection systems can be used in CBWM. Three arrangements that may be useful in this study area are: door-to-door collection (collectors approach residences and ask for their waste, or ring a bell to notify residents to bring out their wastes), curbside collection (residents leave their waste outside their house by the road for collection), and collection from multiple drop-off sites.

Ali and Snel describe a system of CBWM that involved the purchasing of communal bins for waste disposal at multiple drop-off sites in Karachi, Pakistan. An independent evaluation found that this system was successful in improving the cleanliness of the area. However, their evaluation of multiple case studies also indicates that other projects have problems finding space for the bins, managing the maintenance of the bins, and siting the bins, due to residents' reluctance to live near communal trash drop-offs (1999). Also, for all residents to have convenient access to a drop-off bin, the linear layout of the study area would require a greater number of bins than would a block-based community.

A project in Khulna City, Bangladesh opted for a door-to-door community-based waste collection system because it found that the travelling distance of the conventional approach (requiring residents to bring their waste to communal road-side bins, similar to a drop-off approach) deterred residents from using the communal bins. Instead, many residents dumped their waste in open spaces or drains (Khulna City Corporation 2000). It can be assumed that using drop-off sites in the study area may have a similar result, in that residents may opt to continue more convenient and environmentally damaging waste disposal projects rather than travel to drop-off centres. For this reason, I recommend the use of a door-to-door or curbside collection system.

It is important to note that a drawback of the door-to-door collection system is that waste does not get collected if residents are not at home when the collectors come by. Curbside collection addresses this limitation, but a problem with this system is that animals and pests are attracted to waste left out in the open (as was observed during the waste characterization study).

4.3.2 Route of the collection service

The study area has the geographic limitation of being long and narrow. It is difficult to optimize a collection route with one or two secondary collection sites in this type of layout. The collectors will likely be using a motorcart to collect the trash from households. However, the collection is essentially limited in pace, as stops need to be made at each household.

The waste characterization study used a motorcart to collect from fifty houses spread out along the entire length of the study area. The collection time for fifty stops (with pauses for weighing and sometimes speaking with residents) was approximately 1.5 hours at the end of the study when a routine had been established. It takes approximately 2.5 hours to walk the length of the study area along the paved road on the west, and returning along the dirt road on the east.

If the waste collection team comprised a motorcart driver and a collector on foot to remove trash from the roadside and place it in the motorcart, the route would be covered at a slow walking pace. To collect from all of the houses on both sides of the road, the route would essentially be covered twice (2.5 hours x 2 = 5 hours). Allowing for a slower pace due to stops at each household, it is likely that a waste collection team of one driver and one walking collector could service the entire study area in an eight-hour day. If this system did not allow for

route coverage within a day, two collectors on foot could substantially reduce the collection time (one could walk along each side of the road, for example).

These calculations are rough estimations, and will vary according to the type of collection scheme introduced. For example, a door-to-door collection system would require more time at each residence, whereas a drop-off centre system would require fewer stops and less time overall. There are many potential arrangements of collection routes that are feasible; the above described is one of the more simple approaches. The community-based organization can choose route that best suits its equipment and labour arrangements.

4.3.3 Household level storage

The requirements for household level storage vary with the collection system. A door-to-door collection project in Karachi, Pakistan, encouraged householders to use any container with a lid to store their waste (Zurbrügg and Ahmed 1999). However, a door-to-door system in the study area may operate more efficiently with disposable containers, as this will reduce the need for collectors to make multiple trips between a household and the cart. Curbside collection systems require storage containers that can be left outside prior to collection.

The waste characterization study provided plastic bags to households for waste collection. While a similar system of using “designated bags” has worked in Kitakyushu, Japan (Hitsumoto 2002), it may not be sustainable to expect households in the community to assume this cost for themselves on a permanent basis; in addition, the use of purchased plastic bags for waste collection purposes contributes to the overall amount of waste in the community. Finally, this solution may prove problematic as there are many dogs in the study area, and there were some incidents of dogs getting into waste left at the curbside during the waste characterization study.

Residents in the centre of the city place their waste at the curbside in open reusable baskets. Again, dogs in the study area could prove problematic in this regard. Baskets with lids attached may be an improvement on this system. As I assume residents will bear the costs for household containers, I recommended that community members be approached to discuss a reasonable solution that does not place an undue financial hardship on households.

4.3.4 Frequency of collection

According to the household survey, currently 61% of respondents dispose of their household waste daily; 17% do so once every two days; 14% twice a week; 5% once a week, and 3% dispose of waste at another frequency.

The Chief Officer of Pollution Control said that residents in the centre of Siem Reap have their waste collected once a day, and businesses have their waste collected more frequently. He and the Sala Kamraeuk Commune Leader recommended that the CBWM project collect waste daily, or possibly every other day as they perceive that there is relatively little waste generated in the community.

The Siem Reap Commune Leader suggested daily collection, since the accumulation of organic wastes can be problematic. This suggestion is supported by observations from the waste characterization study; the organic waste gave off an incredibly foul odour and attracted pests. Secondary collection of wastes from the sorting area was arranged for every other day; but when this waste was left out over night, there were repeated incidents of dogs opening the bags and dragging the contents around the sorting area.

The Chief Officer of Pollution Control and the Siem Reap Commune Leader said that in the study area, people tend to dispose of at least some of their waste whenever it is generated, especially if they litter or throw waste in the river. Due to the convenience of these habitual practices, and due to the unpleasant effects of storing largely organic waste, it is recommended that the CBWM project collect waste on a daily basis, seven days a week.

The Vice Director of MICC said that they expect to remove waste from the secondary collection sites at least once a day, and more frequently if warranted by the volume of waste.

4.3.5 Volume of waste

As noted above in the “Waste Composition” section of this report, it is expected that the study area will produce approximately 1,940 kg and 12m³ of waste each day. The size of the motorcart obtained will dictate the number of trips that will need to be made between the collection route and the secondary collection sites. The motorcart used in the waste characterization study easily held up to 1.16 m³ of waste.

With this capacity, ten or more trips to the secondary collection site could be required. Additionally, the motorcart used in the waste characterization study

was quite shallow; one could be constructed with higher sides that could hold 2-3 m³ of waste. Since these arrangements will depend on the specifications of the equipment the project can obtain, what it can afford, and how often waste is collected, the above calculations are quite speculative.

It is important to remember that these volume estimates do not include collection from commercial areas such as the markets. These locations will likely add significant volume to the waste totals if they are included in the project; unfortunately, there is no way to estimate this additional volume without conducting a test collection from the markets.

4.3.6 Space for dealing with refuse

As CBWM usually relies on the periodic removal of collected waste from a secondary storage site, temporary storage of large amounts of garbage is essential. Low-income residential areas are often very densely populated, and finding a safe, contained storage space for waste can prove difficult.

Anschtz notes that discussion with local NGOs and opinion leaders proved effective in finding land for a secondary collection site in Ghana, and this approach combined with a media campaign was effective in Cameroon (1996). In Mali, land was set aside in a rezoning process for waste management purposes (Diarre and Togola 1997).

The amount of space required for storage will depend on the volume of waste produced by the community and the frequency of waste collection and secondary waste removal.

The Siem Reap and Sala Kamraeuk Commune Leaders said that it is difficult to set aside a space for storing waste, as all of the land in the area is owned already. The Vice Director of MICC said that the secondary collection sites should be placed on the West side of the river where there is paved road to facilitate truck movement. The Secretary Director of a local school said that the school does have some space that could be used for short-term waste storage. However, this site is located on the dirt road on the East side of the river, and locating a waste storage site on school grounds may be unhealthy or unsafe. He suggested that there should be one storage area in each commune.

The Chief Officer of Pollution Control said that he would like to see a centre built for waste management purposes. It could be used for recycling, composting, and waste storage for up to two days. CSARO runs a similar facility in Phnom Penh; however, this project received international financing. The issue

of land availability also persists with this proposal, and an increased labour force would be required for the regular operation of a composting and recycling centre.

4.3.7 Workers

The Chief Officer of Pollution Control said that he believes waste pickers working on the city dump should be hired to work as collectors in the study area. The Siem Reap and Sala Kamraeuk Commune Leaders said that they believe local residents who are unemployed or under-employed should be hired to work in the project as it is a local initiative funded by local money.

A Solid Waste Management Program Officer for CSARO suggested hiring a driver who has his or her own motorcart, thereby reducing the capital costs to the community and ensuring that the driver has a vested interest in keeping the motorcart in working order. Alternately, he suggested buying the motorcart collectively to give the community an interest in maintaining the equipment well.

4.3.7 Potential solutions

Many of these issues are connected to project design, which has not yet been decided upon. It is recommended that community members, local leaders, and external informants (such as RUPP and the Department of the Environment) remain involved in the discussion of these issues. This type of collaboration encourages local problem solving and community investment in the project, both of which will add to its long-term sustainability.

4.4 Finances

4.4.1 Identifying the costs associated with running a CBWM project

Cost recovery in many CBWM projects is often low (Anschtz 1996). This is compounded by the fact that the poorest of the poor often can't afford collection fees, and it can be difficult to create an equitable collection fee structure (Assaad 1996). Reliance on NGO funding can create external dependencies, and governments often cannot or will not contribute to the financial aspects of CBWM. These obstacles leave few reliable options for the funding of CBWM.

The pay and status of labourers engaging in waste collection are often low, and so there is not much motivation for them to work either effectively or long-term in this field (Anschtz 1996). Further, the difficulties in financing CBWM may affect payments to community waste workers, and ultimately derail the

project. For example, in a CBWM project on the edges of Abidjan, Côte d'Ivoire, youth workers were not paid the wages they were promised because householders were not paying their waste collection fees. The workers stopped providing the service and this project eventually failed (Cissé 2003). Finding a way to provide sufficient payment to waste workers is important to the success of CBWM projects.

