



CLOSING  
THE LOOP

# CLOSING THE LOOP ON PLASTIC POLLUTION IN NAKHON SI THAMMARAT, THAILAND

## Baseline Report



# Acknowledgement

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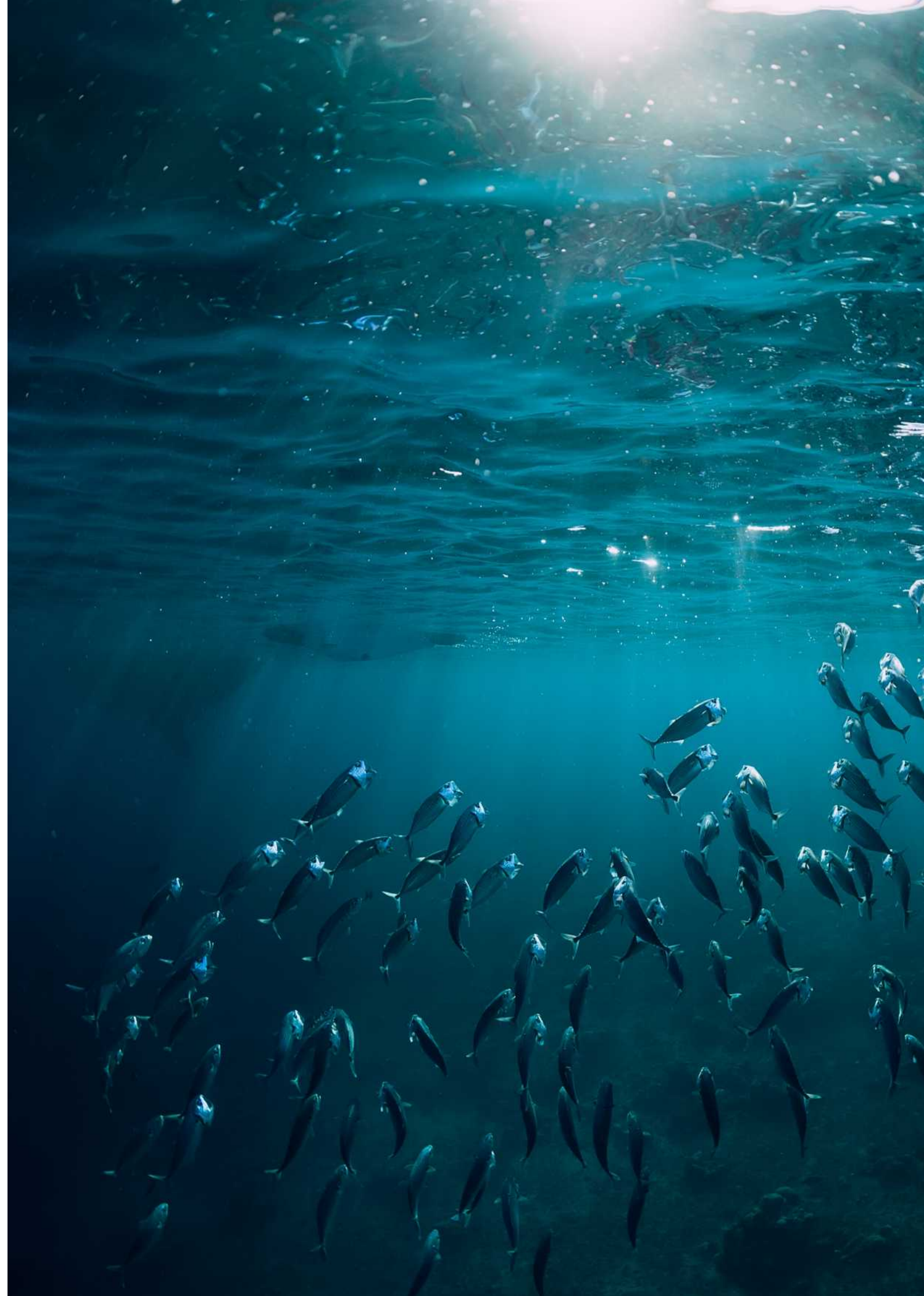
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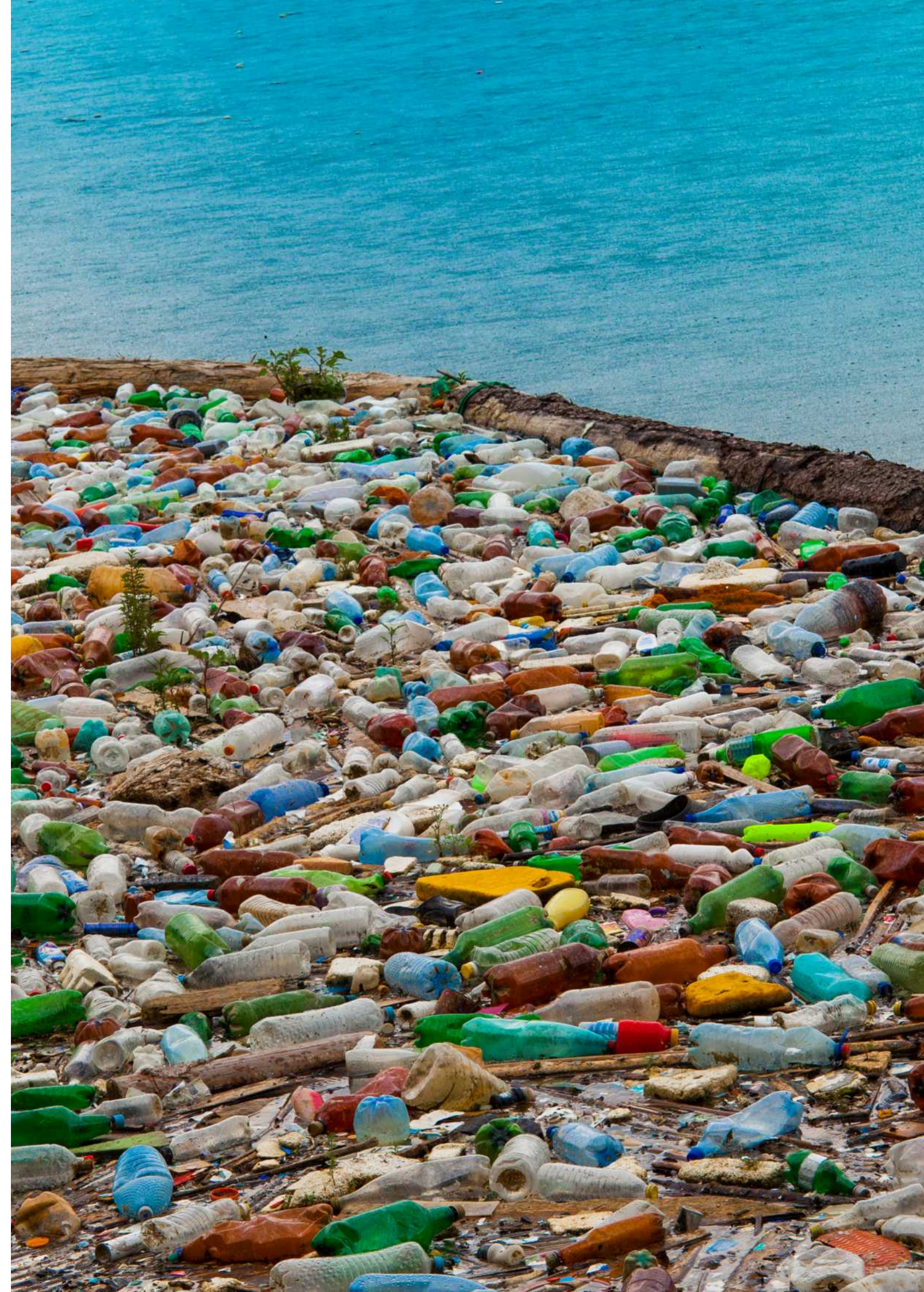
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## Abbreviation

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<b>3Rs</b>	Reduce, Reuse, Recycle
<b>APEC</b>	Asia-Pacific Economic Cooperation
<b>ASEAN</b>	The Association of Southeast Asian Nations
<b>B.E.</b>	Buddhist Era
<b>CSO</b>	Civil Society Organization
<b>CTL</b>	Closing the Loop
<b>DEM</b>	Digital Evaluation Model
<b>DMCR</b>	Department of Marine and Coastal Resources
<b>EGAT</b>	Electricity Generating Authority of Thailand
<b>EPR</b>	Extended Producer Responsibility
<b>EIMP</b>	Environmental Impact Mitigation Plan
<b>ESCAP</b>	United Nations Economic and Social Commission for Asia and the Pacific
<b>GHSL</b>	European Commission Global Human Settlement Layer
<b>GPS</b>	Global Positioning System
<b>ICT</b>	Information and Communication Technology
<b>IGES</b>	Institute for Global Environmental Strategies
<b>ISIC</b>	International Standard Industrial Classifications of All Economic Activities
<b>ISWA</b>	International Solid Waste Association

<b>LAOs</b>	Local Administrative Organisations
<b>MFA</b>	Material Flow Analysis
<b>MOI</b>	Ministry of Industry
<b>MONRE</b>	Ministry of Natural Resources and Environment
<b>MOPH</b>	Ministry of Public Health
<b>MSW</b>	Municipal Solid Waste
<b>Mt</b>	Metric tonne
<b>PAO</b>	Provincial Administration Organisation
<b>PCD</b>	Pollution Control Department
<b>PPC</b>	Plastic Pollution Calculator
<b>PPP</b>	Public-Private Partnership
<b>SAOs</b>	Sub-Sub-District Administrative Organisations
<b>SDG</b>	Sustainable Development Goals
<b>SPP</b>	Small Power Producer
<b>SWM</b>	Solid Waste Management
<b>SUPs</b>	Single-Use Plastics
<b>THB</b>	Thai Baht
<b>UOL</b>	University of Leeds



# SUMMARY

CLOSING THE LOOP ON PLASTIC POLLUTION  
IN NAKHON SI THAMMARAT CITY MUNICIPALITY, THAILAND

P12 **Statement from Nakhon Si Thammarat  
City Municipality City Municipality**

P14 **Executive Summary**

Key Findings on Plastic Waste in Nakhon Si Thammarat  
City Municipality City Municipality  
Plastic Management Recommendations  
Policy Recommendations

## Statement from Nakhon Si Thammarat City Municipality

Nakhon Si Thammarat City Municipality is a cultural and commercial city with historic surroundings. We are one of the most livable cities in Thailand in terms of healthcare, culture, environment, education, and infrastructure. In 2021, we embarked on a journey to transform Nakhon Si Thammarat City Municipality into a smart city with a focus toward Sustainable Development Goals (SDGs) and long-term financing for sustainable development.

It is vital for Nakhon Si Thammarat City Municipality to align our local priorities particularly on an effective waste management program with the National Roadmap for Plastic Waste Management 2018 – 2030 and the ASEAN Framework of Action on Marine Debris. This Baseline Assessment Report contributes greatly to the future changes of the Nakhon Si Thammarat City Municipality and also shared important results that will be utilised into our City Action Plan on Plastic Waste Management that is currently being developed with the support from United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and Institute for Global Environmental Strategies (IGES). Thus, we believe that the Closing the Loop Project will greatly address challenges of mismanaged plastic waste that is emitted to land, canals and the ocean as well as support Nakhon Si Thammarat City Municipality to develop holistic integrated plastic waste management.



We aim at closing the loop of plastic waste at the rate of 100% by 2027 while also encouraging public involvement and participation among stakeholders to have better understanding on plastic waste management. This ambitious goal, of course, could not be accomplished by Nakhon Si Thammarat City Municipality alone – We can only achieve this through collective efforts by governmental agencies, the public, private sector, education institutions, civil society organisations and international organisations.

I want to thank again UNESCAP, IGES, University of Leeds, Dr. Jutamas Kaewsuk and Ms. Chochoe Devaporihartakula for their partnership and continued support on this journey. The success of the city development on plastic waste management towards a circular economy approach will very much rely on corporative operations of key local and international players and I look forward to collaborating with you all in the years to come.

**Sincerely,**

**Dr. Kanop Ketchart**  
Mayor, Nakhon Si Thammarat City Municipality

# Executive Summary

Thailand is one of the top ten largest world contributors to plastic waste in the ocean. While it generates approximately 2 million tonnes of plastic waste each year, only around 500,000 tonnes are properly managed. The remaining 1.5 million tonnes ended up in the marine environment.<sup>1</sup> *The National Roadmap for Plastic Waste Management 2018 – 2030*<sup>2</sup> serves as the framework for Thailand to move towards sustainable plastic management by transitioning to a more circular economy. Three main measures will be put in place to achieve this, 1) reduction of plastic production; 2) reduction of single-use plastic consumption; and 3) proper plastic waste management after consumption. Per *The Roadmap*, three plastic products were banned in 2019, 1) cap seal, 2) oxo-degradable plastic and 3) plastic microbeads. Many single-use plastics (SUPs) will be banned in 2022, such as plastic bags less than 36 microns in thickness, styrofoam food boxes, plastic straws and plastic cups.

Starting in January 2020, major retailers, plastic manufacturers and department stores nationwide banned single-use plastic bags. In addition to that, *Thailand Public-Private Partnership for Sustainable Plastic and Waste Management (Thailand PPP Plastic)* was established in 2018, to achieve plastic waste reduction goals of at least 50% and to increase recycling to 100% by 2027. In 2021, PPP Plastics has scaled up and included 39 partnered organisations from various sectors including government, public, private sector, international organisations and educational institutions.<sup>3</sup>





Achieving these national goals depends on the contribution of all layers of governments, particularly cities. To support this, Nakhon Si Thammarat City Municipality City Municipality has been working with The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) project *Closing the Loop* to develop this baseline study. This report analyzes the current plastic waste management system in Nakhon Si Thammarat City Municipality City Municipality and identifies key recommendations to address while developing the Plastic Waste Management Action Plan.

<sup>1</sup> Pollution Control Department. (2019). Booklet of Thailand State of Pollution 2018. Bangkok.

<sup>2</sup> The Government Public Relations Department. (19 April 2019). "Roadmap on Plastic Waste Management." [http://thailand.prd.go.th/mobile\\_detail.php?cid=4&nid=7831](http://thailand.prd.go.th/mobile_detail.php?cid=4&nid=7831).

<sup>3</sup> PPP Plastics. (2021). "Role of Public Private Partnership for Sustainable Plastic and Waste Management (PPP Plastics) for solving the plastic waste problem in Thailand."

## Key Findings on Plastic Waste in Nakhon Si Thammarat City Municipality City Municipality

Key results of the Plastic Pollution Calculator (PPC) for Nakhon Si Thammarat City Municipality City Municipality	
	<ul style="list-style-type: none"> <li>39,000 tonnes/year</li> <li>1.05 kg/capita/day (national average = 1.08 kg/capita/day)<sup>4</sup></li> <li>383 kg/capita/year</li> </ul>
	<ul style="list-style-type: none"> <li>9,000 tonnes of plastic waste is generated each year</li> <li>23% of MSW is plastic (national average = 17.6%)<sup>5</sup></li> <li>Plastic bags make up 48% by mass of all plastic waste</li> </ul>
	<ul style="list-style-type: none"> <li>448 tonnes/year of plastic is emitted into the environment</li> <li>Leakage whilst waiting for collection is the largest source of plastic pollution (47%), followed by littering (34%) and emissions from the dumpsite (8%).</li> </ul>
	<ul style="list-style-type: none"> <li>90 tonnes/year of plastic enters waterways</li> <li>Whilst only 1% of plastic waste this is equivalent to many millions of plastic items</li> <li>362 tonnes/year of plastic waste is retained uncontrolled on land or in drains</li> </ul>

<sup>4</sup> KAZA, S., L. YAO, P. BHADA-TATA and F.V. WOERDEN. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development Series, Washington, DC: World Bank, 2018.

<sup>5</sup> KAZA, S., L. YAO, P. BHADA-TATA and F.V. WOERDEN. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development Series, Washington, DC: World Bank, 2018.





## Municipal Solid Waste (MSW)

### How much waste?

39,000 tonnes of municipal solid waste per year (1.05kg per person per day). This average is comparable with the national per capita waste generation (1.08 kg/capita/day).

### Where is it from?

The residential waste accounts for 66% of MSW generation, with a further 23% of MSW being generated by commercial activities, 6% from institutional establishments, whilst the remaining 5% of waste originates from 'other' activities.



## Plastic Waste

### How much plastic waste?

9,018 tonnes of plastic waste are produced per year, about 23% of the total MSW generation in the city. The highest quantities of plastic waste are generated by single-family dwellings followed by offices and other services, retail and wholesalers, food and beverage sectors and the accommodation sector.

### Which products?

48% of the plastic waste is plastic bags. In addition, drink bottles (8%), sanitary products (7%), single-use food services (5%) and other plastic film (4%) can be found in the plastic waste.



## Plastic Pollution

### How much marine litter?

1% of plastic waste generation or 90 tonnes of plastic waste becomes marine litter annually.

### How much land-based pollution?

4% of plastic waste is retained on land, though it may end up as water pollution in the future, particularly as it breaks down into smaller pieces that can be dislodged and washed away in floods.

### How does it become pollution?

The largest emission source is leakage from the collection system whilst waste is waiting to be collected (210 tonnes/year). This is followed by littering (151 tonnes/year) and final disposal site (38 tonnes/year).