In Hanoi, Vietnam, a full-time collector can earn the equivalent of \$55-60 CAD per month, and those using waste collecting as a supplementary form of income can earn about \$15 CAD per month. Richardson (2003) notes that in the Nhan Chinh project, 90% of waste collection fees support the collectors' wages, and 10% of the fees are given to the leader and vice-leaders of the project's organization.

Waste collectors in the informal collection sector in Manila, Philippines, earn \$2.5 USD per two-hour collection day, and collect four days each week. The average household garbage fee is \$2.3 USD per month (Bennagen et al 2002).

4.4.2 Potential solutions

Incentives are a good way to motivate fee collectors, and to encourage the long-term financial viability of the project. In Ouagadougou, Burkina Faso, fee collectors receive a financial bonus for collecting the waste fees of more than 90% of their list of monthly service subscribers (ENDA/WASTE 1997).

Fee payment is an option for funding, and can be encouraged through the creative application of flexibility with respect to payment timing and method. For example, some community members may be more willing to pay with work in-kind, such as equipment maintenance services. Additionally, in Ivory Coast a waste collection service started to offer additional household cleaning services to overcome low willingness to pay (Anschtz 1996). The use of incentives and sanctions are also a good way to motivate payment for waste services.

Even when the community is willing to pay fees, it is important to have an effective fee structure. Differential fee structures require businesses and other heavy waste producers to pay more for their waste collection services in order to cross-subsidize low-volume household waste collection (Anschtz 1996).

The Sala Kamrauek Commune Leader suggested that for the first step of the project, all households should pay the same fee in order to give a sense of fairness to the process. This system could then be assessed after a time to see if it is the most suitable way to structure fees. The Siem Reap Commune Leader

said that he was not sure how to best structure fees. He said the community should make this decision collectively, as they need to give their input on the issue.

Table 12 displays a list of costs associated with CBWM projects. The costs of project components were established through the household survey results and informal discussions with an NGO involved in CBWM, local partners, and the worker hired to assist with the waste characterization study. The sources and determinations of these costs are described in notes following Table 12. All prices are quoted in American dollars (\$1 USD \approx 4,000 Riels).

Table 12. Monthly costs, capital costs, and revenue estimates

<i>a) Monthly costs</i>	
Labour	\$175 – 660
Fuel	\$105
Equipment maintenance	\$0-20
Secondary collection	Negotiable
Fee collector incentive	\$0 – 10% of fees
TOTAL:	\$280 – 575
<i>b) Capital costs</i>	
Uniforms (for three workers)	\$30
Motorcycle	\$650
Motorcart	\$240
Handcart (may be used in addition to motorcart)	\$130
Land for storage pre-secondary removal	\$0-500
TOTAL:	\$920-1,550
<i>c) Revenues</i>	
100% fee payment rate	\$1,000
90% fee payment rate	\$900
75% fee payment rate	\$750
60% fee payment rate	\$600
40% fee payment rate	\$400
Commercial fees	\$100 ~
TOTAL:	\$500 – 1,100

a) Monthly Costs

Labour: CSARO estimates that their workers earn about \$150 per month for a full-time route. This is a generous rate of pay as poverty reduction is an aim of this organization. MICC pays its collectors \$50 per month, and its drivers \$75 per month. The extrapolated cost of renting a motorcart and driver from the waste characterization study is \$360 per month; we later learned that we could have

negotiated a much better price with local assistance. Labour costs assume two workers and one motorcycle driver. The range of this aggregate cost accounts for the extreme values of the component costs. For example, the low end of the monthly labour cost (\$175) uses MICC rates of pay for a driver (\$75) and two workers (2 x \$50). The high end uses CSARO's rates of pay for workers (2 x \$150) and the waste characterizations study rate for the driver (\$360).

Fuel: This cost assumes a fuel use of 4L per day based on a conservative extrapolation of our fuel use during the waste audit and a fuel cost of \$0.88 per litre, which was the observed fuel price at the time of research. \$3.50 per day ≈ \$105 per month.

Equipment maintenance: RUPP researchers estimate monthly equipment maintenance costs at \$20.

Secondary collection: The price for secondary collection has yet to be negotiated with MICC. Unfortunately, there is no comparable precedent here. MICC has recently suggested that the project pay 50% of all fees collected to MICC for secondary collection services. A set of calculations has been added to each scenario to assess the financial viability of this proposal.

Fee collector incentive: The models assume that the community organization will be responsible for fee collection. One of the scenarios grants a 10% honorarium to the organization for their work.

b) Capital costs

Equipment: CSARO and RUPP researchers provided the purchase prices of equipment and other capital costs.

In the financial models, a 10% monthly payment for capital costs is modeled. This monthly rate of payment assumes that the community organization obtains a loan to pay for the capital costs incurred, and is repaying the loan on a monthly basis. There are a number of banks and NGOs in Cambodia that offer both microcredit and small business loans, such as the Association of Cambodian Local Economic Development Agencies (ACLEDA) NGO, "which was established as an independent Cambodian Non-Government Organization in 1993 for small and micro enterprise development, which aims to

raise the standards of living of the poor by promoting economic activities ranging from self-employment and small to medium size business” (ACLEDA 2005). ACLEDA offers loans of up to \$10,000 USD, with an average loan size of \$400 USD. The 10% monthly payment rate assumes a twelve-month repayment time, which is standard for banks such as ACLEDA (ACLEDA 2005). The average bank interest rate for a loan in Cambodia is approximately 20% per annum (Tourism Cambodia 2003). Using a 20% annual interest rate (bringing the total amount of money due to the bank after one year to 1.2 times the amount of the original loan) and a one-year repayment time (consisting of twelve monthly payments), the following formula solves for the monthly payment amount as a proportion of the initial loan, symbolized as “L”:

$$(L \times 1.2)/12 = 1.2L/12 = 0.1L$$

Therefore, the original loan will be paid off in one year if the community organization pays 10% of the original loan amount for twelve months at an annual interest rate of 20%. After the loan repayment term, the financial viability of the project will change, and will probably improve. It will be important for the community organization to re-evaluate both component costs and household fees at the end of the repayment term.

It is important to note that banks such as ACLEDA often charge rates higher than 20% for high-risk microcredit loans; some interest rates are as high as 48% per annum (ACLEDA 2005). The community organization will need to approach a financial institution with their budget to obtain a more concrete estimate. This is one example of why further costing will need to be completed by the community organization as a next stage in the design of a CBWM project.

c) Revenues

Fees: CSARO charges between \$0.80 and \$1 per household per month for waste collection services in Phnom Penh. MICC charges \$1 per household per month in Siem Reap. The residential rate of \$1 per household per month has been used to be consistent with other prices in Siem Reap. The above monthly fees assume equal payment by all households. If a cross-subsidizing system were introduced, it is assumed that the average fee per household would remain close to \$1.

Fee payment rate: As noted above, Salequzzamana et al (2003) observed a willingness to pay rate of over 90% in Khulna, Bangladesh. As few studies report rates of willingness to pay for CBWM services, reported rates of willingness to participate will also be used as a measure of willingness to pay for the purposes of financial modelling. Richardson describes three projects in Hanoi with rates of willingness to participate of participation rates of 63%, 70%, and 97% (2003). These levels of willingness to pay provide a range of fee payment rates that is used in the following scenarios. An optimistic 90% is the highest rate of payment that is modelled, and 40% is the lowest, based on the reported 41% rate of willingness to pay in the study area.

Commercial fees: CSARO charges between \$5 and \$10 per month for commercial waste collection; MICC negotiates its prices on a case-by-case basis. This is a flexible revenue category that depends on the details of fee structure. The models assume revenue of approximately \$100 from commercial sources, which is an estimate, as the number of commercial establishments in the study area has not been ascertained and a rate of payment for these establishments has not yet been negotiated. Households running businesses may require special payment arrangements. For example, they could pay only the commercial rate for waste collection, and be exempt from paying household fees. This is another design element that will need to be decided by the community organization.

Following is a set of financial models for the CBWM project in the study area (Tables 13 to 20). The suggestions from the literature cited earlier in this section have been incorporated into some of these scenarios modelled in Tables 13 to 16. These scenarios are very design specific; the details will change based on each project decision that is made. As such, these scenarios are meant to describe different approaches and their effects on the overall financial standing of the project. These scenarios are also meant to show a range of prices for secondary collection that may be affordable for the community.

Scenario 1: High expenditure / honorarium and education scenario

In this scenario, the project pays 10% of the collected fees to the community organizers as an incentive for collecting a high percentage of fees (see Table 13). It is assumed that not all residents in the study area will pay their

fees for the waste collection service; 60%, 75% and 90% fee payment rates are modelled to give a hypothetical range of how different fee payment rates affect the financial feasibility of the project. These higher rates of fee payment are assumed to be the result of incentives for fee collectors and educational efforts.

Costs for educational efforts are listed as \$100 per month. This cost includes payment for ongoing educational efforts (such as door-to door waste stewards and other liaison work).

The high expenditure scenario includes the rental of a motorcart and hiring of the driver, which are assumed to be higher monthly costs than if the community itself invested in a motorcart and paid on a monthly instalment plan (as is modelled in Scenario 2).

In this scenario, it is assumed that two handcarts will be purchased for door-to-door collection, as this is a more equipment-intensive arrangement. It is assumed in this scenario that land will not be donated for the storage of waste before secondary removal. It is valued at a cost of \$500, as suggested by Lay Chanthy of RUPP. Ten percent of the purchase price of the land and equipment is included as a monthly repayment cost.

The collectors are paid \$100 per month. This amount is less than that received by CSARO workers in the CBWM project in Phnom Penh, but it is twice the rate paid to MICC workers. The higher payment rate is justified by the increased workload associated with a door-to-door collection system.

Table 13. Scenario 1 worksheet

<i>Monthly costs</i>		<i>Capital costs</i>		<i>Revenues</i>	
Labour	\$460	Uniforms	(\$30)	60% fee payment	(\$600-60) = \$540
Fuel	\$105	10% monthly payment on capital total	\$3	75% fee payment	(\$750-75) = \$675
Equipment maintenance	\$20				
Secondary collection	negotiable	Land for waste storage pre – secondary removal	(\$500)	90% fee payment	(\$900-90) = \$810
Education	\$100	10% monthly payment	\$50		
Honorarium	Subtracted from fee totals	Two handcarts	(\$260)	Commercial fees	\$100 ~
		10% monthly payment	\$26		
TOTAL:	\$685	TOTAL:	\$79	TOTAL:	\$640 - 910

The total costs add up to \$764 without including the secondary collection costs. Depending on the rate of fee payment, the project will be able to afford secondary collection at a price of between -\$124 and \$146 per month (the negative dollar value at the bottom of the range indicates that this is not a financially viable scenario).

As noted above, MICC has recently suggested that the project pay 50% of all fee revenue for secondary collection services. In this scenario, giving 50% of the fees to MICC for secondary waste removal affects the affordability of the project as displayed in Table 14:

Table 14. MICC 50% fee proposal for Scenario 1

<i>Fee payment rate</i>	<i>Revenue (\$1 fee + commercial fees)</i>	<i>50% remaining after paying MICC</i>	<i>Fixed costs to be subtracted (monthly costs, capital costs, and honorarium)</i>	<i>Remaining funds</i>
60%	\$600 + 100 = \$700	\$350	\$685 + 79 + 60 = \$824	\$350 - 824 = - \$475
75%	\$750 + 100 = \$850	\$425	\$685 + 79 + 75 = \$839	\$425 - 839 = - \$414
90%	\$900 + 100 = \$1000	\$500	\$685 + 79 + 90 = \$854	\$500 - 854 = - \$354

The resulting negative value of the funds remaining in each fee payment rate scenario indicates that there is no fee payment rate that will support giving 50% of the fees collected to MICC for secondary waste removal. This is supported by the following equation, which is designed to find the fee payment rate (FPR) at which it is affordable to give one half of fees to MICC. In this equation, the fee of \$1 is multiplied by the fee payment rate applied to 1,000 households to give the total revenue from fees, to which is added \$100 from commercial fees. This total amount of revenues is divided by two to give the amount of money that will be left for project operation after paying MICC. Fixed costs are then subtracted from this total (in this case, \$685 for monthly costs, \$79 for capital costs, and 10% of the fees collected from all households for the honorarium, which is represented as the fee payment rate times one hundred in order to depict 10% of one thousand households). Finally, the formula requires that the calculations are greater than zero, to give a fee payment rate that will be profitable. Solving for this equation shows the fee payment rate at which the net revenues will be greater than zero:

$$(1 \times \text{FPR} \times 1000 + 100) / 2 - (685 + 79 + 100 \text{ FPR}) > 0$$

$$(1 \times \text{FPR} \times 1000 + 100) / 2 > (764 + 100 \text{ FPR})$$

$$(1 \times \text{FPR} \times 1000 + 100) > 1528 + 200 \text{ FPR}$$

$$1000 \text{ FPR} > 1428 + 200 \text{ FPR}$$

$$800 \text{ FPR} > 1428$$

$$\text{FPR} > 1.785$$

It is not possible to have a fee payment rate of 179%; therefore, in this situation, it is not financially feasible to pay MICC 50% of the fees collected.

Scenario 2: Low expenditure / motorcart scenario

This scenario models a more capital-intensive arrangement (see Table 15). The community purchases a motorcart. Ten percent of the purchase price is included as a monthly cost until the motorcart is paid off. Labour prices are lower as the driver's rate of payment is lower than if he/she was providing the motorcart. Additionally, this scenario assumes a drop-off centre system, which is less labour intensive. Labour is given the same costs as MICC pays to its workers (\$50 per collector and \$75 for the driver).

This scenario does not pay the community organization a 10% honorarium, and does not include funding for ongoing educational efforts. Because of this lack of educational efforts and incentives, lower fee payment rates are modelled than in the high expenditure scenario.

The rate of resident fee payment is modelled at 40%, 75% and 90% in this scenario. The low-end estimate is based on the assumption that those who reported willingness to pay in the survey contribute fees, but that those who were not willing to pay were not persuaded to participate in the project. Also included in this model is a lower fee of 3,000 Riels (\$0.75 USD) at 60%, 75% and 90% payment rates; it is assumed that the lower fee price increases willingness to pay (Table 16).

Table 15. Scenario 2 worksheet, costs

<i>Monthly costs</i>		<i>Capital costs</i>	
Labour	\$175	Uniforms	(\$30)
Fuel	\$105	Motorcycle	(\$650)
Equipment maintenance	\$20	Cart	(\$240)
Secondary collection	negotiable	10% monthly payment	\$92
TOTAL:	\$300	TOTAL:	\$92

Table 16. Scenario 2 worksheet, revenues

<i>Revenues (\$1 fee)</i>		<i>Revenues (\$0.75 fee)</i>	
40% fee payment	\$400	60% fee payment	\$450
75% fee payment	\$750	75% fee payment	\$562.50
90% fee payment	\$900	90% fee payment	\$675
Commercial fees	\$100 ~	Commercial fees	\$100 ~
TOTAL:	\$500 - 1,000	TOTAL:	\$550 - 775

Total costs before secondary collection are \$392. Based on a \$1 fee, the project can afford to pay between \$108 and \$608 for secondary collection. Based on a \$0.75 fee, the project can afford to pay between \$158 and \$383 for secondary collection. This scenario presents a wide range of costs; it is important to note that without educational efforts or an honorarium, it is likely that the fee payment rate will be at the lower end of the range. This scenario also demonstrates that a 25% reduction in fees would reduce the operating budget to a range of \$150 to \$225, depending on fee payment rates.

In this scenario, giving 50% of the fees to MICC for secondary waste removal affects the affordability of the project as displayed in Tables 17 and 18:

Table 17. MICC 50% fee proposal for Scenario 2; \$1 fee

<i>Fee payment rate</i>	<i>Revenue (\$1 fee + commercial fees)</i>	<i>50% remaining after paying MICC</i>	<i>Fixed costs to be subtracted</i>	<i>Remaining funds</i>
40%	\$400 + 100 = \$500	\$250	\$300 + 92 = \$392	\$250 - 392 = -\$142
75%	\$750 + 100 = \$850	\$425	\$300 + 92 = \$392	\$425 - 392 = \$33
90%	\$900 + 100 = \$1000	\$500	\$300 + 92 = \$392	\$500 - 392 = \$108

Table 18. MICC 50% fee proposal for Scenario 2; \$0.75 fee

<i>Fee payment rate</i>	<i>Revenue (\$0.75 fee + commercial fees)</i>	<i>50% remaining after paying MICC</i>	<i>Fixed costs to be subtracted</i>	<i>Remaining funds</i>
40%	\$450 + 100 = \$550	\$275	\$300 + 92 = \$392	\$275 - 392 = -\$117
75%	\$562.50 + 100 = \$652.50	\$326.25	\$300 + 92 = \$392	\$326.25 - 392 = -\$65.75
90%	\$675 + 100 = \$775	\$387.50	\$300 + 92 = \$392	\$387.50 - 392 = -\$4.50

Using a version of the formula explained above (not including the honorarium), it is possible to find the exact fee payment rate that could support this financial arrangement with MICC. With a \$1 fee, the rate is as follows:

$$(1 \times \text{FPR} \times 1000 + 100) / 2 - 392 > 0$$

$$(1 \times \text{FPR} \times 1000 + 100) / 2 > 392$$

$$(1 \times \text{FPR} \times 1000 + 100) > 784$$

$$1000 \text{ FPR} > 684$$

$$\text{FPR} > 0.684$$

This arrangement with MICC is financially feasible with a fee payment rate of 68% or greater. The following equation assumes a \$0.75 fee:

$$(0.75 \times \text{FPR} \times 1000 + 100) / 2 - 392 > 0$$

$$(0.75 \times \text{FPR} \times 1000 + 100) / 2 > 392$$

$$(0.75 \times \text{FPR} \times 1000 + 100) > 784$$

$$0.75 \times \text{FPR} \times 1000 > 684$$

$$0.75 \text{ FPR} > 0.684$$

$$\text{FPR} > 0.912$$

Paying MICC 50% of fees becomes financially feasible at a fee payment rate of 91% or greater in this scenario.

Scenario 3: Medium expenditure / honorarium scenario

In this scenario, it is assumed that the local authorities could negotiate a better price for motorcart rental than the price obtained in the waste characterization study. A rate of \$250 per month is used (see Table 19). No equipment maintenance is included in this scenario as it is assumed the owner/lesser of the vehicle will assume these costs. The collectors are paid \$75 per month in this scenario, as a curbside collection system of relatively medium labour intensity is assumed.

Fifteen percent of fee payment is allocated to a community organization honorarium. It is assumed that some of the educational responsibilities could be assumed by the community organization as a part of this honorarium.

Fee payment rates are included at 60%, 75% and 90%.