### Which products become pollution?

Plastic bags presents the largest share of plastic pollution (57%) in the city. Other small dense items (11%), drink bottles (6%) other plastic film (5%), single sue food service (5%) and other plastic bottles (5%) are major types of products emitted into the environment.

### Which products specifically become marine litter?

54% plastic bags, 18.5% plastic film, 8.1% bottles, 12% food service and packaging, 4.7% sanitary products.

### Which sub-districts?

Nai Mueang sub-district is the highest area contribute for aquatic plastic debris with an estimated 34.7 tonnes of plastic waste annually. This is because of having the largest amounts of plastic waste emissions into the environment and because an estimated 65% of the population live within 500 metres of a waterway

### How does it get to the water?

59% of the plastic waste enters the water by land-based sources, like being blown by the wind or moved by surface runoff. It is seen that 28% of aquatic plastic debris enters waterways directly via dumping and another 12% from different waterways.

### When?

The peak season for marine plastic litter is the months of November to January, matching the winter monsoon season in Thailand.



## Plastic Management

### **How much is recycled?**

Only 0.7% of plastic waste is recycled in the City, which is practiced by both informal and semi-formal recyclers. These businesses are functioned at both door-to-door collection of valuable recyclable materials from homes and businesses and scavenging at the disposal site.

### **How much goes to landfills?**

94.3% of plastic waste is retained at the final disposal site of the city.

## Plastic Management Recommendations



## Reduce Use of Single-Use Plastic Bags

### **Why?**

Largest type of marine litter and targets are set to address in the National Action Plan on Plastic Waste Management Phase 1 (2020-2022) in Thailand.

### **How?**

Bans, tax/levy, support alternatives, voluntary agreement in the retail sector, Extended Producer Responsibility (EPR) schemes.



## Target Littering

### **Why?**

Second largest emission source, accounting for 34% of all plastic emissions.

### **How?**

More public bins, frequent evacuation, signs about fines, enforce penalties, raise awareness, increase street sweeping.



## Improve Waste Storage

### **Why?**

Leakage while waiting for collection accounted for the highest emission source at 47%.

### **How?**

Provide separate collection containers to households and improve existing waste containers' quality (right size, easy loading to truck, tapered shape, protection from animals/rain/wind, durable, well maintained).





## Improve the Quality of Existing Waste Containers

### Why?

Overflowing waste containers and poorly maintained or damaged containers are significant reasons for plastic escaping the collection system.

### How?

Plan collection system to avoid over-capacity and well-designed containers with the proper size, loading shape and durability considering the local situation.



## Reduce Fly-Tipping and Illegal Dumping

### Why?

The fourth-largest source of plastic emissions into the environment accounting for 6% of all plastic emissions.

### How?

Signboards alerting polluters, regular clean up of known sites, surveillance, free/affordable waste collection for bulky items, cooperation between the local authority and land owners.



## Increase Recycling

### Why?

Only 0.7% of plastic is recycled, mainly by the informal sector

### How?

Community-based waste management, implementation of source separation synchronously, neighbourhood collection stations, awareness-raising, waste sorting units and integration of informal sector.



## Improve Capacity at Disposal Site/ Upgrading Solid Waste Treatment Technologies

### Why?

The disposal site is uncontrolled and, in particular, does not have any form of litter mitigation techniques. Therefore, it is at high risk of emitting plastic waste into the environment.

### How?

Reduce wind-blown leakage by applying daily covers, controlled waste placement to ensure site stability, perimeter fencing, wind protection in discharge zones, waste compaction and flood mitigation measures. In addition, the City should consider investment projects on solid waste treatment to replace landfill solutions by advancing clean solid waste treatment technologies.

## Policy Recommendations



### Move from Policies to Actions

#### Why?

A number of policies and strategic plans are in place and ready to translate into action on the ground.

#### How?

A Nakhon Si Thammarat City Municipality City Municipality Action Plan on Plastic Waste Management with a time-bound implementation plan, coordination and monitoring mechanisms can help to translate them to tangible actions.



### Promote 3Rs (Reduce, Reuse and Recycle)

#### Why?

Preventing plastic waste through reduce, reuse and recycling strategies will reduce waste management costs and prevent pollution.

#### How?

Coordinate with other plans, programmes to reduce single use plastics, awareness on responsible consumption and production, increase recycling.



### Strengthen Capacity of Local Bodies

#### Why?

Nakhon Si Thammarat City Municipality City Municipality is responsible for waste management.

#### How?

Short to medium term training programs, strengthen institutional set up.



### Encourage Public Participation

#### Why?

Public participation in the decision-making processes is highlighted in the Thai laws and ensure the success of waste management activities.

#### How?

Awareness raising campaigns, public feedback mechanisms, behaviour change and support to community programs.





## Sustainable Financing and Cost Recovery

### Why?

Current fees and charges do not cover plastic waste management operations.

### How?

Increase coverage of existing fee, gradual increases as service improves, cost saving in waste management operations, polluter-pay-principles.



## Integrate Informal and Private Sector Participation

### Why?

Informal sector plays a critical role in collection of plastics for recycling and can be scaled up; private sector involvement currently limited and could introduce operational efficiency.

### How?

Private sector: Competitive bidding, establish clear scope and specifications in contracts, assess qualifications and monitor performance. Informal sector: TBC



## Use of Digital Tools, Data Management

### Why?

To increase the regularity of data updates, automate plastic waste monitoring and management, and provide cost effective monitoring tools.

### How?

Integration of the Digital Tool developed under Closing the Loop into plastic waste action plan monitoring plans.



# CHAPTER 1

CLOSING THE LOOP ON PLASTIC POLLUTION  
IN NAKHON SI THAMMARAT CITY MUNICIPALITY, THAILAND

## Introduction

P28 **Background**

P30 **Aims**

P31 **Methodology**

The Plastic Pollution Calculator (PPC)

Review of Governance Aspects

Data Collection

P40 **Limitations**



## CHAPTER 1

# Introduction

## 1.1 Background

Plastic pollution is one of the serious environmental challenges that require an urgent global response. It is estimated that about 8,300 million tonnes (Mt) of virgin plastics have been produced to date. By 2015 approximately 6,300 Mt of plastic waste had been generated, of which only 9% had been recycled. The rest of this plastic was incinerated (12%) or accumulates in landfills and the natural environment (79%). If current production, consumption and waste management trends continue, roughly 12,000 Mt of plastic waste will end up in landfills or the natural environment by 2050<sup>6</sup>. Fast-growing cities with weak waste management systems in Southeast Asia, South Asia and China are responsible for about 60% of plastic waste leakage<sup>7</sup>. Ocean plastics also cost the tourism, fishing and shipping industries in the Asia-Pacific Economic Cooperation (APEC) region alone US\$ 1.3 billion a year<sup>8</sup>, while good management and recycling of plastic can save consumer goods companies US\$ 4 billion per year.

<sup>6</sup>Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, 347(6223), 768-771. doi:10.1126/science.1260352

<sup>7</sup>Ocean Conservancy. (2015). *Stemming the tide: Land-based strategies for a plastic-free ocean*. McKinsey. Ocean Conservancy, Washington, D.C.

<sup>8</sup>A., Campbell H. F. and Rule M. J. (2008). *Understanding the Economic Benefits and Costs of controlling marine debris in the APEC region* (MRC 02/2007). SOM Steering Committee on Economic and Technical Cooperation(SCE), Ocean and Fisheries Working Group(OFWG). National Marine Science Centre.

<sup>9</sup>UNEP (2014) *Valuing Plastics: The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry*.

The lack of effective policies, technologies and capacities to manage plastic waste at the local level has regional and global implications. More actions are required to address plastic application and waste management in the region, including policy coherence on the various aspects, including plastic ban and use regulations, influencing consumer behaviour to limit the use of single-use plastics and building circularity across the waste value chain. Tackling plastic waste also has positive impacts on the ocean. It creates opportunities for development within the 2030 Agenda for Sustainable Development Goals (SDGs) framework, which requires integrated approaches across all SDGs. For reducing marine plastic debris, the main targets addressed are Sustainable Cities and Communities (SDG 11), Responsible Consumption and Production (12) and, most critically Life Below Water (SDG 14) which calls for preventing and significantly reducing marine pollution of all kinds (Target 14.1).



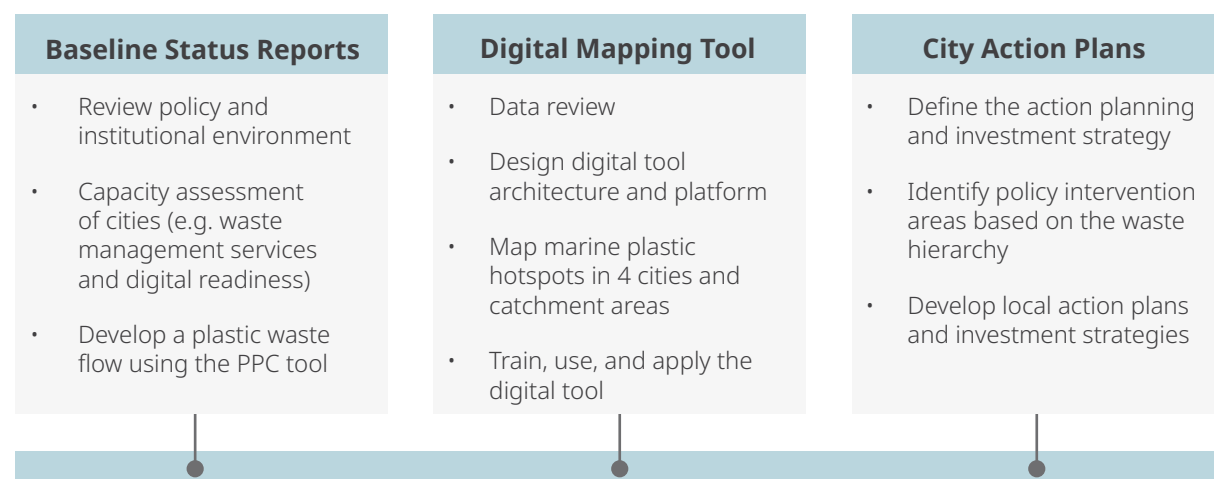
**Figure 1**

Regional Overview of the Closing the Loop Project

## 1.2 Aims

The project *Closing the Loop: Scaling up Innovation to Tackle Marine Plastic Pollution in Cities* aims to reduce the environmental impact of cities in the Association of Southeast Asian Nations (ASEAN) by addressing plastic waste pollution in the marine environment. In line with the ASEAN framework of Action on Marine Debris, G20 Osaka Blue Vision and national policies and action plans, this project assists four cities in the ASEAN region (**Figure 1**): **Da Nang**, Viet Nam, **Kuala Lumpur**, Malaysia, **Surabaya**, Indonesia and **Nakhon Si Thammarat City Municipality**, Thailand by developing city action plans to address plastic litter, make plastic waste management more circular and reduce the amount of plastic waste entering the marine environment from land-based sources.

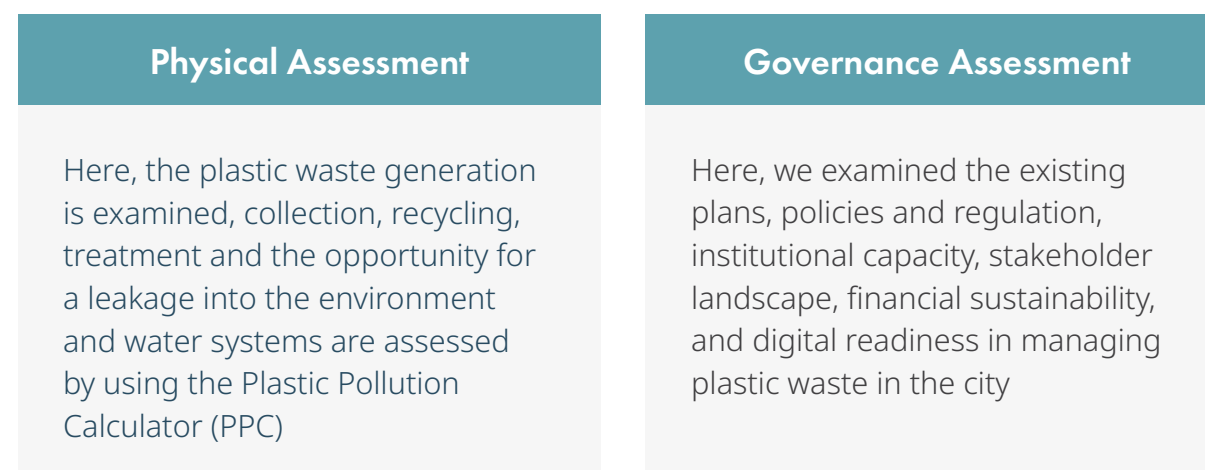
As shown in **Figure 2**, the project also builds capacities and technical expertise on innovative data collection methods and digital tools to allow local governments and their partners to monitor and visualise plastic waste and identify hotspots to improve management. It also raises awareness of marine litter and city-driven solutions for better plastic value chain management, promoting behavioural change among consumers and the industry and creating an enabling space for policy development.



**Figure 2**  
Project activities and outcomes

## 1.3 Methodology

This baseline report presents and analyzes the current plastic waste management system in Nakhon Si Thammarat City Municipality City Municipality. Considering the importance of addressing both the physical (hardware) components and the governance (software) features<sup>10</sup> for sustainable waste management, it covers data related to both aspects, as shown in **Figure 3**.



**Figure 3**  
Data collection

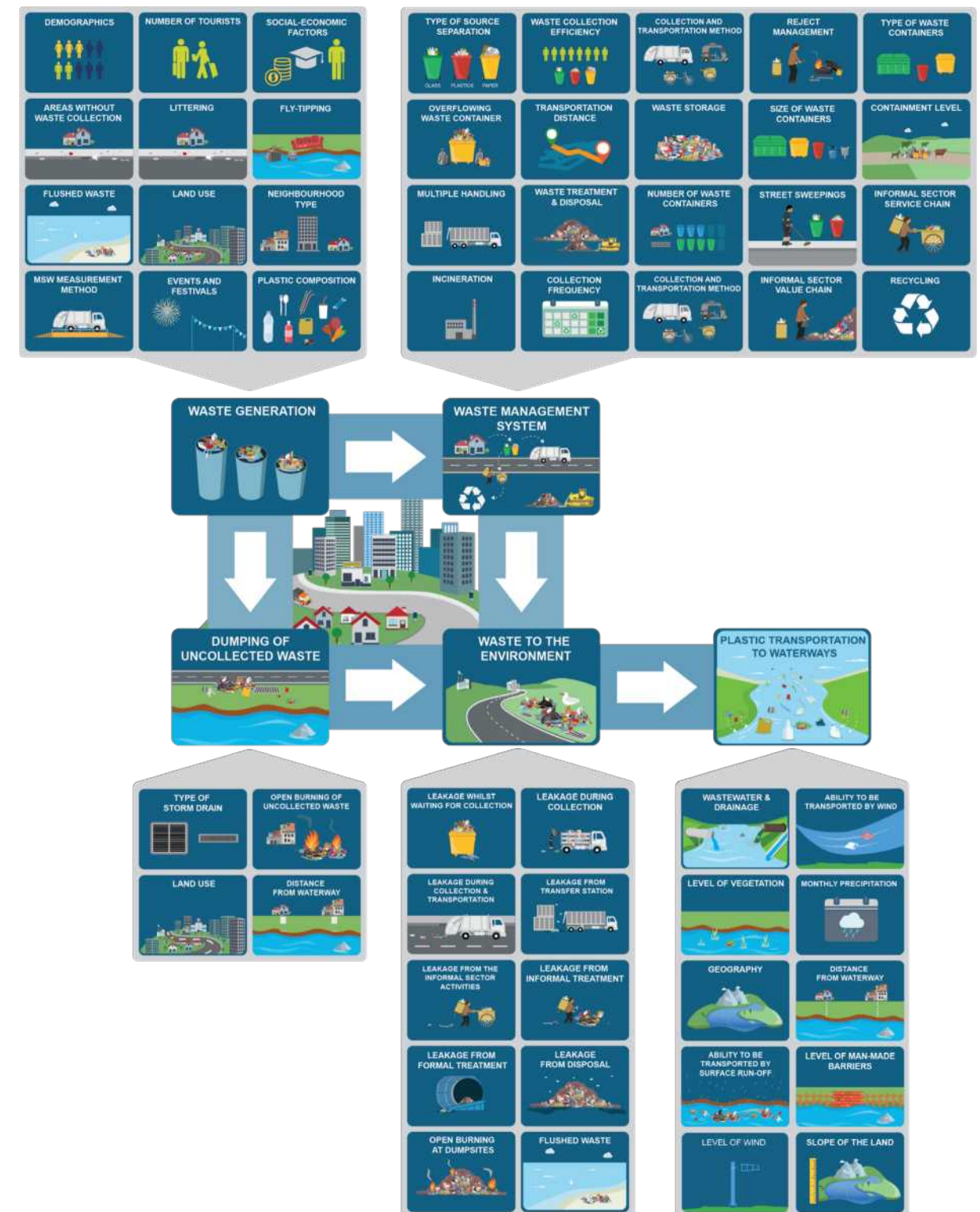
<sup>10</sup> Scheinberg et al., 2010b



### 1.3.1 Plastic Pollution Calculator (PPC) Tool

#### Material Flow Analysis Approach

The study applied a toolkit call the Plastic Pollution Calculator (PPC),<sup>11</sup> designed by The International Solid Waste Association (ISWA) and the University of Leeds. This toolkit models land-based plastic pollution at the local and regional levels to measure the item-specific plastic waste generation and its subsequent movement throughout the waste management system and the environment at an intra-urban granularity. The tool-kit includes quantification of macro-plastics that leak into the environment and become unmanaged. This is achieved by relating the local infrastructure quality, socio-economic conditions and waste management practices to the likelihood of plastic emission. The tool is based on the Material Flow Analysis (MFA) approach and breaks down to 11 main plastic item types (i.e. bottles, bags), 16 waste generating sources (i.e. land uses and activities that produce waste) and is calculated at daily intervals over a defined period of time (e.g. the year 2020).



**Figure 4**

Generalized material flow analysis (MFA) approach used in the Plastic Pollution Calculator (PPC) and visualization of some essential factors at each stage of the solid waste management system are included in the conceptual models for determining transfer coefficient

<sup>11</sup> <https://plasticpollution.leeds.ac.uk/wp-content/uploads/sites/89/2020/07/Plastic-Pollution-Calculator-Summary.pdf>

## Calculation of Plastic Emissions into the Environment

As shown in **Figure 4**, all major components of the solid waste management system are modelled to balance the plastic item flows across each process. Acknowledging the challenge in calculating plastic waste emissions to the environment due to variations in time and space/location, the PPC uses conceptual models to relate all factors important in estimating plastic emissions based on available data and expert opinions. The relationships are assigned a number to estimate the quantitative influence based on available data and expert opinion and are then converted to mathematical algorithms. Input data on waste management infrastructure, practices and other influencing factors are also combined to estimate the possible amount of plastic waste emitted into the environment. The transfer coefficients, an ability to be moved by wind or surface runoff, probability of collection for recycling and likelihood of becoming entangled in vegetation once released into the environment are also calculated for each plastic item type within the MFA.



## Spatial Distribution of Plastic Emissions and Leakage

The PPC is applied at the sub-city-sub-district or neighbourhood level, assuming that the lowest administrative areas have relatively homogeneous features for key plastic waste emission factors (e.g. waste management infrastructure, socio-economic, geographical characteristics). This allows a reasonably accurate picture of plastic flows across a whole city or region (also accounting for any transboundary flows). However, sub-districts and neighbourhoods are not entirely homogenous. Thus, the PPC estimates the spatial distribution of plastic emissions within a sub-district by allocating each emission source to one of five grids, including 1) residential activity grid (e.g. population density), 2) on-residential activity grid (e.g. shops, tourist sites, parks), 3) all grid activity (e.g. combined residential and non-residential activities), 4) roads grid and 5) waste infrastructure grid (e.g. dumpsites, transfer stations). These grids are overlaid to provide an overall spatial representation (hotspot map) of plastic emissions at the sub-sub-district level. The PPC also identifies the important factors influencing the likelihood of a plastic item being transported in the environment (e.g. distance to waterways, meteorological conditions, the geographical and built landscape). A conceptual model is created to estimate plastic emissions entering waterways by assigning a relative weighting to each factor depending on its perceived influence and relationship with other variables. The PPC uses a digital elevation model (DEM) and flow routing algorithms to map the routes that plastic waste emitted into the environment can travel due to surface runoff and the locations where plastic released into the environment may eventually reach waterways and the ocean.



## 1.3.2 Review of Governance Aspects

One of the significant reasons for the failure of solid waste management in the cities is poor governance due to lack of 1) existing solid waste management policies and regulations, 2) financial capacity to introduce new solid waste management (SWM) technology/infrastructure, 3) appropriate institutions and capacities, 4) the development of the private sector and recycling industries, 5) finance and cost recovery systems, 6) strategic planning/ directions, looking at waste management as an end-of-pipe issue, 7) political will and 8) stakeholder participation and partnership<sup>12</sup>. None of this is exceptional for plastic waste management in developing cities. In examining governance aspects, the focus was placed on proactive policies and sound institutions, stakeholder participation and inclusivity, financial sustainability and digital readiness<sup>13</sup>.

### Proactive Policies and Sound Institutions

Strong policies and sound institutions are key to a sustainable plastic waste management system. Without them, plastic waste management systems will not work well over the long term. So, the adequacy of the national/ local policies/ legal framework and measures of the institutional strength and coherence of the city's solid waste management has been assessed.

<sup>12</sup> Marshall and Farahbakhsh 2013; McDougall et al. 2001; Premakumara and Maeda 2014

<sup>13</sup> Wilson et al, 2015

## Stakeholder Participation and Inclusivity

Even though municipal governments are responsible for managing solid waste, including plastic litter and marine debris, they cannot provide adequate service in isolation. Sustainable plastic waste management systems need to incorporate all key stakeholders in planning, implementing and monitoring changes, particularly three main groups of stakeholders, 1) the service providers, including both formal and informal sectors, who actually offer the service, 2) the users, who are the clients; and the external agents in the enabling environment, including national and 3) local governments, who organize the boundary conditions and make change possible. Thus, here, the key stakeholders involved in the plastic waste management system in the city were assessed and the degree of their inclusion and methods/ mechanisms available to involve in the planning, policy formation and implementation and evaluation were considered.

## Financial Sustainability

Securing financial sustainability in solid waste management (SWM) is a major city issue. In developing cities, SWM, in general, represents a significant proportion of their total recurrent budget, yet despite relatively high budgets, collection service coverage is often low, and disposal standards remain poor. Thus, the degree to which a city's SWM service is financially sustainable was assessed.

## Digital Readiness

Having an appropriate digital system in cities opens new ways to prevent, reduce and even eliminate waste from specific sectors and streams, advance resource recovery, achieve high standards of treatment and disposal and substantially reduce pollution and its environmental impacts. At the same time, it provides new tools to stimulate stakeholders' interaction, awareness and citizens' participation, to be able to enforce a "polluter pays" model and apply extended producer responsibility (EPR) principles towards smart cities.

### 1.3.3 Data Collection

The structure of the report consists of five major sections, including (1) introduction, (2) city profile, (3) plastic waste management, plastic leakages and hotspots, (4) governance review and (5) recommendations and conclusions. Data collection is based on the following activities.

#### Establishment of Local Project Teams

A lead local partner was designated, and a local research team was mobilized with a team of members, working with the city and familiar with the local situation. They functioned both as a lead researcher and as a point of contact with the city authorities and key stakeholders.

#### Desk Research

A desk review includes collecting secondary information and data from existing resources, open sources, government published data and other reports from stakeholders.

**Field Surveys and Observations:** Field surveys and observations were used to understand current situations and problems of the city's MSW management and plastic waste management. Due to the lack of secondary data on plastic waste generation, characteristics and management to PPC, primary data related to different sources such as households (multi- and single-family dwellings), public areas, informally collected waste, littered waste, commercial areas, institutional areas, transportation areas, food and accommodation waste, recreation waste, health and social care, recycling activities, and at the disposals have carried out. In addition, images were taken as evidence.

#### Interviews

An open-ended questionnaire about the municipal waste management system and current waste management practice was used to gather information from key stakeholders, including municipal staff, local government agencies, and communities. Both formal and informal private sectors dealing with plastic waste and academia and Civil Society Organization (CSO) that have been involved in awareness-raising activities and skill-up training to promote 3Rs (reduce, reuse, recycle) of plastic waste were also included.

### Mapping Method

The distribution of residents along the water body and the coast by the distance was described in the cadastral map of Nakhon Si Thammarat City Municipality City Municipality.

### Sampling Survey

Waste sampling and sorting methodology were applied to 13 different sectors, as shown in **Figure 5**. A total of 155 samples were collected at kerbside bin(s), communal bin(s), storage room or were existing from each waste source and transferred to the sorting area. Sorting procedures were conducted following the guidance of 12-plastic item characterization developed by the University of Leeds.

Input Data/Waste Sources					
Multi-family dwellings				Transportation/storage waste	
Single-family dwellings				Food, drink, accommodation	
Public Waste				Office and other services	
Informally Collected Waste				Recreation waste	
Littered Waste				Public administration	
Fly-tipped Waste				Education	
Retail and Wholesale Waste				Health and social care	

1 - Plastic Bags	2 - Sanitary products*	3 - Other plastic film	4 - PET bottles	5 - Other plastic bottles	6 - Pots, trays and tubs (PTTs)
					
7 - Expanded Polystyrene (EPS)	8 - Single-use food service**	9 - Cigarette butts*	10 - Other small dense items (all dimensions ≤20 cm)	11 - Other large dense items (at least one dimension >20 cm)	12 - Covid related PPE***
					

**Figure 5**

Waste Sampling Sources



## 1.4 Limitations

The Plastic Pollution Calculator (PPC) functions by performing material flow analysis (MFA) to map plastic waste flows across each sub-district in the city, with emissions of plastic waste determined via analysing the waste management infrastructure, practices and linking it to the PPCs conceptual models. However, this approach relies on there being sufficient reliable data available to perform the MFA. For the case of Nakhon Si Thammarat City Municipality, some input data was not directly available, and the model had to either assume using proxies or estimate using expert opinion from the local teams guided by the University of Leeds. Data that proved challenging to obtain included understanding the amounts of littering, dumping and open burning present. These data needs are discussed more in the following section.

Similarly, reliability was occasionally lacking even when data was available, leading to potential irregularities in the results. For example, the waste generated by households was calculated to be significantly lower than the total waste arriving at the landfill. Whilst this is possible, it is thought that potential inconsistencies between the literature data used for household waste generation rates and the official data of waste arriving at landfills may lead to this difference being exaggerated. Whilst it would have been preferable not to use literature data for the household waste generation rates and instead use the waste characterisation study performed here, this was not possible due to COVID-19 restrictions. These restrictions meant household surveys could not be undertaken to ascertain household size, and therefore per capita generation.



Another limitation of the study was that it assumed that the waste management within a sub-district was homogeneous. This was done in order to describe the waste management systems in a simple way. Other efforts were made to account for differences in waste management by allowing for specified land use, however likely to have some variance. For example, compactor trucks were reported as the main method used to collect waste from households. Alternately, auto-rickshaws may be used instead in some hard to access areas. Within this study, only the dominant waste management practice is assigned. Similarly, behavioural practices (i.e. dumping waste in rivers) is known to be highly spatially dependent. However, within the PPC, probabilities of direct dumping to water are assigned based on the average distance of the population within that sub-district to waterways, and therefore does not account for the specific locations within the sub-district that may lack waste collection services.

Lastly, whilst the interventions provided are linked to the plastic pollution source, items, pathways, and sinks in Nakhon Si Thammarat City Municipality City Municipality were unable to estimate the impact of these interventions. This is due to sensitivity analysis required to account for the complex relationship that upstream and downstream interventions may show, which was out of this project's scope.





# CHAPTER 2

CLOSING THE LOOP ON PLASTIC POLLUTION  
IN NAKHON SI THAMMARAT CITY MUNICIPALITY, THAILAND

## City Profile

- P44 **Population**
- P46 **Topography and Flooding**
- P48 **Economic Development**
- P49 **Governance**

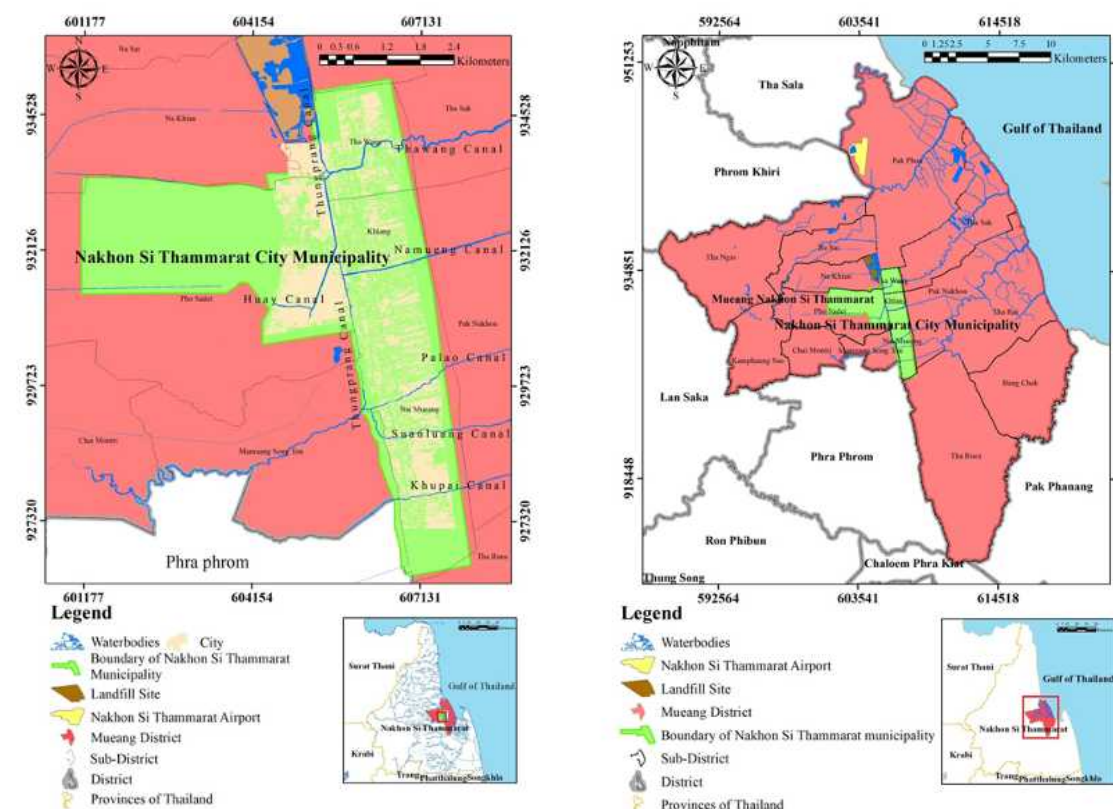
## CHAPTER 2

# City Profile

## 2.1 Population

Nakhon Si Thammarat City Municipality City is the capital of the Nakhon Si Thammarat City Municipality Province in Southern Thailand. The Tapi River runs for 230 km from the Khao Luang Mountains to Surat Thani. The Pak Phanang River travels 156 km from the Khao Bantad Mountains into Pak Nakhon Bay. Most of the province is rural, with urban development concentrated in the Mueang Nakhon Si Thammarat City Municipality Sub-district, a lowland region located on the province's eastern coast.

Nakhon Si Thammarat City Municipality Province is home to 1.56 million people largely residing in rural villages and small settlements. Nakhon Si Thammarat City Municipality City Municipality is the urban area with the highest density with a population of approximately 102,152 across 46,165 households<sup>14</sup> in an area of 22.56 sq.km. The average population density is 4,528 people/sq. km, which is higher than Bangkok (4,363 people/sq. km). The population has remained fairly stable with little migration or growth (0 - 1% per year). The city exhibits a clear linear urban morphology, concentrated along two main roads: Ratchadamnoen Rd. and Highway 401, which connects Nakhon Si Thammarat City Municipality to Surat Thani Province.



**Figure 6-7**

Sub-sub-districts in Nakhon Si Thammarat City Municipality City Municipality

Sub-Sub-district	Category	Population	Household
Naimueang	Urban	42,398	18,832
Klang	Urban	17,040	8,226
Thawang	Urban	16,854	7,563
Phosadet	Urban	24,664	11,052
Nakhian	Rural	1,196	472
<b>Total</b>		<b>102,152</b>	<b>46,165</b>

**Table 1**

The population and households of sub-sub-districts in Nakhon Si Thammarat City Municipality City Municipality<sup>15</sup>

<sup>14</sup> Department of Provincial Administration (DOPA), 2019. Nakhon Si Thammarat City Municipality City Municipality: Population and Housing Statistics Report 2019

<sup>15</sup> Ibid.

## 2.2 Topography and Flooding

The City is located at the foot of the Khao Luang Mountain range, a site of deforestation for over a decade. This loss of forest cover has resulted in significant changes in environmental conditions, such as temperature, humidity, and increased run-off.