Table 19. Scenario 3 worksheet

<i>Monthly costs</i>		<i>Capital costs</i>		<i>Revenues</i>	
Labour	\$400	Uniforms	(\$30)	60% fee payment	(\$600-90) = \$510
Fuel	\$105	10% monthly payment	\$3	75% fee payment	(\$750-\$112.50) = \$637.5
Secondary collection	negotiable			90% fee payment	(\$900-135) = \$765
Honorarium	Subtracted from fee totals			Commercial fees	\$100 ~
TOTAL:	\$505	TOTAL:	\$3	TOTAL:	\$610 - 865

The total monthly costs in this scenario add up to \$508 before secondary collection. In this scenario, the community can afford to pay from \$102 to \$357 per month for secondary collection, depending on fee payment rates.

In this final scenario, giving 50% of the fees to MICC for secondary waste removal affects the affordability of the project as follows:

Table 20. MICC 50% fee proposal for Scenario 3

<i>Fee payment rate</i>	<i>Revenue (\$1 fee + commercial fees)</i>	<i>50% remaining after paying MICC</i>	<i>Fixed costs to be subtracted (monthly costs, capital costs, and honorarium)</i>	<i>Remaining funds</i>
60%	\$600 + 100 = \$700	\$350	\$505 + 3 + 90 = \$598	\$350 - 598 = - \$248
75%	\$750 + 100 = \$850	\$425	\$505 + 3 + 112.50 = \$620.50	\$425 - 620.50 = - \$195.5
90%	\$900 + 100 = \$1000	\$500	\$505 + 3 + 135 = \$643	\$500 - 643 = - \$143

Using a version of the formula explained above (including the honorarium), it is possible to find the exact fee payment rate that will support this financial arrangement:

$$(1 \times \text{FPR} \times 1000 + 100) / 2 - (505 + 3 + 150 \text{ FPR}) > 0$$

$$(1 \times \text{FPR} \times 1000 + 100) / 2 > (508 + 150 \text{ FPR})$$

$$(1 \times \text{FPR} \times 1000 + 100) > 1016 + 300 \text{ FPR}$$

$$1000 \text{ FPR} > 916 + 300 \text{ FPR}$$

$$700 \text{ FPR} > 916$$

$$\text{FPR} > 1.31$$

Since it is not possible to have a fee payment rate of 131%, the fee sharing arrangement with MICC is not feasible in this scenario.

All of the above scenarios indicate that the design of a CBWM system, project component costs, fee payment rates, and educational efforts affect the financial feasibility of a project. The three scenarios identify potential arrangements that are financially feasible. However, the secondary collection fee to be charged by MICC remains the biggest uncertainty regarding feasibility, and one that cannot be resolved without negotiation.

5. Implementation, Evaluation, and Adjustment

It is recommended that indicators for project evaluation be identified at the beginning of the project. Such indicators may include resident satisfaction with the service, pollutant levels in nearby waterways and fields, number of participants in the project over time, and so on. Mr. Phourn Lina of the Office for Pollution Control informed me that there is water testing in the Siem Reap River at three points, but none of these points are in or near the study area. Introduction of water testing either in or downstream from the study area would provide valuable information about the effects of residents' waste (and wastewater) disposal behaviours. The Office of Pollution Control could conduct this testing, or the office could train local residents to conduct the tests themselves.

Prodipan's CBWM project in Khulna City, Bangladesh uses survey data and NGO reports to evaluate project impacts on the community in the following issues: methods of waste disposal, cleanliness of the area, environmental education and motivation in the community, health and economic effects, and the relationship between willingness to pay and project activities (Salequzzamana et al 2003).

Monitoring of indicators should be carried out in a consistent manner and for a set period of time (perhaps six months or one year, with a built-in process for on-going community evaluation). Implementation, evaluation, and adjustment are iterative processes that enable the researchers and the community to tailor the program to local needs.

6. Conclusions and Final Recommendations

It is the conclusion of this report that a CBWM project in the study area is potentially feasible, but its success is not guaranteed. With responsible and accountable community management, an increased level of community environmental awareness, and a high level of willingness to participate and pay, the likelihood of creating a sustainable project will be greatly improved.

It is important that this project has the support of the Department of the Environment (via the Chief Officer for Pollution Control), the local commune authorities, and other key informants in the area. If the cooperation of MICC can be assured and formalized at an affordable price, the financial feasibility of the project will also be greatly improved.

Recommendations for next steps

Community consultation is an advisable next step in this project.

This consultation could be carried out by researchers from the Royal University of Phnom Penh, or by the CBWM organization that is established to administer the project. The design of CBWM is mutable, and it is important that a project be tailored to local needs. Issues such as fee structure (including the affordability of fees), local enforcement measures and incentives, the allocation of land for secondary collection sites, and the composition of the community organization need to be discussed with local authorities and residents. Community participation could be elicited in a vote, public meetings, or focus groups.

Zurbrügg and Ahmed claim that “enhancing awareness and genuine [community] participation in the planning, design, implementation, and evaluation phases are important prerequisites for establishing successful primary refuse collection schemes” (1999: 2). Project sustainability rests on the motivation of the community and the structures built to support long-term interests in the project; community consultation is integral to both.

It is important that the entire community be represented in consultations, since gender, age, and location of residents all appear to be connected to waste-related attitudes and behaviours. **It is also recommended that the structure of the community organization established to administer this project reflect the diversity of this study area.** The local authorities who will serve in this organization will need to ensure residents are selected for participation from all locations, age groups, socio-economic groups, and both genders. It is likely that

there will be cultural challenges to creating a truly inclusive organization; if the CBWM project is to address the diverse needs of the study area, these prejudices will need to be dealt with.

It is difficult to make particular design recommendations for this CBWM project, as there are many possible configurations of service provision with regard to the collection system, equipment purchases, hiring of workers, and so on. **It is recommended that the community-based organization consider local preferences for these design options in their decision-making, and that it also take into account the financial implications of these decisions.**

A more complete costing needs to be completed by the community organization, once it is established. Some of the prices obtained in the above cost analysis were obtained by “outsiders,” and so may be inflated. Additionally, local preferences for such costs as honorariums and labour prices must be taken into consideration.

The above financial scenarios demonstrate the importance of negotiating an affordable price for secondary waste removal with MICC. If the negotiation process does not proceed well, **it is recommended that the community organization ask the City Governor to act as a facilitator in further negotiations.**

Awareness-raising activities are an important next step in preparing a CBWM project, especially considering the low willingness to pay in this area, and the convenience of the current waste disposal practices of burning and dumping waste in the river. These educational programs need to be mindful of the complex and uneven levels of environmental awareness in the area, and should be designed with regard to the level of diversity in this community. Topics to be addressed include what pollution is, how it occurs, how pollutants affects health and natural surroundings, what are toxic wastes, and so on.

It is recommended that educational programs use multi-media, including personal messages, public workshops and demonstrations, distribution of written notices (such as posters and leaflets), radio announcements, and interactions with local schools. After educational programs have been set up and run in the study area, another series of surveys may be required to assess any changes in willingness to pay and willingness to

participate in CBWM. This option depends on the availability of funding for such research.

To enhance the ability of the local community to evaluate the impact of its CBWM interventions on river quality, **it is recommended that the Office for Pollution Control conduct water quality tests, or develop local capacity for water testing, in the study area.**

Recommendations for future research

It is recommended that further research be conducted into the feasibility of a composting project of some type in the study area. Composting would reduce the amount of waste generated by the community, and could potentially offer a source of income for householders.

To support composting research, another more comprehensive waste characterization study could be conducted. If this study was conducted after a CBWM collection program had already been established, waste collection routines would be standardized, and reasons for waste hoarding would be reduced, thereby making the results of the study more reliable and reducing cases of non-participation.

It is also recommended that more research be conducted on the relationships between waste-related behaviours and attitudes and socio-economic factors such as gender, income, and age. The results of the household survey and waste characterization study have suggested some interesting connections between these variables that could affect the form and function of a CBWM project. A greater understanding of these relationships would allow for more precise targeting of educational materials for those who are less willing to pay for waste collection services, for example. This research could be conducted by RUPP and Waste Econ researchers in the form of a follow-up survey or as a series of focus groups. Alternately, this research could be conducted as a participatory action research project led by the community organization.

Finally, **it is recommended that partners from the Office for Pollution Control, RUPP, WasteEcon, and the community organization conduct research on wastewater management in the study area.** Household solid

waste is not the only contributor to river pollution in this area, and efforts toward improved wastewater management will also enhance local water quality. At this point, it is difficult to understand the nature and magnitude of the contribution of wastewater to river pollution.

Appendices

Appendix A: Key players in CBWM

Community-based organizations (CBOs)

Anschutz notes that community supervision of a project is a crucial part of true community management (1996). CBOs can be responsible for such functions as fee collection, hiring of waste workers, and community education. In addition, negotiations with municipalities on waste issues can place community leaders in a potentially advantageous position as liaisons with government institutions.

A CBO can be formed either internally of its own accord, or its creation may be precipitated by a government or NGO with the aim of creating a leadership and organizational mechanism to run community-based projects. Lee notes that those formed autonomously within the community are often more effective, independent, and sustainable (1998). This indicates that a community that has already organized itself and established decision-making and leadership processes is more likely to be successful in the face of the difficulties of implementing a CBWM program.

Non-governmental organizations (NGOs)

Often, communities are unable to institute CBWM of their own accord; “external intermediary institutions are needed to provide support to communities in mobilizing internal resources and gaining access to outside inputs that enhance their capacity to improve their habitat” (Lee 1998: 993). NGOs can offer much to CBOs interested in pursuing CBWM initiatives. They can assist the community by facilitating government connections, improving grassroots networking, replicating existing CBWM projects in other locations, and providing initial start-up funds (for wages, equipment, and so on.).

However, there are drawbacks to reliance on non-governmental organizations. Satterthwaite notes that aid agencies and development banks have a “limited capacity to support local institutions that respond to the needs and priorities of low-income groups” (2001: 137). NGOs are often based in industrialized nations, possibly creating a foreign dependence. This can also lead to the exclusion of local knowledge from decision-making processes.

Furthermore, NGO commitments are often relatively short-term, potentially leading to discontinuity in the project.

Government

“[CBWM] has reduced pressure on the city governments. The city government can divert its resources to more neglected or problematic areas” (Hasan and Khan 1999: 107). As such, CBWM can be appealing to politicians as a long-term solution for local environmental issues.

The role of governments in CBWM can include financing, organizational partnership, and the creation of CBOs. With regard to a successful CBWM program in the Phitsanulok province of Thailand, Yamvinij notes that cooperation between community members and municipal officials was integral to the process of introducing CBWM (1999-2000).

The secondary removal of collected waste is an integral part of waste management: “A reliable primary waste collection scheme depends upon the design and location of transfer points and subsequent haulage of waste by the municipality to the disposal sites” (Ali and Snel 1999: 18). This secondary waste collection function is often provided by municipal services, or by the same private companies that provide contracted collection to municipalities. Therefore, government involvement in this aspect of CBWM is often important.

Local entrepreneurs

Local entrepreneurs can be incorporated into CBWM in many ways, including collaboration with the recycling industry, the compost industry, and livestock feed purchasers. A community can potentially self-finance its waste management if there is already an active recycling industry, compost industry, or livestock interests that can use refuse as feed. These industries may be willing to pay for useful waste, or they may be willing to trade their labour as waste collectors in return for access to certain waste products. This arrangement sometimes takes the form of employing waste pickers from city dumps or the streets as collectors in a CBWM project.

Household participants

Anschtz observes, “community members can participate in solid waste management by showing proper sanitation behaviour, by contributions in cash, kind or labour, by participation in consultation and by participation in administration and management of solid waste services” (1996: 17).

Extending Anschtz’s consultation of the water literature, we can identify an aspect of waste management sustainability in Serageldin’s article on water and sanitation; he notes that “experience shows unequivocally that services are efficient and accountable to the degree that users are closely involved in providing financing for them” (1994: 15).

Gender- and youth-specific responsibilities

The participation of certain sectors of the community in CBWM (such as women and youth) is of particular importance. The meaningful participation of women in waste issues is imperative, as women are generally responsible for waste disposal within the home. Women usually give higher priority to improvement of any type of community services, and often initiate CBWM projects. They are also often involved in education campaigns, whether regarding waste or other issues (Anschtz 1996).

Youth have a less distinct role in CBWM than women do, although children often assist in household duties, including waste disposal. Adolescents are sometimes employed in CBWM (Cissé 2003). Thus, an awareness of youth issues and their community involvement are considerations for CBWM projects.

Appendix B: Methods

Household survey

Researchers at the Royal University of Phnom Penh (led by Mr. Lay Chanthy) conducted a survey of 300 of the 1,000 households in the study area in the spring/summer of 2004. The questionnaire administered during the survey was designed with the advice of Prof. Virginia Maclaren from the University of Toronto. A systematic sample of every third house in the study area was selected for participation in the survey. The survey took place over a period of four days during daylight hours. The interviewers were third-year environmental science students from RUPP who had received one day of training from Mr. Chanthy on how to administer the survey.

The survey was directed to the wife or mother of the household wherever possible, as women usually have responsibility for waste management tasks in Cambodia. The questionnaire asked about socio-economic characteristics of the household and posed questions about attitudes towards waste and the environment, waste management, and willingness to pay for collection services. I worked together with researchers at the Royal University of Phnom Penh to perform statistical analyses of the survey data. A copy of the questionnaire can be found in Appendix C.

Waste characterization study

I completed a waste composition study in the study area in the summer of 2004 to observe the amounts and composition of the waste produced in the study area. I selected a stratified random subset of 50 households from the 300 households canvassed for the household survey. Although it was not possible to include all 300 households in the waste composition study because of time and cost constraints, the sample of 50 meets the minimum requirements needed for sound statistical analysis. This subset was stratified according to income (using survey responses to the household expenditures variable, which was a proxy for income since the collected income data was determined to be unreliable) and house location (directly on the river or on the roadside, on the east or west side of the river).

Once the 300 surveyed households were thus categorized, the subset was selected (using a random number table and the survey identifier numbers) to represent the same proportions of each category found in the full sample. Residents were asked to collect their household waste (any materials they would

normally burn, bury, or throw in the river or other public spaces) in the provided plastic bags each day for a week. This extended observation period was chosen to minimize hoarding behaviours that can skew data collection. With the help of a local assistant, I collected the waste each morning and it was then taken to an area provided by a local school for sorting.

To exclude instances of hoarding on the first and last days of the study participation, those data points more than two standard deviations away from each respective household's average daily weight of waste were excluded from this average during the analysis. Those points more than two standard deviations away from the average that occurred during the observation period, but not on the first or last day of participation, were assumed to be fluctuations that could be expected to occur regularly and were not excluded from the average weight calculation. In some cases, resident comments on our morning collection route substantiated that these fluctuations were not due to hoarding, but to normal variations in waste generation; for example, a resident with a lot of waste mentioned that she had had a party the previous night. Overall, six cases of first-day hoarding and two days of last-day hoarding were excluded from the results.

The occurrence of first-day hoarding is supported by the first-day waste total of 124.2kg (versus the average of 92.5 kg for the other six days of observation). The five outliers removed because of suspicion of hoarding behaviours accounted for 43.3kg of the first-day waste total. This hoarding could be due to residents saving their waste from the previous days (as some were approached to participate several days before the study actually began), or could be due to residents picking up excess waste lying around their house that they usually leave there. I observed that much of the plastics and paper collected on the first day was coated with dirt. My suspicion that yard waste was included in the first day of collection was later confirmed when we found that there was a disproportionately high amount of dirt in the waste collected on the first day – 25.6% by weight versus the study average of 14.0%.

Higher volumes of waste also could have occurred because people used the opportunity of the study to dispose of their neighbour's waste. This may explain the few instances of last-day hoarding that were observed among people who may have perceived the end of the waste study as their "last chance" to

have waste collected at the door. However, many people didn't realize that the study had ended when it did, possibly because eight plastic bags were handed out in case residents needed an extra bag over the seven-day study period. On the day after the study ended, I observed that many of the study households had put out bags of waste to be collected. This lack of awareness of the study end for some was beneficial in that it may have prevented last-day hoarding.

Finally, there were some instances of non-participation in the study. The head of one household repeatedly stated that the family did not have any waste to be collected since it did not produce any. Some other households also had one or two days of non-participation, either because they forgot, because dogs ate their trash, or because they had "no waste."

Key informant interviews

I conducted a series of semi-structured interviews with local stakeholders in the summer of 2004, including commune leaders, a private waste hauler, an educator, a Buddhist monk, an NGO, and a representative of the Department of the Environment's Office for Pollution Control. All interviews were conducted in the interviewees' place of work, and each lasted approximately forty minutes. The interviews were designed to establish local attitudes towards waste and the environment, and to establish stakeholders' willingness to participate in CBWM. I conducted the interviews with the assistance of a translator, Mr. Phourn Lina of the Office for Pollution Control. A list of the questions posed to key informants can be found in Appendix D.

Limitations of the research

Language is the most significant limitation of this research. The key informant interviews and waste characterization study were completed with the assistance of a translator. It is possible that some subtleties of the situation in the study area may have been missed because of the language barrier.

Human error also factors into this research as it has involved a large amount of data recording and analysis. Minor errors have been found in the survey sheets completed by hand, in the coding of these survey results, and in the analysis of the data. I have checked the data input and analyses multiple times, and to the best of my ability, to reduce this source of error.

Appendix C: Household survey

Feasibility Study

HOUSEHOLD QUESTIONNAIRE FOR PILOT PROJECT ON COMMUNITY-
BASED WASTE MANAGEMENT

April 2004

Objectives:

1. Identify socio-economic characteristics of householders
2. Identify householder preferences for:
 - a. Waste collection frequency
 - b. Door-to-door collection versus collection at transfer sites
 - c. Collection fees
3. Perceptions and attitudes about waste
4. Willingness to separate organics and inorganic
5. Current waste behavior
 - a. Current amount of separation of organics and inorganic and destination of the separated waste
 - b. Current disposal locations
 - c. Waste responsibilities within the household
6. Willingness to participate in organizing a community-based collection system

Target respondent: assuming women have most responsibility for waste management in the household, ask to speak to the mother or wife of the household; if she is not available, interview the father or husband or any other adult in the household.

PILOT PROJECT ON COMMUNITY-BASED WASTE MANAGEMENT IN SIEM REAP TOWN

**Household Questionnaire
for
Pilot Project on Community-based Waste Management**



Interview ID :
 Date of interview :
 Interviewer name :
 Interviewee name :
 Time for interview: from..... to.....

- Address : N°, Village, Commune, Srok Siam Reab.
- Location of house: West river West road East river East road
- Distance to river: metres Size of backyard: metres xmetres
- Housing material: Mostly brick or cement Mostly wood
 Mostly thatch Mostly bamboo Other
- Roof material: Concrete Tile Zinc Thatch Plastic sheet Other
- Observe waste around the house: A lot Not so much Little None

Q1. How many people in your household fall into each of the following categories? (put a check mark beside the category for the person being interviewed)

Age category	Number	# of Male	# of Female
Child under 6 years old			
Child 6 – 17 years old			
Adult over 17 years old			
Total family member			

Q2. What are the education levels of the following family members?