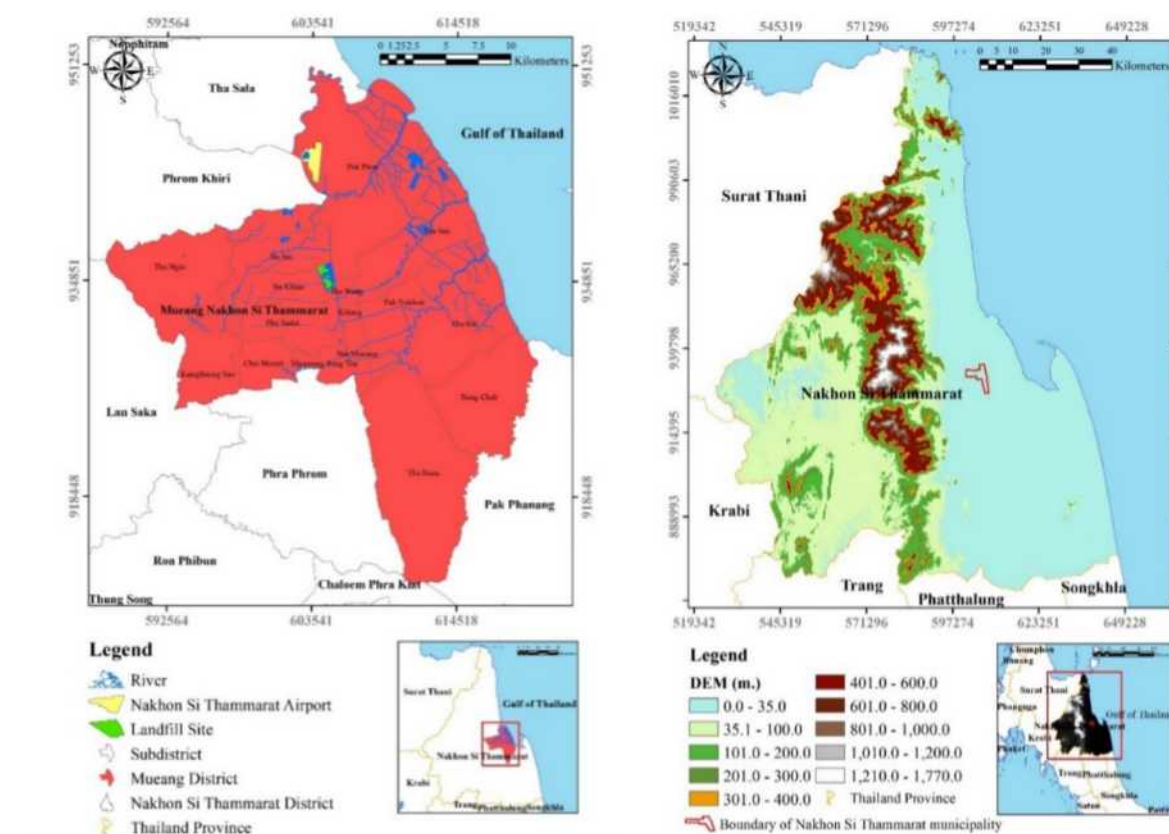
A sizeable urban canal network binds the City, and canals run directly through commercial and residential zones. These then empty into the Gulf of Thailand via several branching rivers, primarily the Plai Bang Khwai, Pak Nakhon and Tha Sak. Since the City is vulnerable to flood events due to population growth and deforestation in the upstream catchment, flood water flows quickly from the top of the mountain to this network of canals before reaching the sea.

Efforts have been made to mitigate flooding for the province. Take, for example, the canal networks developed in Southern Thailand in response to an extreme flood season in 1988, 50 years, of significant infrastructure investment by the Office of the Royal Development Projects Board (ORDPB) that completed over 69 projects since 1974<sup>16</sup> and the major flood mitigation project was completed in 2018 by creating a series of new diversion channels and floodgates to control drainage.

<sup>16</sup> Office of the Royal Development Projects Board, 2020. Summary of Royal Development Project in Nakhon Si Thammarat City Municipality.

[http://www.rdpb.go.th/rdpb/projectData/files/south/summary\\_roy\\_southProject62.pdf](http://www.rdpb.go.th/rdpb/projectData/files/south/summary_roy_southProject62.pdf)

Key environmental challenges for Nakhon Si Thammarat City Municipality are water quality degradation driven by wastewater, municipal waste and agricultural pollution<sup>17</sup>. In addition, high flood often washes waste off the land and into nearby water bodies and discharges into the ocean. Across the city, 71% of the population live within 500 metres of one of these waterways, whilst a further 24% live within a kilometre. The topography of Nakhon Si Thammarat City Municipality is thus predominantly flat with heavy precipitation during the wet season of October until December often leading to localised flooding. The impact of these flood events on the movement of plastic litter within the city and beyond is outside the scope of this baseline report and should be an area for further investigation.



**Figure 7-8**

The distribution of rivers and streams in Mueang Nakhon Si Thammarat City Municipality, and the Terrain of Nakhon Si Thammarat City Municipality province, respectively.

<sup>17</sup> Steele, C. L., Pumphrey, L. M., Longnecker, N. W., & Gelin, R. M. (2014). Development and Initiation of Sustainable Wastewater Management in Nakhon Si Thmmarat, Thailand. <https://digitalcommons.wpi.edu/iqp-all/2187>





## 2.3 Economic Development

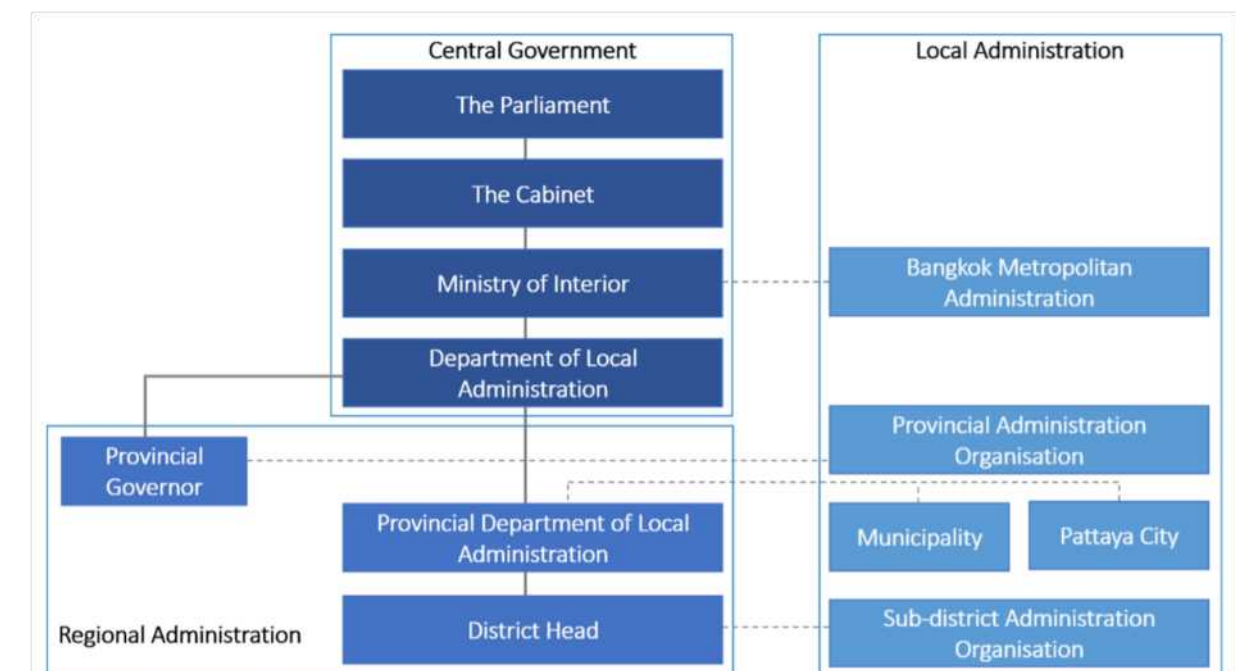
Nakhon Si Thammarat City Municipality Province has a total economic production estimated at US \$5.4 billion, which grows at around 2.2% per year. The regional economy is driven by their thriving tourism industry, receiving about 4 million domestic and international visitors in 2019, which generated over US \$554 million in revenue. However, most people are employed in the agriculture sector through plantations, fisheries and livestock production<sup>19</sup>. Agriculture accounts for 48.7% of land coverage<sup>20</sup> in the province. Several mining operations in the upland regions play a relatively smaller role in the provincial economy (tin, tungsten, barite, feldspar).

Nakhon Si Thammarat City Municipality City Municipality is a regional hub for commercial activity, tourism, education and culture. The tourism industry, in particular, has played a significant role in driving economic development.

## 2.4 Governance

Nakhon Si Thammarat City Municipality Province is part of the Southern Region and the second largest of the 14 provinces. It is subdivided into 23 sub-districts which vary in size and population. Governance is overseen by the Provincial Administration Organisation (PAO) and 54 municipal management organisations, including Nakhon Si Thammarat City Municipality City Municipality and the adjacent, Tha Sala, Prom Khiri, Lan Saka, Phra Phrom, Chaloem Phra Kiat and Pak Phanang Municipalities. Non-municipal areas are governed by 130 Sub-Sub-District Administrative Organisations (SAOs), and for local administration, sub-districts are further divided into 170 sub-sub-districts and 1,428 villages.

Nakhon Si Thammarat City Municipality City Municipality covers five sub-sub-districts and 67 communities and is governed by the Provincial Office for Local Administration.



Source: Compiled by IGES - Chochoe Devaporihartakula

**Figure 9**

Administrative Governance of Thailand





# CHAPTER 3

CLOSING THE LOOP ON PLASTIC POLLUTION  
IN NAKHON SI THAMMARAT CITY MUNICIPALITY, THAILAND

## Status of Plastic Waste Management, Leakage and Hotspots

### P52 **Municipal Solid Waste (MSW) Generation**

MSW Generation by Sub-Sub-Districts  
MSW Generation by Source Activity

### P57 **Plastic Waste Generation**

Plastic Waste Composition

### P61 **Plastic Emissions to the Environment**

Key Sources of Plastic Pollution  
Composition of Plastic Emissions to the Environment  
Plastic Emissions with Time  
Spatial Distribution of Plastic Pollution Emissions

### P72 **River and Marine Plastic Pathways**

Pathways of River and Marine Plastic with Time

### P75 **Fate of Plastic Waste**

Plastic Recycling  
Retained at Disposal Site  
Retained on Land and Drains  
River and Marine Plastic Pollution



## CHAPTER 3

# Status of Plastic Waste Management, Leakage and Hotspots

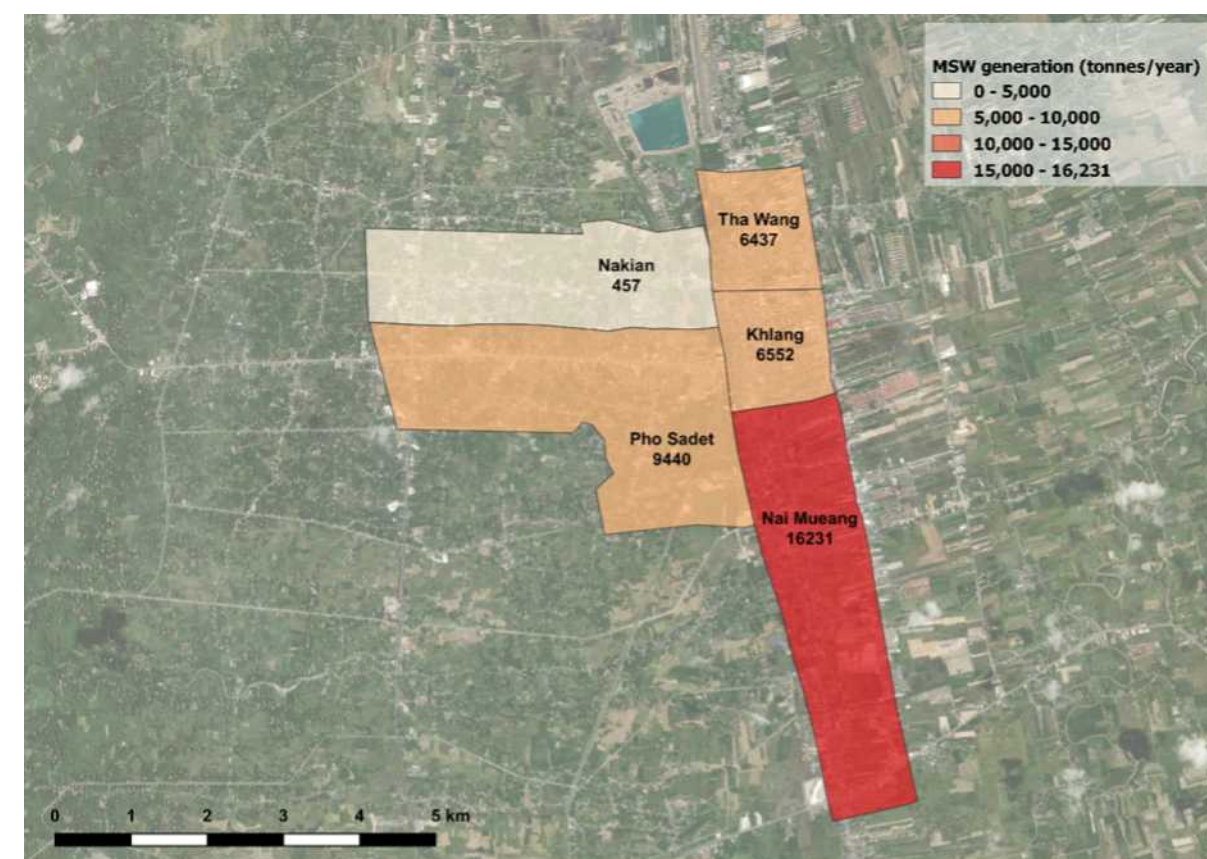
## 3.1 Municipal Solid Waste (MSW) Generation

Nakhon Si Thammarat City Municipality Province generates approximately 368,388 tonnes of municipal solid waste (MSW) annually. Out of that, about 39,118 tonnes of MSW is generated in the urban area of Nakhon Si Thammarat City Municipality City Municipality each year. With a residential population of 102,152 people, this equates to an average waste generation rate of 1.05 kg per resident per day. This average is very similar to the reported value for Thailand as a whole, with the World Bank What a Waste 2.0 report suggesting a 2016 waste generation rate of 1.08 kg/capita/day<sup>18</sup>. Tourists contribute to some of this waste, with Nakhon Si Thammarat City Municipality City Municipality receiving an estimated 488,000 tourists each year with an average length of stay of 1.5 days. Accounting for these tourists, the waste generation rate per person (i.e. residents + tourists) reduces to 1.03 kg/person/day. However, this does not account for the likelihood that tourists have higher waste generation rates than residents.

<sup>18</sup> KAZA, S., L. YAO, P. BHADA-TATA and F.V. WOERDEN. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development Series, Washington, DC: World Bank, 2018.

### 3.1.1 MSW Generation by Sub-Sub-Districts

Figure 10 shows that waste generation across the sub-districts of Nakhon Si Thammarat City Municipality City Municipality is spatially diverse, with the more populated and commercially active sub-districts generating higher quantities of MSW. Namely, the Nai Mueang sub-district generates the most significant amount of MSW at 16,231 tonnes per year, whilst the sub-district of Na Khian generates the least at only 457 tonnes per year. This result is primarily due to the disparity in population between the sub-sub-districts, as the associated waste generation rates are believed to be similar.



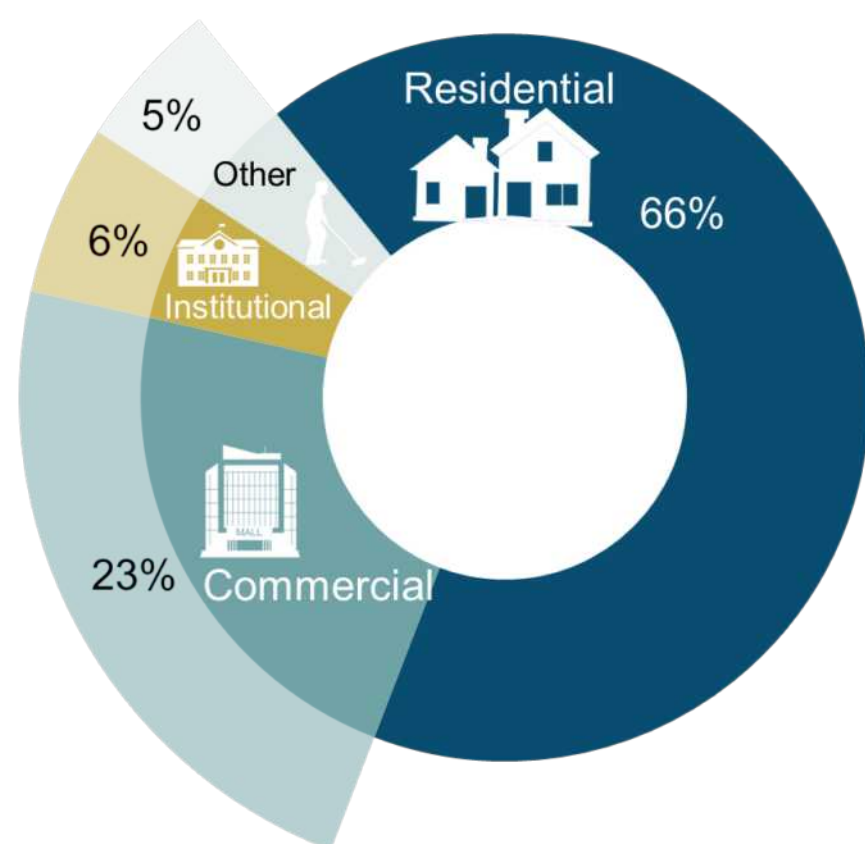
**Figure 10**

Map of MSW generation (tonnes/year) by sub-district.