	No edu	Prim	Secon-	High	Certi	Univer	Sex-Age
Person being interviewed		-				-	
The head of household (if different from person being interviewed)							
The person with the highest education level in the household (if different from the above)							

3a. What is the monthly household income of household members by occupation?

Occupation	Number of people	Monthly income for each person
1.		
2		
3		
4		
5		
6. Feed animal for sale		
Monthly household income in total		

3b. About how much per month does your household spend on the following items?

Items	Monthly expenditure	Items	Monthly expenditure
Food		Cloths	
Electricity		Fuel for cooking	
Fuel for car or motor		Telephone	
Health care		Children education	
Water		Festival and culture	
Other		Other	

Q4. How many rooms does your house have? _____ rooms (not including kitchen and bathroom)

Q5. Do you own or rent your house? Own Rent

Q6. What services does your home have?

Curbside waste collection Piped water supply Ground water

Connection to electricity supply Television cable

Others.....

Q7. Which of the following people in your household are mainly responsible for waste management within the home? (more than one person can be checked)

Wife Other female adult Husband Other male adult Female child

Male child Maid Not specific

Q8a. How much of your waste do you dispose in the following ways?

	All	Most	Some	Little	None
On the streets					
Give to the garbage trucks					
In open space nearby					
In the river					
Burn					
Bury in our backyard					
Other (specify)					

Q8b. How do your neighbors management their waste?

- Burn Bury Dump behind house Dump under the house Throw into the river
- Dump at the curbside Dump on the free land near the house Others

Q9. How often do you usually dispose of your household waste?

- Two times per day Once a day Every two days Every three days
- Two times per week Once per week Throw immediately after generate
- Others

Q10. If your family does not receive curbside waste collection service, explain why.

- There is waste collection available but I don't pay
- No waste collection available in this area
- I do not produce any waste for collection
- I do not need the service because I can dispose of my waste in other ways
- Other

Q11a. How do you think about the quality of Siem Reap River at the present?

- Heavy polluted Polluted Some polluted No problem
- Don't know

Q11b. If this river has been polluted, what are the major sources to pollute this river?

- Solid waste Wastewater illegal buildings along the river Don't know
- Other (specify).....

Q11c. What do you think for improving the quality of this river?

- Provide waste collection, Provide wastewater collection system Improve law and enforcement Educate people Don't know Other (Specify).....

Q12a. Do you feel that any of the following environmental issues are problems for your area?

Environmental Issue	Not a problem	A small problem	A big problem
Lack of water supply			
Poor water quality			
Noise			
Dust			
Lack of waste collection services			
Poor or no sewage collection			
Air pollution			
Air pollution from burning waste			
Odours			
Flooding			
Other			

Q12b. Does your area face with solid waste problems? Yes No

Q13. If you feel that lack of waste collection services is a small or big problem for your community, could you please explain which of the following reasons make you think that way?

Because uncollected waste causes the following problems:

	Not a problem	Small problem	Big problem	Don't know
It attracts dogs				
Waste appears everywhere and is unsightly/messy				
It attracts flies and mosquito				
It causes other people throw their waste on my land				
It attracts rats				
It pollutes the water (river)				
It causes health problems				
It smells				
Other (specify)				

Q14a. What do you think about the following ideas for improving waste management in your community?

	Agree strongly	Agree	Neutral	Disagree	Disagree strongly

Educate people about waste problems					
Improve law enforcement and strictly prohibit people from burning or throwing waste in the river					
Our community should work together to provide its own collection service and hire local collectors					
The city should provide collection services					
Other? (specify)					

Q14b. Do you want to have waste collection service in your area? Yes No
 If no why don't you want to have? I have space for disposing my waste I can burn
 I don't produce much waste for collection Other

.....

Q15a. In the rest of Siem Reap, households pay 4,000 Riels per month for monthly curbside collection. Would you be willing to pay 4,000 Riels to have waste collected from you home at curbside?
 Yes, definitely Maybe Yes, if the other houses pay, too
 No, definitely not No answer

Q15b. Would you be willing to pay 3,500 Riels per month for curbside collection every second day?
 Yes, definitely Maybe Yes, if the other houses pay, too
 No, definitely not No answer

Q15c. Would you be willing to pay 2,500 Riels per month for curbside collection twice per week?
 Yes, definitely Maybe Yes, if the other houses pay, too
 No, definitely not No answer

Q15d. Would you be willing to pay 2,000 Riels per month for curbside collection once per week?
 Yes, definitely Maybe Yes, if the other houses pay, too
 No, definitely not No answer

Q16. Do you separate any of your wastes to sell or give away? Yes No
 If not separate pls state the reason why?.....
 If yes, which items do you separate and about how much money do you

receive per month for those that you sell?

Types of material	How much separated?				Monthly income from selling	If for selling, sell to whom?	If for giving away, give to whom?
	All	Most	Some	None			
Metals							
Newspaper, paper							
Bottles							
Cans							
Plastic							
Clothing							
Food waste							
Others							

(For selling to: 1. Hetchai buyer, 2. Depots, 3. Enterprise, 4. Other?)

(For giving away to: 1. Friend, 2. poor people, 3. waste picker, 4. other?)

Q17. If you separate any of your wastes now, why do you separate them?

Why separate?	Most important reason	Less important Reason	Not important
To earn income			
To reduce the amount of waste needing disposal in my home			
Because it is good for the environment			
Because our family has always done it			
Others (specify)			

Q18a. Do you feed any animals? Yes No

If yes, which animals do you feed? Do you use any of your food wastes for feeding your animals?

Type of animal	Number of animals	Type food wastes
Pigs		
Cows		
Goats		
Chickens and Ducks		
Dogs?		
Others		

Q18b. If you separated your kitchen wastes for feeding animals, do you separate all kind of kitchen waste? Separate all Separate some Separate little Others

Q19. Do you make compost from food and/or garden waste? Yes No
If yes, why do you do it? To make the soil better for tree and vegetable growing
For reducing the amount of waste to dispose Because our family has always done it
For selling Others

Q20a. Would you be willing to separate your food wastes from the rest of your waste on a regular basis? Yes Maybe completely not

Q20b. If your answer is yes, will you separate all kind of kitchen waste from other wastes?
Separate all Separate some Separate only the specific Others

Q21. Do you have any comment or suggestions about waste management in your community?

.....
.....
.....
.....
.....
.....
.....

Appendix D: Key informant interview schedule

General Questions (will be posed to all)

Do you consent to participate in this interview? Yes___ No___

Where do residents currently dispose of their waste? Why?

Where do you think waste should be disposed of? Why?

Is waste a problem in this community?

What are the connections between waste in this community and your health?

How does waste in this community affect the environment?

Where could waste be stored once it is collected from residences, and before it is picked up by the city waste service?

Who do you believe should be responsible for coordinating waste disposal in your community?

Would you be willing to participate in the organization of waste management in your community?

What is the best way to encourage people in this community to participate in a project?

What is the current level of environmental training and awareness in this community?

Are there any examples of environmental action in this community?

Are there ways of teaching new skills or information that have previously been successful in this community?

Private waste collection company

What are the prices of eg collection equipment, labour costs of collection, the prices associated with the recycling industry, and so on.?

Local environmental authorities

How often do residents dispose of household wastes?

If there was a waste collection service, how often should a collector remove the waste from residences?

Do residents compost organic (food) wastes?

Do residents separate their wastes?

Which items are separated for reuse or resale?

To whom are separated items passed on? (eg itinerant buyers, neighbours, local farmers, and so on.)

What is the price paid to residents for the following recyclables:

Metal

Paper

Plastics

Other

Local educators

What is taught about waste in the school system?

What is taught about pollution?

What is taught about environmental protection?

Local commune leaders

How often do residents dispose of household wastes?

If there was a waste collection service, how often should a collector remove the waste from residences?

Do residents compost organic (food) wastes?

Do residents separate their wastes?

Which items are separated for reuse or resale?

To whom are separated items passed on? (eg itinerant buyers, neighbours, local farmers, and so on.)

What is the price paid to residents for the following recyclables:

Metal

Paper

Plastics

Other

How much money would residents be willing to pay each week to have waste collected from their homes? From their block?

How should waste collection fees be collected? (e.g. each household pays the same; pay according to weight of waste; pay according to volume of waste; pay according to household size, and so on).

What organizations and institutions operate in this community (for example, religious institutions, NGOs, and so on)? How would you describe the social relationships of people in this community?