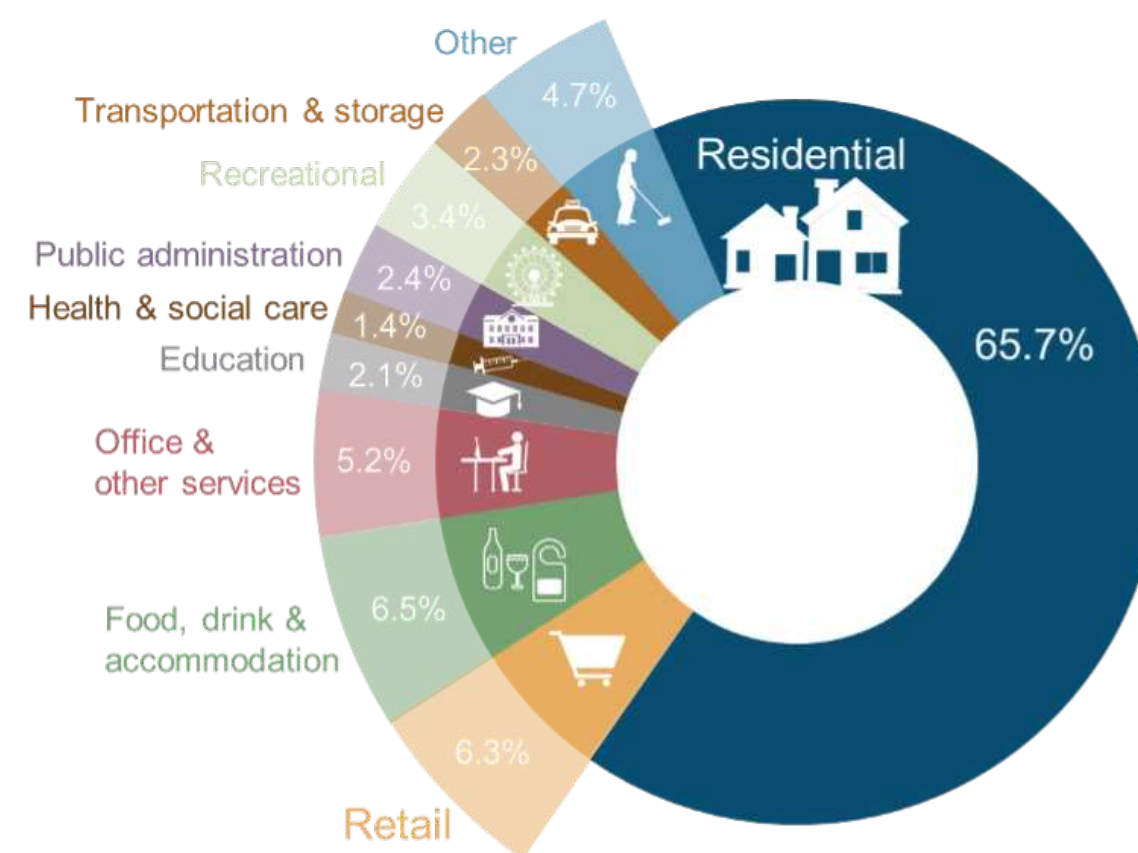
### 3.1.2 MSW Generation by Source Activity

The MSW generating activities that produce this waste can be thought of broadly as residential waste, commercial waste, institutional waste (e.g. schools, healthcare, public administration) and other waste (e.g. street sweepings, litter that remains uncollected, flushing of sanitary waste, recyclables sold directly to the informal sector). **Figure 11** shows that residential waste accounts for 66% of MSW generation, with a further 23% of MSW being generated by commercial activities, 6% from institutional establishments, whilst the remaining 5% of waste originates from 'other' activities. The 'other' waste category is kept separate from the remaining sources, as its origin cannot be fully known. However, it is likely that some of this category also originates from household activities (e.g. flushing sanitary waste, selling recyclables to the informal sector).



**Figure 11**  
MSW generation by broad sectors

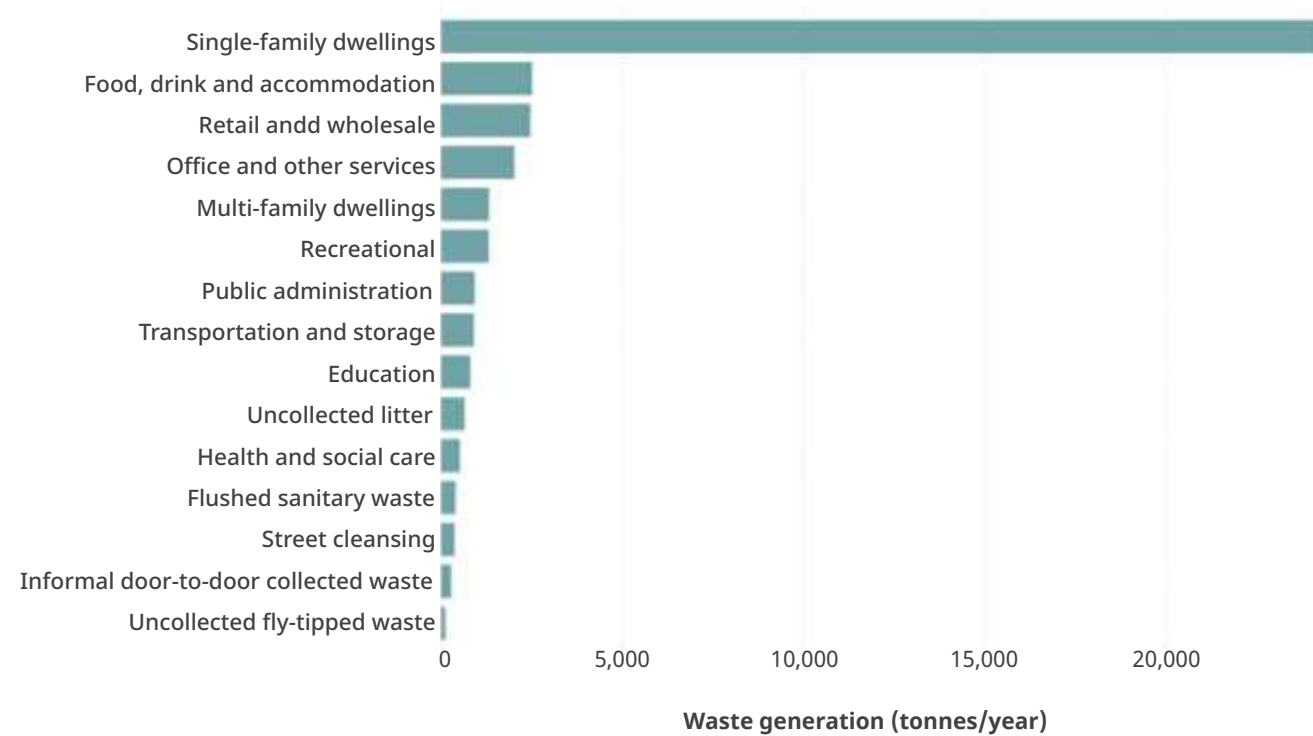
The non-household generated MSW can be further divided by the detailed sectors according to the International Standard Industrial Classifications of All Economic Activities (ISIC), Rev. 4<sup>19</sup>, as shown in **Figure 12** and **Figure 13**<sup>20</sup>. It can be seen that the major contributions to the commercial sector come from retail, food, drink and accommodation and office and other services. On the other hand, institutional waste generation is weighted more towards public administration and education than health and social care.



**Figure 12**  
MSW generation by detailed activity

<sup>19</sup> UNITED NATIONS. International Standard Industrial Classification of All Economic Activities (ISIC), Rev. 4. Statistical Papers, New York: United Nations, 2008

<sup>20</sup> As no Nakhon Si Thammarat City Municipality specific data was found for the distribution of commercial and institutional waste generation by detailed sectors, the PPC used national Gross Value Added (GVA) data for Thailand as a proxy for waste generation. The relative percentages for this GVA was averaged for each land use to the relative land use percentages specified for Nakhon Si Thammarat City Municipality.

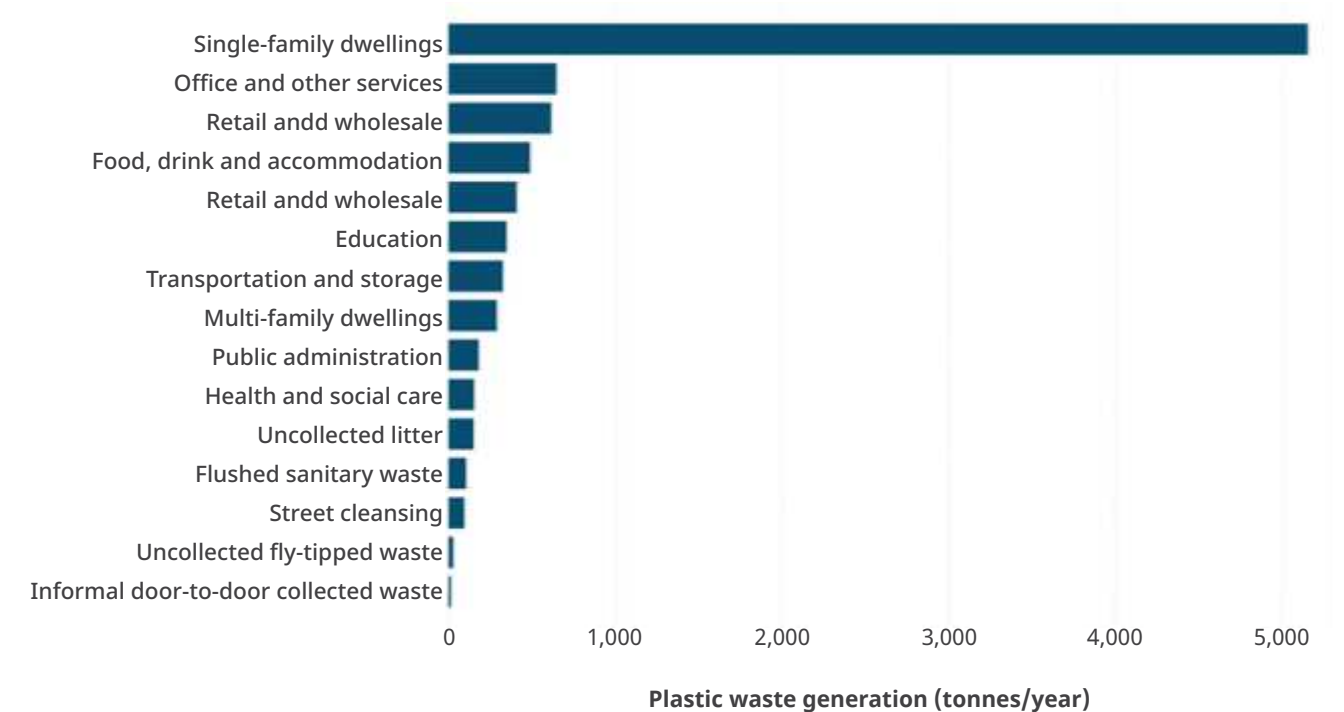
**Figure 13**

MSW generation in tonnes per year by detailed activity



## 3.2 Plastic Waste Generation

Each of the detailed MSW generating activities shown in **Figure 13** has a unique waste composition, with the amount and composition of plastic waste generated varying for each. Applying these compositions to the waste generation quantities shown in the previous section calculates 9,018 tonnes of plastic waste is generated per year. The distribution of this plastic waste is largely consistent with the overall MSW quantities for each detailed activity, as shown in **Figure 14**. The highest quantities of plastic waste are generated by single-family dwellings, followed by office and other services, retail and wholesale and food, drink and accommodation sectors.

**Figure 14**

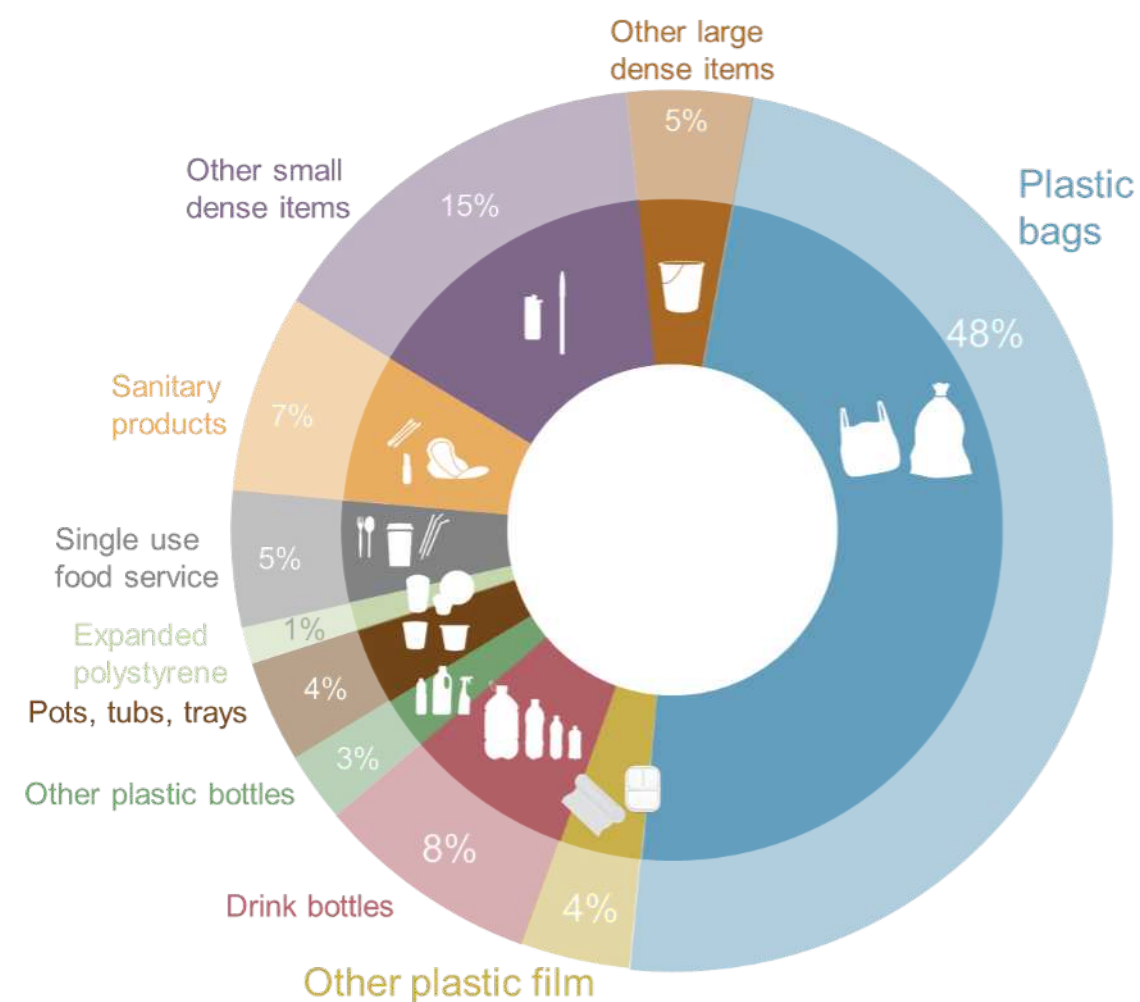
Plastic waste generation by detailed activity



### 3.2.1 Plastic Waste Composition

In order to understand the fate of plastic waste released into the environment, it is essential to account for the physical properties of common items. For example, knowing if an item is easily transported by wind or if it floats are key in predicting the transportation of uncontrolled waste plastic in the environment. Likewise, the economic value of that item further dictates its likelihood of being collected by informal waste pickers for recycling.

The overall composition of the plastic waste generated is shown in **Figure 15**, whilst a more comprehensive breakdown by each detailed activity is shown in **Figure 16**, as obtained through a waste characterisation study performed in Nakhon Si Thammarat City Municipality in November 2020. As this waste characterisation was performed during the COVID-19 pandemic, waste generating patterns may have altered due to behavioural changes or sanitary practices. The waste characterisation study added a separate category for COVID-19-related plastic items (e.g. face masks) to adjust for this abnormality. However, this category only accounted for 0.4% of MSW sampled or 1.5 % of plastic waste sampled by mass. Therefore, the COVID-19-related waste was included within the sanitary products category to accurately reflect waste generation in 2020. As this is deemed negligible in size, the composition is not anticipated to vary considerably from non-COVID-19 years, and therefore these results are potentially applicable to other years.



**Figure 15**

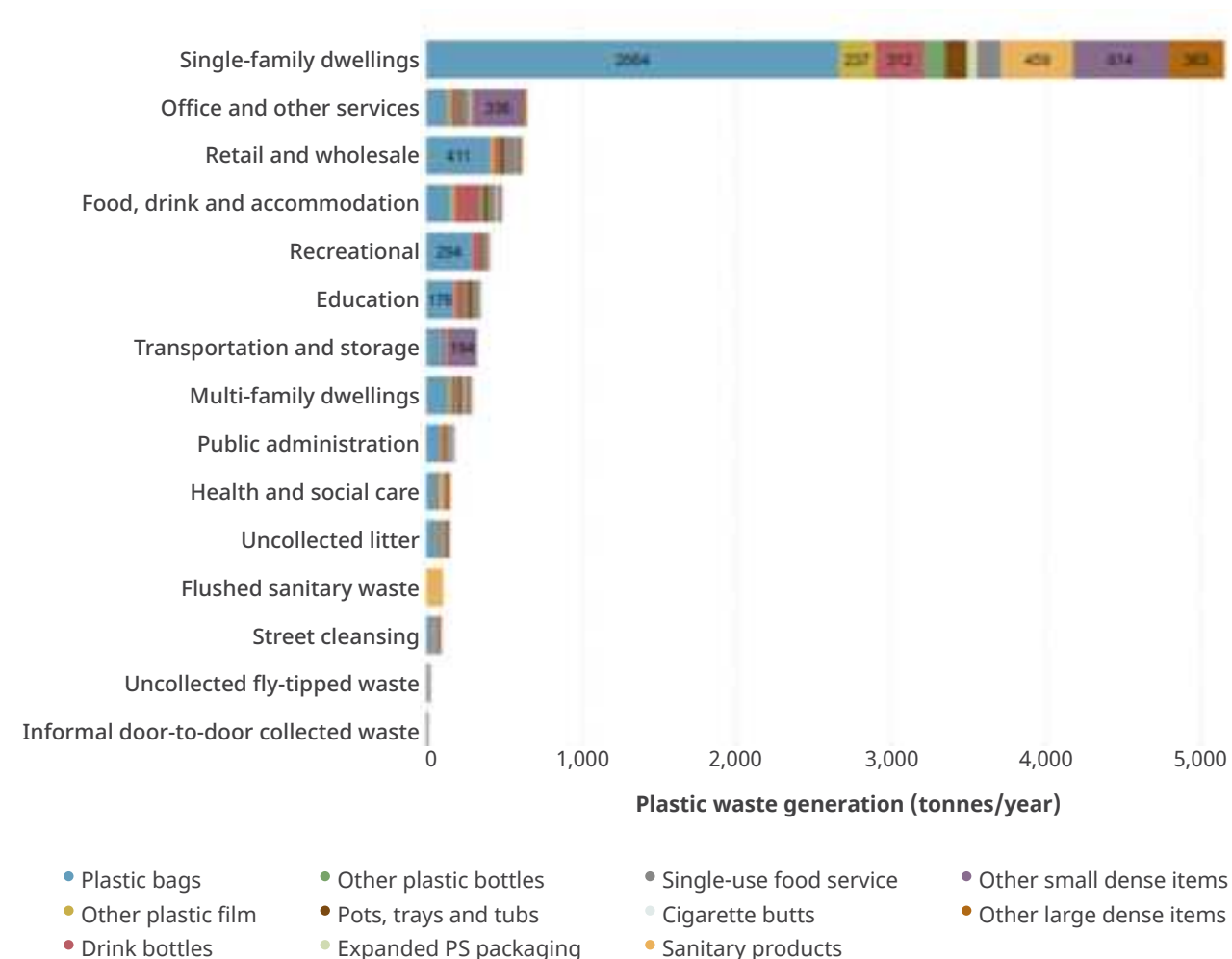
Plastic waste item composition

It can be seen from **Figure 15** that plastic bags dominate the plastic waste generation, accounting for 48%. This extremely high value becomes even more influential considering that these plastic bags weigh considerably less than other typical plastic items such as drink bottles, and therefore by count, represent an even higher percentage. In addition to plastic bags, other plastic film makes up 4% of plastic waste generation. Combined, over half of the plastic waste generated is comprised of flexible plastic film, which commonly has low value and is susceptible to leaking and becoming marine litter due to its ease of transportation by the wind.