Appendix E: Supplementary graphs

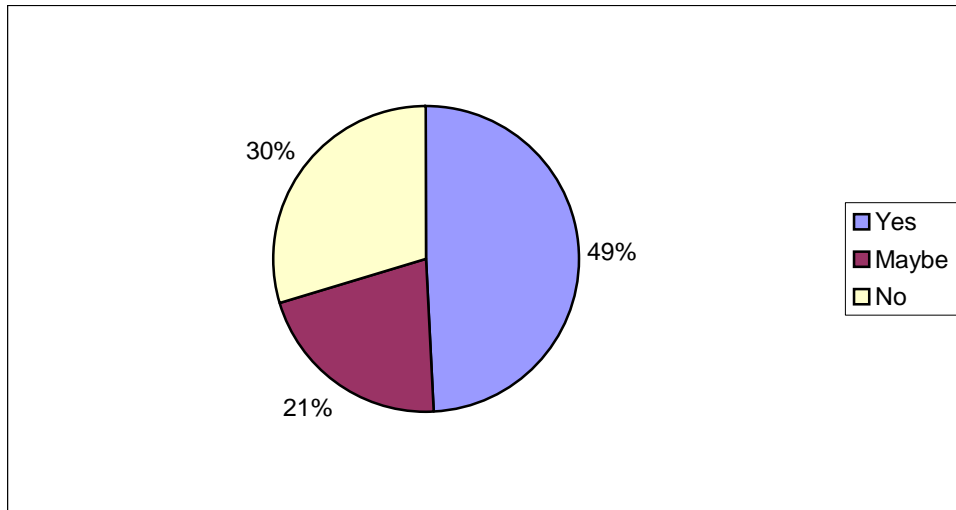


Figure 20. Willingness to separate food waste

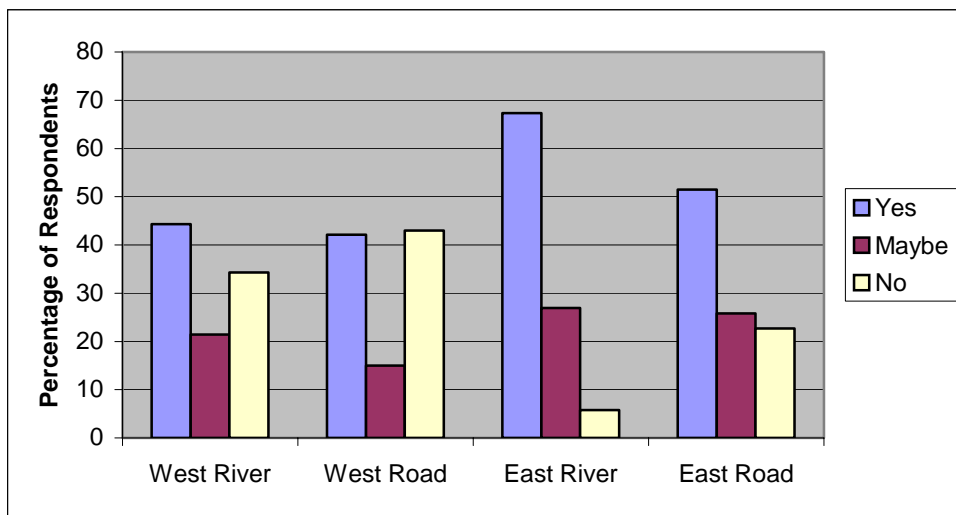


Figure 21. Willingness to separate food waste, by location

Figure 20 shows that 49% of residents are willing to separate food wastes. Residents in the West Road and West River areas are less willing to separate wastes than are those in the East River (especially) and the East Road (Figure 21, $p = 0.000$). It is difficult to determine a cause for this divergence in attitudes between the East and West sides of the river.

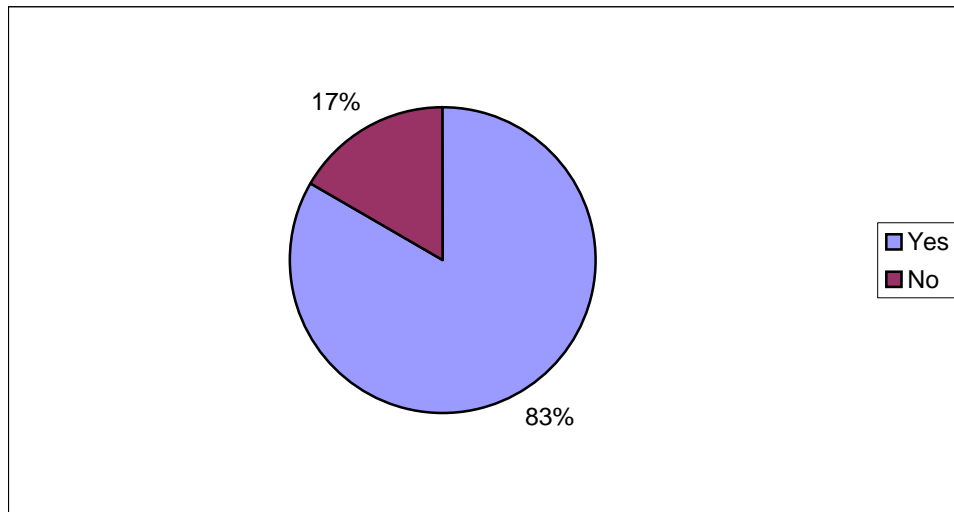


Figure 22. Perception of solid waste as a source of river pollution

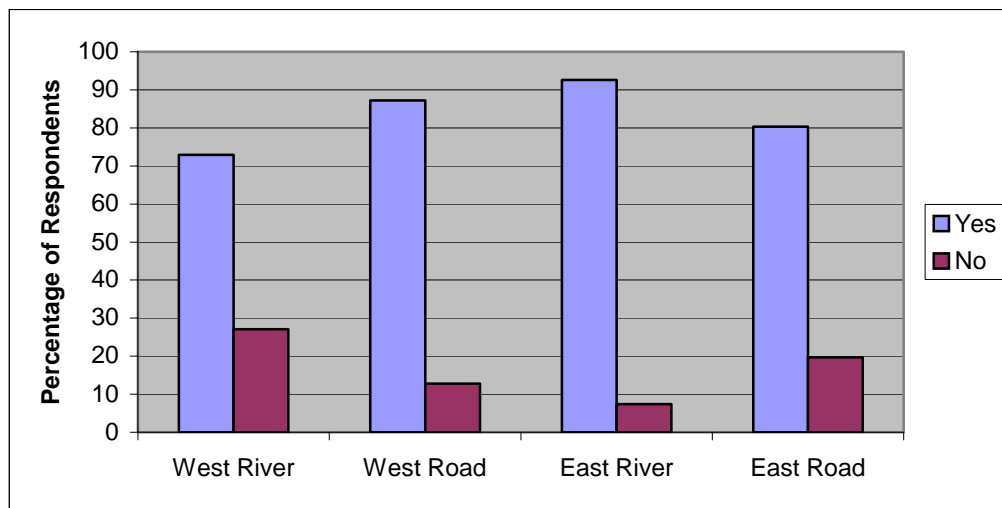


Figure 23. Perception of solid waste as a source of river pollution, by location

Seventeen percent of residents perceive solid waste to be a cause of river pollution (Figure 22). Those living on the West Road and East River hold this perception less than residents of the West River and East Road do (Figure 23, $p = 0.014$). The connections between these pairings of locations are not obvious, particularly as it could be assumed that those living on the river would be more acutely aware of river quality than other residents.

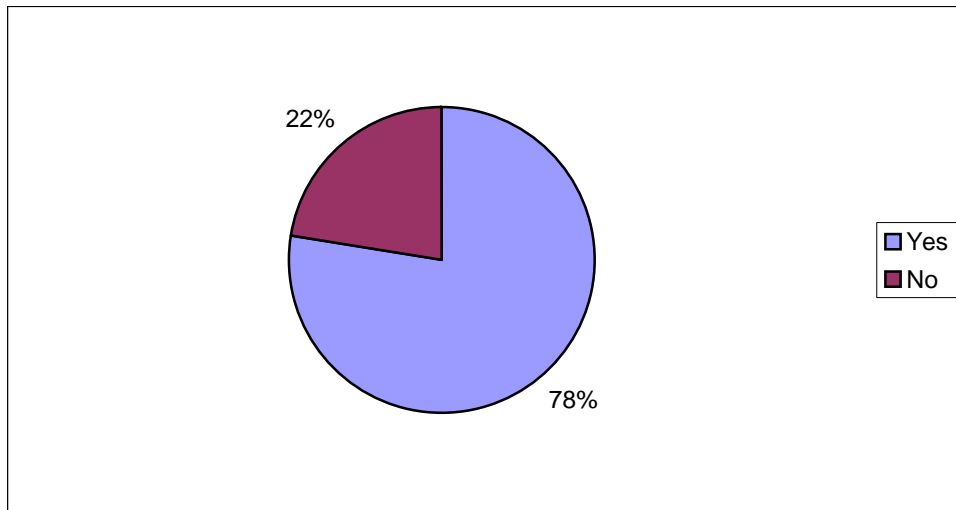


Figure 24. Perception of wastewater as a source of river pollution

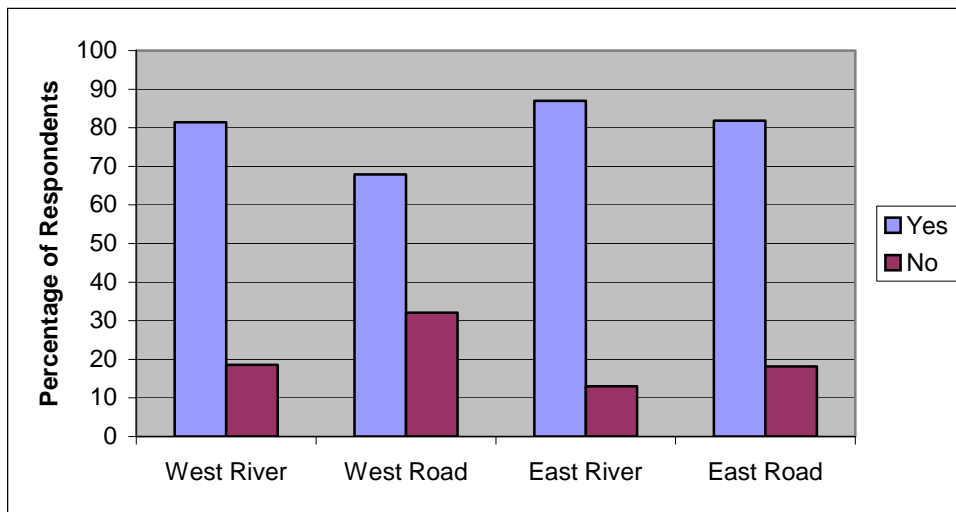


Figure 25. Perception of wastewater as a source of river pollution, by location

Figure 24 shows that 22% of residents perceive wastewater to be a source of river pollution. West Road residents are least likely to hold this perception, followed by West River residents (Figure 25, $p = 0.018$). Again, the assumption would be that those living on the river would be more aware of river quality than other residents.