Following plastic bags, the next highest category of plastic item generated is 'other small dense items' (all dimensions less than 20cm), accounting for 15% of plastic waste generation. This category includes items like pens, lighters, toys, non-food packaging (i.e. toothpaste tubes and brushes). Higher value plastic items commonly targeted for recycling, such as plastic bottles, represent only 11% of plastic waste generation, thereby inherently limiting the potential for recycling.



The dominance of plastic bags in waste composition holds for most waste generating activities, as seen in **Figure 16**. Interestingly, in single-family dwellings, 52% of their plastic waste was plastic bags, whereas this percentage was even higher for retail and wholesale waste composition. Food, drink and accommodation sectors had particularly large proportions of plastic bottles (39%), as did the educational sector (23%), suggesting these sectors may have a high potential for recycling.



**Figure 16**

Plastic waste composition by detailed activity

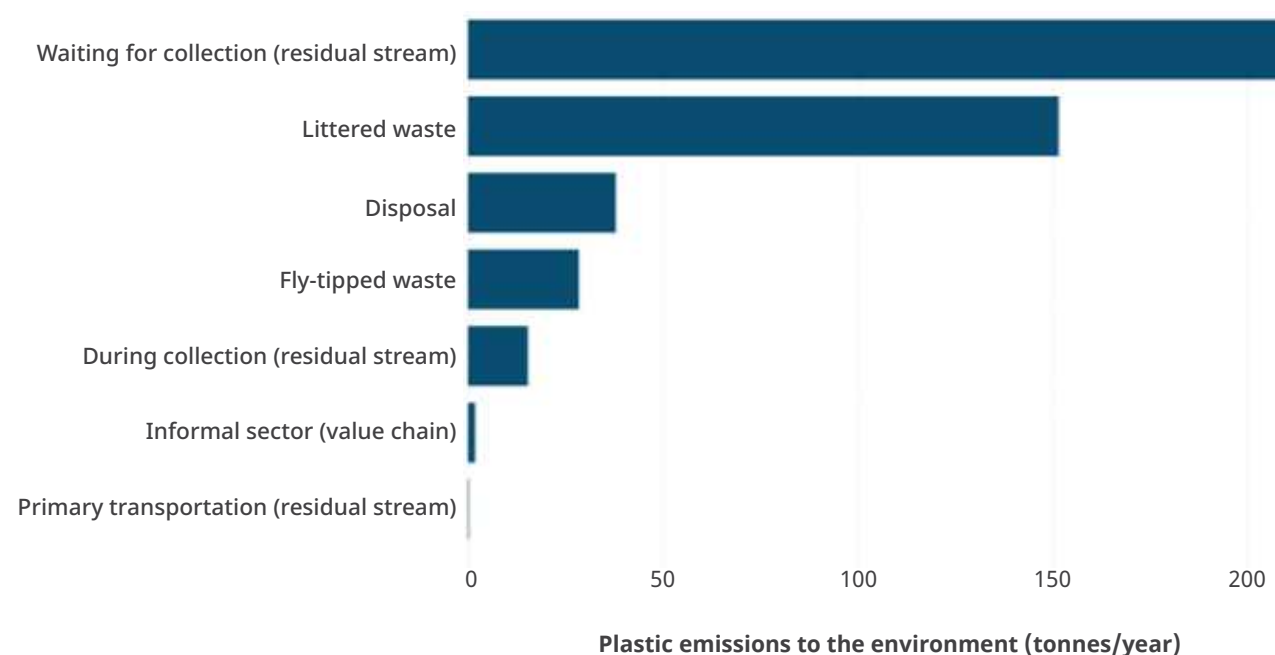
### 3.3 Plastic Emissions to the Environment

Plastic emissions to the environment (i.e. plastic leakage) are hereby defined as plastic waste, which escapes from the MSW management system to become uncontrolled in the environment. Although formally managed dumpsites often lack sound practices, the very nature of collecting and dumping the waste in a defined location is counted here as control and therefore is not included in our definition of plastic emissions. However, any plastic that blows off these disposal sites or is emitted at other stages of MSW management, including that which remains uncollected, is included.



### 3.3.1 Key Sources of Plastic Pollution

The plastic emission sources to the environment for Nakhon Si Thammarat City Municipality are shown in **Figure 17**. It is seen that the largest emission source for plastic uncontrollably entering the environment is directly from leakage in the collection system whilst waste is waiting to be collected. Annually, this source releases an estimated 210 tonnes of plastic waste into the environment across the City.



**Figure 17**

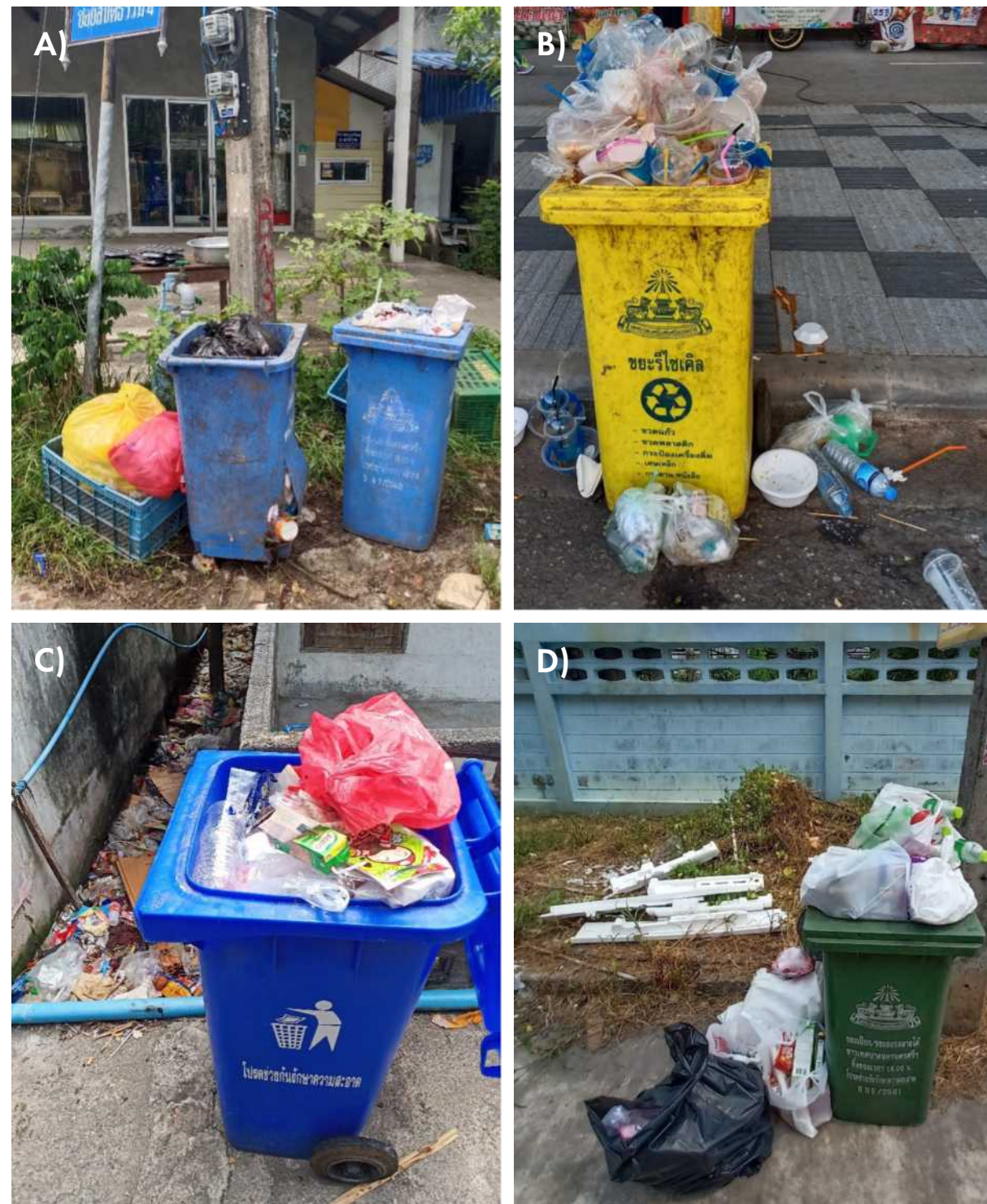
Key source of plastic pollution

This large amount of plastic emission from the collection system is due to two reasons. Firstly, although waste collection containers are provided in the form of wheelie bins, these were largely dilapidated, showing frequent signs of damage and misuse. For example, **Figure 18a** shows a typical waste container in Nakhon Si Thammarat City Municipality whereby the lid is missing, and the container itself shows signs of damage, both of which increase the likelihood of plastic release into the environment. Secondly, the waste containers are not provided to each household but are shared between approximately 4 to 6 households. Although these collection containers are supposed to be collected daily by the waste collection teams, it is reported that bins or streets are often skipped and collected from the following day instead. Unfortunately, as demonstrated the images in **Figure 18**, this has led to many collection containers being of insufficient capacity to hold all of the waste from the community. This results in waste overflowing or being placed in bin bags or makeshift containers nearby.

Although it is expected that much of this waste placed at the side or overflowing from the containers will still be collected along with the bin, the containment level of this waste is drastically reduced. Meaning this waste has a high probability of it escaping and dispersing into the environment, particularly during periods of high wind or rainfall, which can mobilise large amounts of loose plastic into nearby drains or rivers (**Figure 18c**). The next highest emission source for plastic is littering, with 151 tonnes per year of plastic litter, excluding litter discarded to the ground but later collected street sweeping, was released into the environment. Street sweeping activities are often targeted at key areas around commercial hubs or touristic sites and landmarks. However, suburban areas are often much less frequently swept, leading to more litter remaining uncollected in these locations.

The 151 tonnes of litter, which is estimated to go uncollected in Nakhon Si Thammarat City Municipality each year, represents 1.48 kg of plastic per resident each year (4.1 g/capita/day). When including the presence of tourists in Nakhon Si Thammarat City Municipality, this reduces slightly to 1.45 kg of plastic per person each year (4 g/capita/day). These relatively large numbers indicate that littering is a large problem in the city and that action needs to be taken to limit this as a source of plastic pollution, for example, by encouraging behavioural change or providing more public waste containers. Further information on recommended interventions can be reviewed later in this report.



**Figure 18**

Examples of plastic emissions whilst waiting for collection due to A) Damaged waste containers, B) Overflowing waste containers, C) Overflowing waste containers with plastic accumulating in an adjacent storm drain, D) Overflowing waste container with fly-tipping evident in the background.

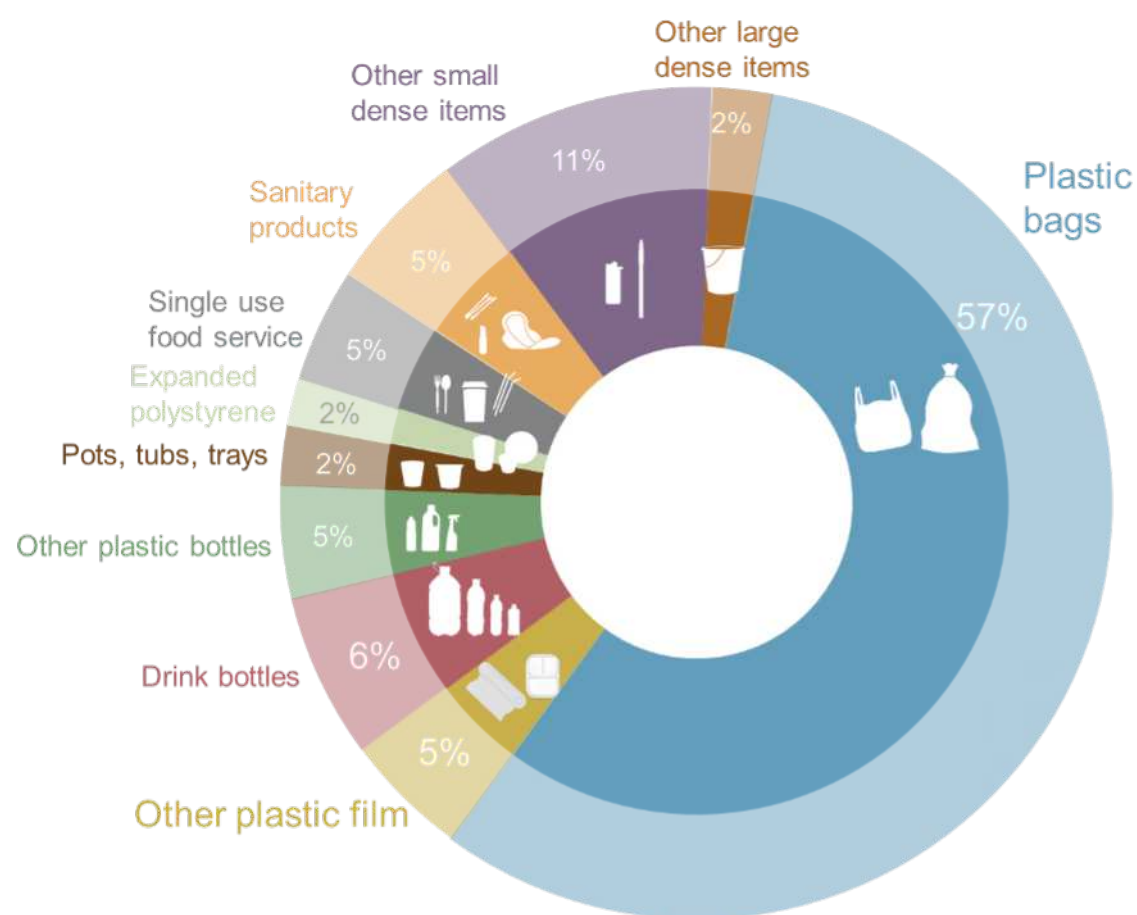
Following leakage whilst waiting for collection and littering, the disposal site forms the third-largest source of plastic pollution, releasing an estimated 38 tonnes of plastic into the environment each year. This value relates only to the plastic waste originating from Nakhon Si Thammarat City Municipality. Therefore, as the dumpsite also receives waste from other municipalities, the total amount emitted to the environment is predicted to be more. The dumpsite operates with minimal management. Typically, waste is dumped in a pile and remains exposed to the elements. This is evidenced by the dumpsite's recent history of regular flooding (2011, 2016, 2017, 2020) during the rainy season. In this sense, the vast majority of the plastic waste which is predicted as escaping to the environment comes about due to flooding events that impact the dumpsite.

The fourth highest source of plastic pollution in Nakhon Si Thammarat City Municipality is due to fly-tipped waste, which is defined as illegally dumped waste on a large scale (multiple items) by residents or businesses, often as a means to avoid paying disposal fees. While the legality of dumping is often complex, this report defines fly-tipping as illegal dumped waste when alternate disposal options are available (e.g. pay the municipality to collect). As such, the open dumping of waste by residents who lack any form of waste collection service is not considered fly-tipping but instead is represented by uncollected waste. This illegal dumping of waste often constitutes large bulk items, which are difficult or costly for individuals to dispose of. An example of a potential fly-tipping site can be seen in the background of Image 18d. It is unlikely that this waste would be collected along with the collection containers and, therefore, may disperse over time. However, as fly-tipping items are often bulky and weigh large amounts, the probability of these reaching the aquatic environment is lower than smaller items such as plastic bottles or bags.