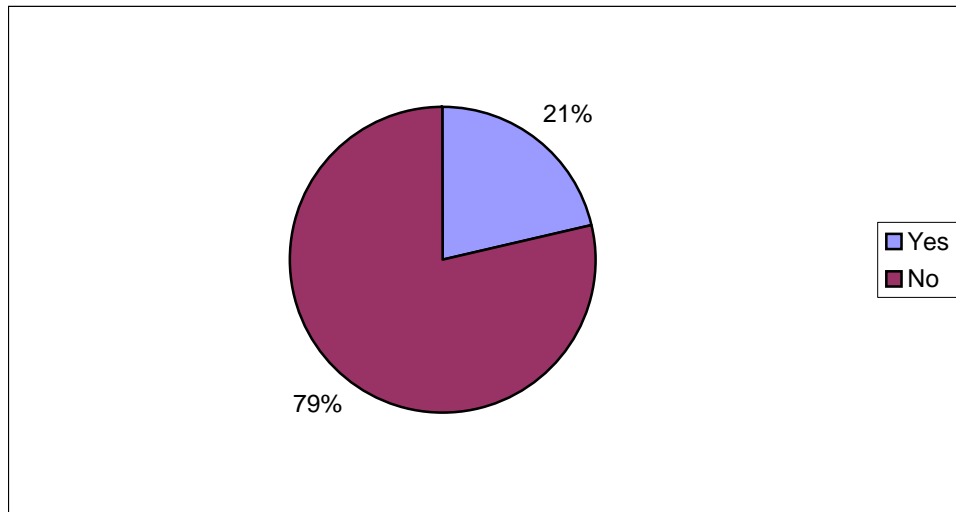


Figure 26. Perception of waste collection as a potential approach to improving river quality

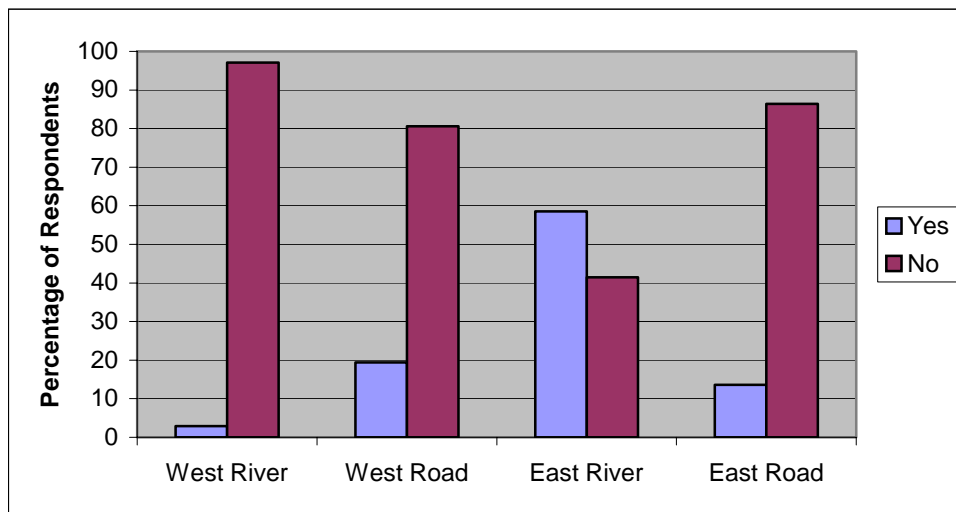


Figure 27. Perception of waste collection as a potential approach to improving river quality, by location

Twenty-one percent of residents believe that waste collection would improve river quality (Figure 26). East River residents are the only group with a majority of respondents expressing this opinion (Figure 27, $p = 0.000$). West River residents are least likely to believe that waste collection will improve river quality despite their close exposure to the river and the trash it carries.

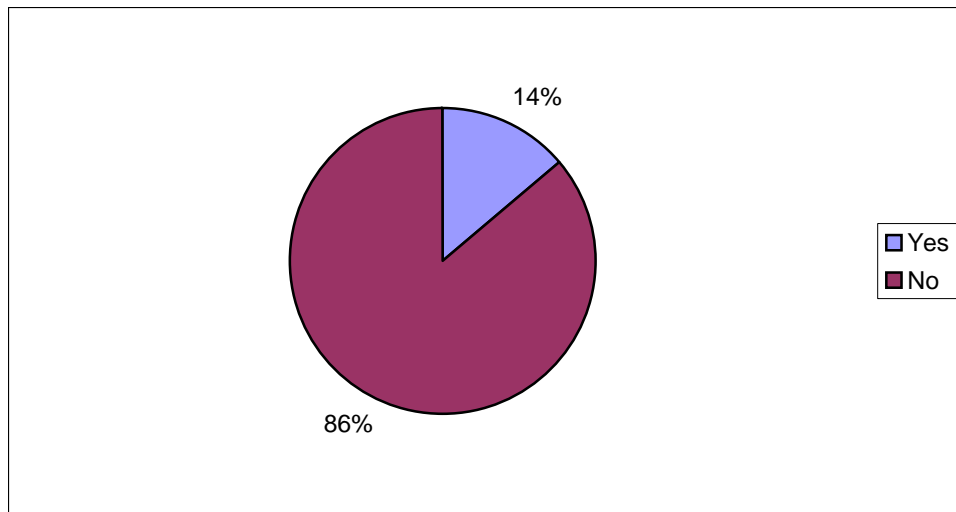


Figure 28. Perception of education as a potential approach to improving river quality

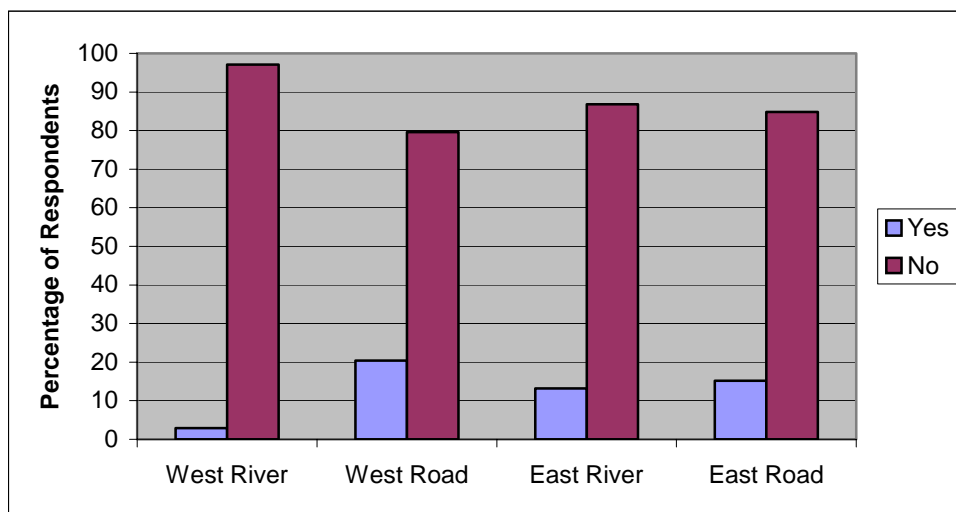


Figure 29. Perception of education as a potential approach to improving river quality, by location

Fourteen percent of residents believe that education could improve river quality (Figure 28). Those who live in the West River are least likely to hold this belief (Figure 29, $p = 0.012$). It is difficult to understand the cause of this difference.

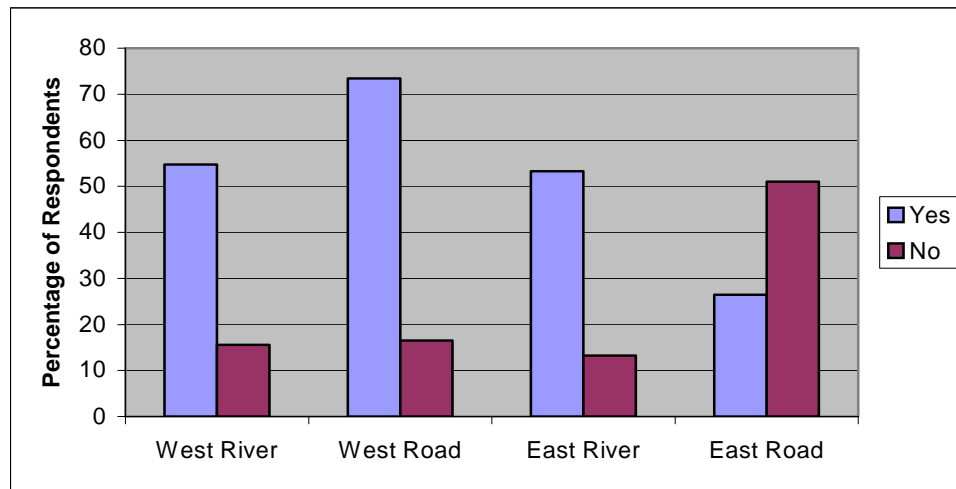


Figure 30. Willingness to pay 4,000 Riels for collection service, by location

East Road residents are particularly reluctant to pay 4,000 Riels for waste collection services (Figure 30, $p = 0.000$). It is possible that this finding is related to socio-economic variables, such as relative ability to pay. However, in the absence of reliable income or expenditure data, it is difficult to know if this observation results from an aggregation of people who are not able to afford 4,000 Riels per month.

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