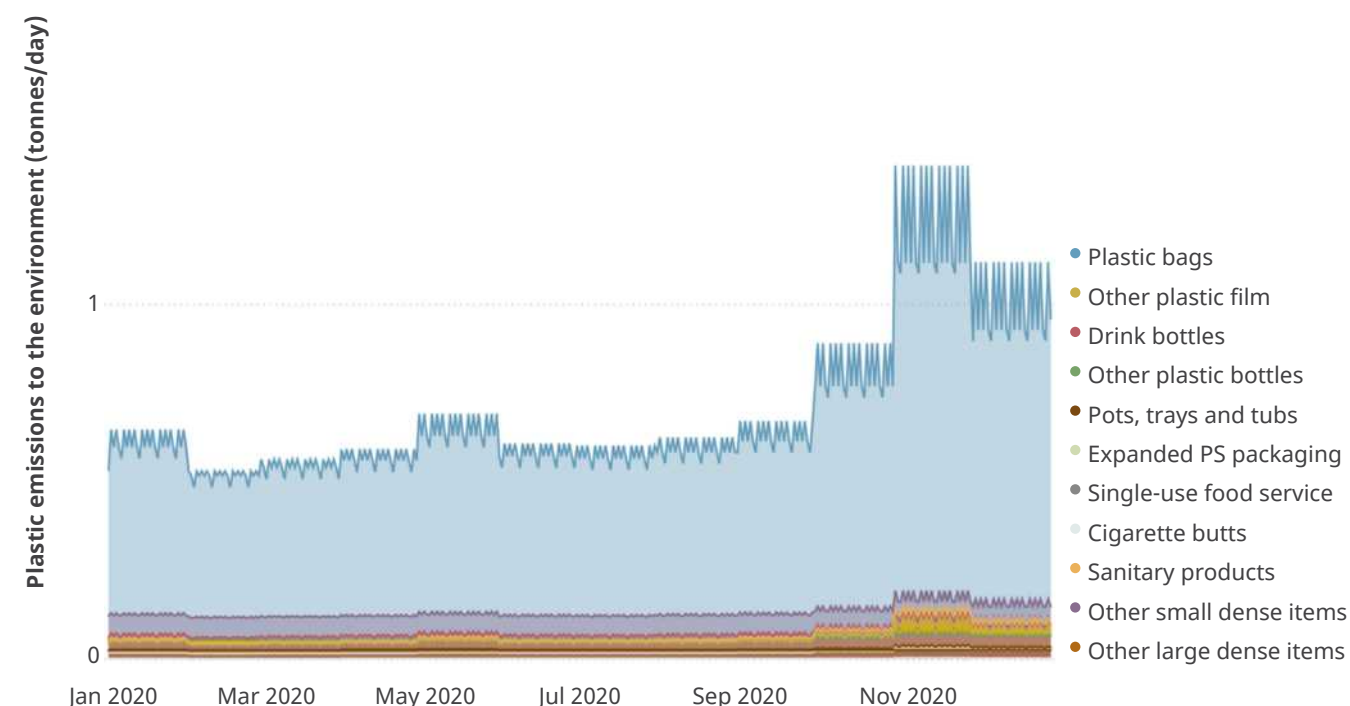
### 3.3.2 Composition of Plastic Emissions to the Environment

The composition of plastic emitted to the environment varies compared to that generated. This is due to an increased likelihood of specific items leaking based on the waste management practices of their source activity and their inherent material form (i.e., making them more susceptible to movement). However, unsurprisingly, due to their high use, low value, and ease of being blown by the wind, plastic bags still dominate plastic emissions to the environment accounting for 57% of all releases. Small dense plastic items account for 11%, followed by plastic drink bottles at 6%.



**Figure 19**

Item composition of plastic emissions to the environment



**Figure 20**

Plastic emissions into the environment by item type with time

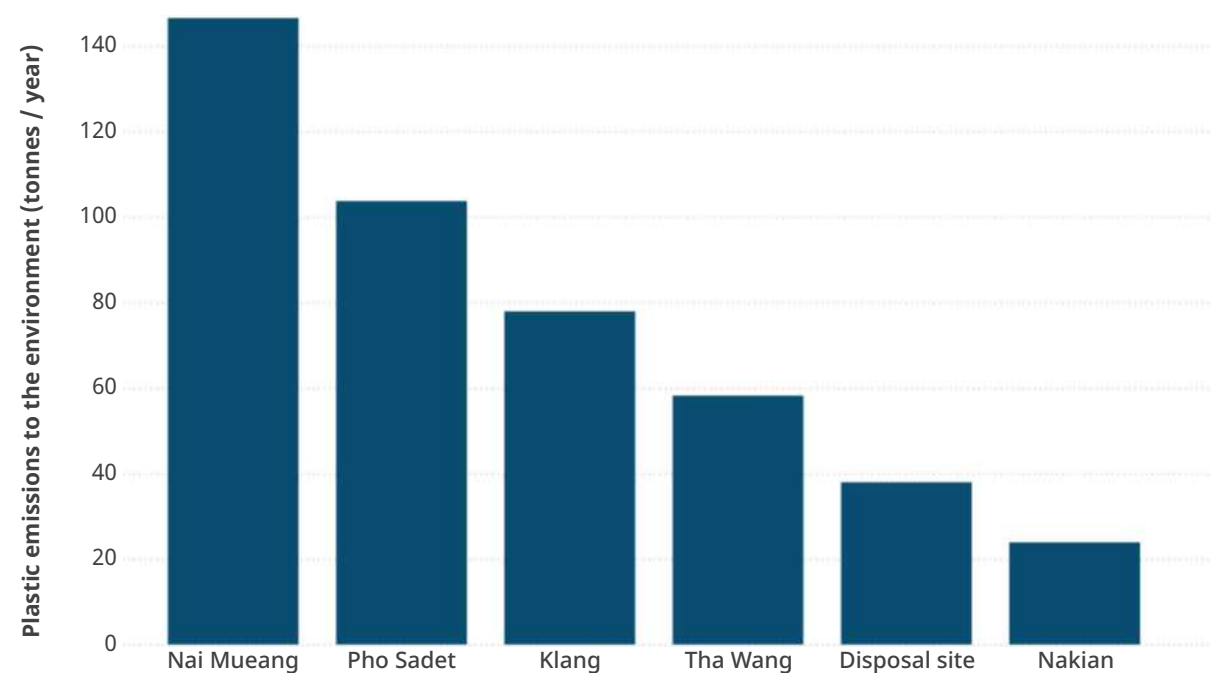
### 3.3.3 Plastic Emissions with Time

The emissions of plastic waste can often vary across the different months of the year. This is particularly the case when emission sources result from wind or surface runoff, which can show seasonal patterns. This time dependence for emissions can be seen in the results for Nakhon Si Thammarat City Municipality, City Municipality with peak emissions occurring during the rainy season (**Figure 20**). This main source for increased emissions during this period is 'waiting for collection', with any waste placed in or around waste bins having a higher likelihood of movement due to increased rainfall. In addition, the emissions from the disposal site are also predicted to increase during this period of flooding. On the other hand, the other prominent emission sources of littering and fly-tipping do not display a temporal dependence and therefore occur throughout the year in large amounts, as seen by the dry season still having considerable emissions.

The smaller peaks are due to the Plastic Pollution Calculator (PPC) considering the time-frame when waste will likely build up within collection containers and overflow, leading to higher emissions (**Figure 20**). Breaking the above result down by item type, plastic bags, in particular, show the most seasonal fluctuation due to their high occurrence in the waste stream and their strong affinity to be moved by wind and surface runoff. Other items also show small fluctuations with time, but not as significant.

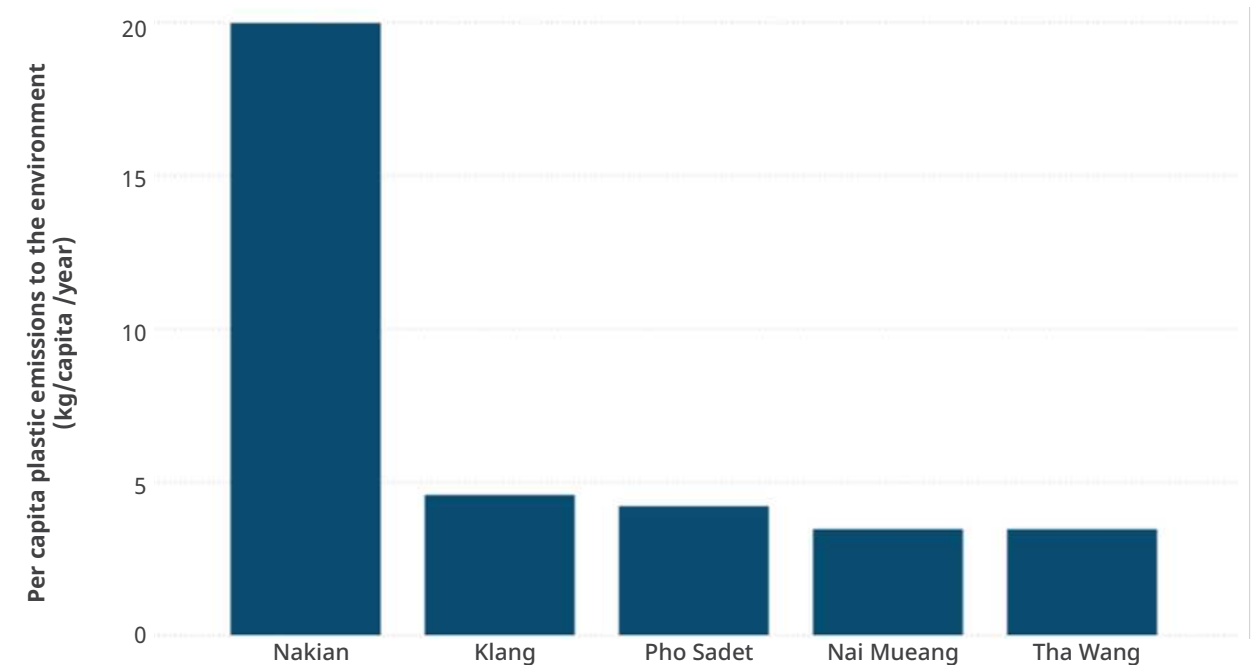
### 3.3.4 Spatial Distribution of Plastic Pollution Emissions

Whilst the results so far have shown the plastic emission results for Nakhon Si Thammarat City Municipality City Municipality as a whole, here we examine the plastic emissions to the environment by spatial location, made possible by running the PPC across each sub-sub-district of the five sub-sub-districts and assigning emissions based on the process outlined in the methodology section. **Figure 21** shows the total plastic emissions to the environment in tonnes per year for each sub-sub-district. Nai Mueang, Pho Sadet and Klang are the top three sub-sub-districts for plastic emissions at 146, 104 and 78 tonnes/year, respectively. These sub-sub-districts have similar waste management conditions but higher emissions because they have the highest. Alongside the five sub-sub-districts of Nakhon Si Thammarat City Municipality City Municipality, the disposal site is also included as a location of plastic pollution. This is kept separate from the other sub-districts as it falls outside of the city boundaries. However, it is still essential to consider this location because it receives the waste from Nakhon Si Thammarat City Municipality City Municipality, therefore is affected by what happens in the urban centre.



**Figure 21**

Plastic emissions to the environment in tonnes per year by sub-district



**Figure 22**

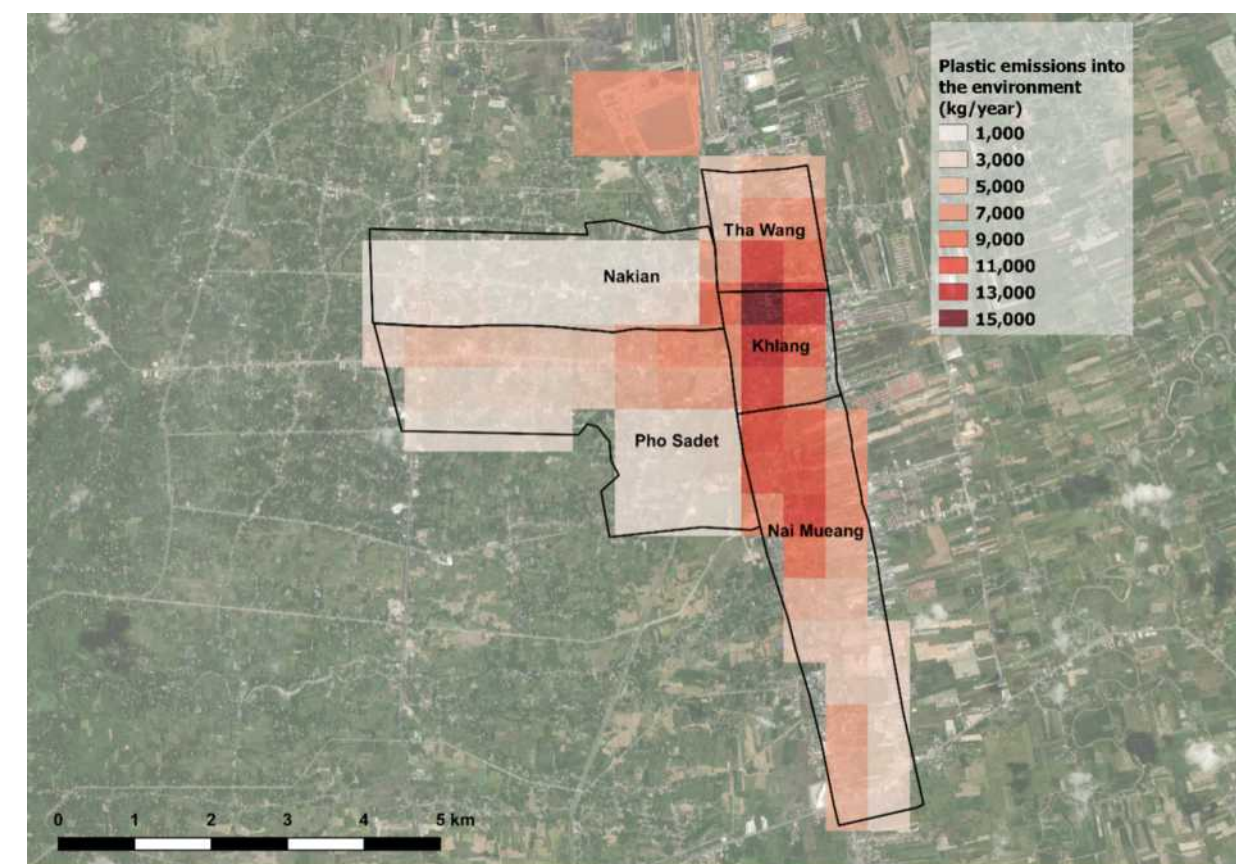
Per capita plastic emissions to the environment by sub-district including (light blue) and excluding (dark blue) tourists in the per-capita calculation.

Na khian sub-sub-district has the lowest plastic emissions at 23 tonnes per year because of its small population of just 1,196. However, for completeness, it is also important to consider the plastic emissions on a per capita basis to fairly compare the volumes in sub-sub-districts (**Figure 22**). On a per-capita basis, Na Khian has the highest emissions at 20 kg/capita/year. This is due to the sub-sub-district being a likely hotspot for fly-tipping activities due to its low population density. In contrast, a densely populated urban centre such as Klang is unlikely to have as much fly-tipping because there is less land in this area for people to dump waste illegally without being noticed.





Tha Wang, Khlang and Nai Mueang appear to have a higher concentration of plastic emissions due to their increased population densities. Interestingly, Tha Wang was the second from the bottom in terms of total emissions, as shown previously in **Figure 21**; however, its small area suggests plastic emissions may be in a similarly high concentration to Nai Mueang, which has considerably more emissions in total. This signifies the importance of considering different types of hotspots, such as total emissions per capita and concentration. Lastly, the disposal site is a source for emissions (**Figure 23**); however, it occurs outside the city boundaries.



**Figure 23**

Spatial distribution of plastic emissions in kg per year. This is visualised per 450 m x 450 m pixel.

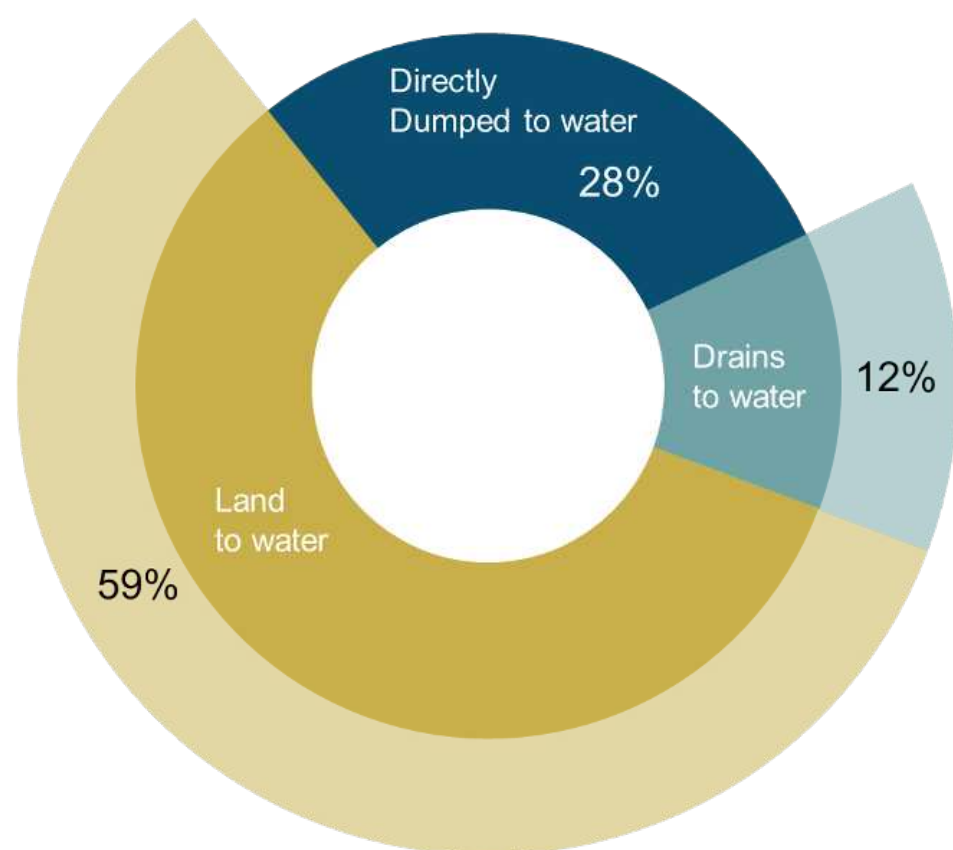
Lastly, the plastic emissions by location of emittance are shown in **Figure 23**, mapped for each pixel (~500 m x 500 m) in kg/year. This spatial representation of plastic emissions is achieved by mapping the waste management infrastructure, residential population and commercial activity before allocating the associated emissions from each sub-district to each, as explained in the methodology section. For the case of Nakhon Si Thammarat City Municipality, only the disposal site location was available for the waste management infrastructure. Therefore, the emissions from residential populations were allocated according to the population distribution reported by the European Commission Global Human Settlement Layer (GHSL) population distribution<sup>21</sup>.

<sup>21</sup> PESARESI, M., A. FLORCZYK, M. SCHIAVINA, M. MELCHIORRI and L.J.E.C. MAFFENINI, JOINT RESEARCH CENTRE. GHS settlement grid, updated and refined regio model 2014 in application to ghs-built r2018a and ghs-pop r2019a, multitemporal (1975-1990-2000-2015) r2019a. 2019.



### 3.4 River and Marine Plastic Pathways

As plastic entering waterbodies has the potential to cause harm to aquatic life, the Plastic Pollution Calculator (PPC) assumes a broad definition for its aquatic plastic debris that encompasses all MSW derived macroplastic waste (over 5mm in size) entering aquatic environments (i.e. permanent rivers and waterbodies). Of course, depending on the location and in-river characteristics, not all this plastic waste may enter the ocean. However, this broad definition is deemed preferable to account for all potential harm. It is essential to note that the term 'plastics pollution' encompasses all damaging aspects of plastic emissions into the environment, accounting for aquatic plastic debris and plastic retained on land, retained in drains or openly burnt.

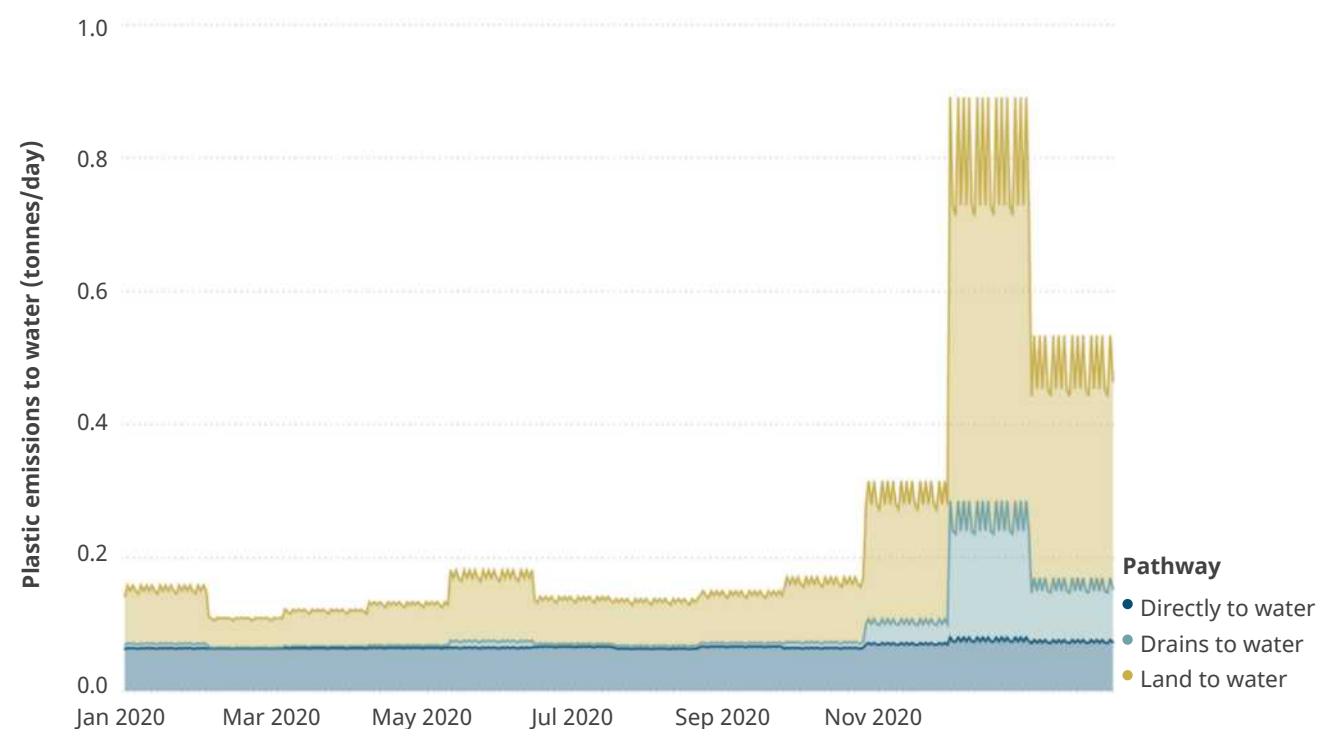


**Figure 24**

Key aquatic plastic debris pathways in Nakhon Si Thammarat City Municipality

The pathways that plastic waste emitted takes to reach waterways is shown in **Figure 24**. 28% of aquatic plastic debris enters waterways directly via dumping, mainly through fly-tipping, followed by littering alongside rivers. A further 59% of aquatic plastic debris enters waterways by moving overland, such as blown by the wind or moved by surface runoff. Storm drains are another common pathway for aquatic plastic debris to move. Within Nakhon Si Thammarat City Municipality storm drains are largely enclosed which significantly reduces the ability for plastic waste to enter and transfer to waterways, however 12% of aquatic plastic debris still enters waterways via storm drains due to poor maintenance, lack of regular cleaning, and aging of the infrastructure. In addition, the presence of a wastewater treatment plant in Nakhon Si Thammarat City Municipality ensures that plastic waste that enters the sewage system is removed, and therefore this is not included as a pathway.



**Figure 25**

Plastic emissions to water with time in Nakhon Si Thammarat City Municipality

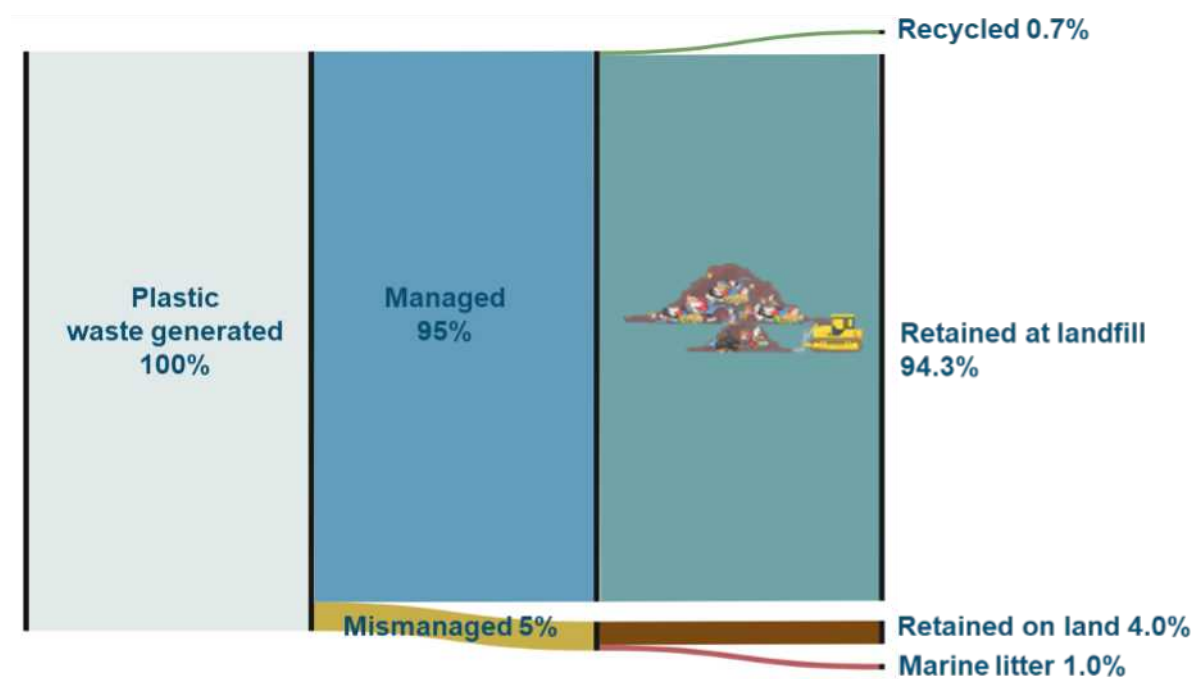
### 3.4.1 Pathways of River and Marine Plastic with Time

Plastic movement strongly correlates with meteorological conditions. For Nakhon Si Thammarat City Municipality this is studied during the months of November to January, matching that of the rainy season in **Figure 25**. The plastic emissions to water from the city peak during November to January, matching the rainy season. As previously described in **Figure 20**, the rainy season results in more plastic emissions and increases the likelihood of plastic being transported into rivers and the ocean overland or through drains.

## 3.5 Fate of plastic waste

An overview of the fate of plastic waste within Nakhon Si Thammarat City Municipality is summarised in the Sankey Diagram of **Figure 26**. It can be seen that of all the plastic waste generated, 94.3% ends up at the disposal site where it remains, and only 0.7% of the plastic is sorted for recycling. Together these fates represent the managed plastic, whereas the remaining 5% of plastic is deemed mismanaged. This mismanaged plastic waste differs from other definitions as it relates only to uncontrolled waste in the environment that can transfer to waterbodies with a high potential to cause damage to the environment and ecosystems. As such, waste retained at the disposal site is deemed managed regardless of the level of control at that site.

Of the 5% of mismanaged plastic waste, 362 tonnes/year (4%) of the plastic waste generated is deemed to be retained on land or in drains, whereby it becomes entangled. Over time, without clean-up activities, this plastic will degrade and break down into innumerable microplastics, many of which will contaminate the nearby environment, including waterways. A further 1.0% enters waterways becoming aquatic plastic debris. No evidence found suggests open burning of waste occurs in Nakhon Si Thammarat City Municipality; however, this is often very hard to quantify, and data on its existence is scarce. Despite this, open burning is often occurring, even in areas with 100% waste collection (e.g. via garden bonfires), but the level of this could not be ascertained in this study.

**Figure 26**

Fate of plastic waste in Nakhon Si Thammarat City Municipality



### 3.5.1 Plastic Recycling

Although the municipality provides source segregated collection containers in Nakhon Si Thammarat City Municipality to collect recyclable materials, major issues were found in their use, suggesting they are ineffective. For example, residents do not typically practice waste separation or use the different containers appropriately. Instead, they tend to put their mixed waste in any of the bins. An example of this is seen in **Figure 27**. This can happen due to a lack of understanding of the system, behavioural habits or issues relating to insufficient capacity of the containers, as discussed previously.



Photo credit: Chochoe Devaporihartakula, Programme Manager at IGES.

**Figure 27**

Colour coordinated collection containers in Nakhon Si Thammarat City Municipality. The yellow containers are designated for recyclables only, but this is not occurring in practice.

This lack of a functioning formal system for plastics recycling is counteracted somewhat by the activities of the informal recycling sector. The 0.7% of plastic recycled is entirely performed by these informal recyclers, sometimes known as waste pickers. This sector operates at the door-to-door level, collecting valuable recyclables from homes and businesses and at the disposal site, extracting any valuable materials from the waste deposited there (**Figure 28**). However, the amount of plastic collected for recycling by the informal recycling sector is minimal. The waste characterisation study performed in Nakhon Si Thammarat City Municipality suggests that only 5% of the recyclables they collect by mass is plastic, of which plastic bottles (drink or otherwise) represent 53% of this plastic collected.



Photo credit: Chochoe Devaporihartakula

**Figure 28**

Nakhon Si Thammarat City Municipality dumpsite showing unmanaged disposal and activities of the informal recycling sector.

### 3.5.2 Retained at Disposal Site

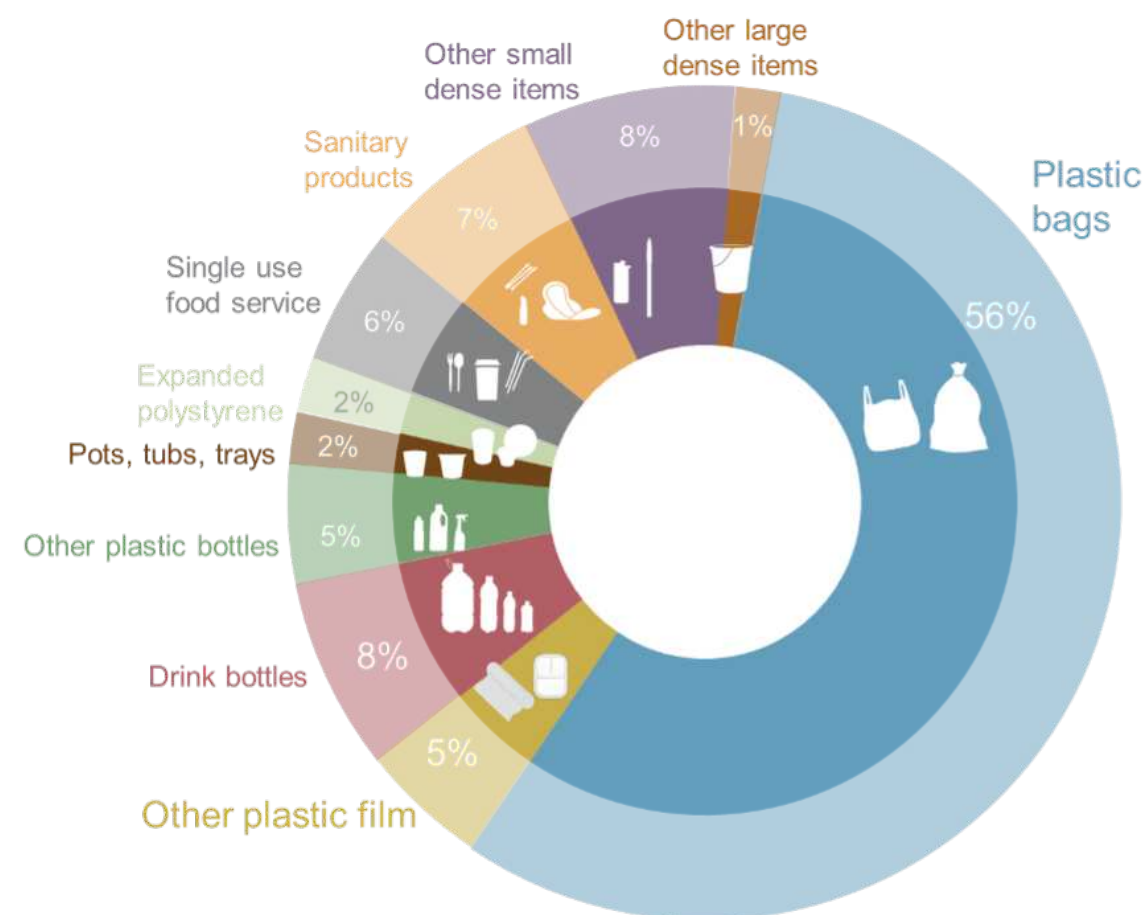
The vast majority of plastic waste generated in Nakhon Si Thammarat City Municipality ends up at the disposal site. The activities at this disposal site are largely uncontrolled, leading to a high potential for plastic emissions. For example, measures employed in well-managed disposal sites such as daily cover and compaction do not occur here. Additionally, the site is regularly exposed to flooding events leading to potentially significant releases of plastic into the environment and other potentially harmful pollutants. This is exasperated by the location of the disposal site, which is adjacent to several canals that facilitate the transport of pollutants into natural waterbodies.

### 3.5.3 Retained on Land and Drains

An estimated 4% of plastic waste is predicted to be retained dispersedly across land and in drains. This plastic waste may become trapped in vegetation and urban infrastructure. Whilst it is assumed that this plastic waste does not become aquatic debris within the modelling timeframe of a year, it is likely that some of this plastic may enter waterways in subsequent years. This is particularly the case if the plastic begins to degrade and fragment into microplastics, making transportation by surface runoff or contaminating soils more likely. Likewise, plastic retained in the storm drain network poses risks of local flooding by obstructing the channels leading to potential flooding.

### 3.5.4 River and Marine Plastic Pollution

About 87 tonnes of plastic waste (0.96% of plastic waste generation) is predicted to become aquatic debris every year in Nakhon Si Thammarat City Municipality. Although this percentage may sound small compared to other flows, the lightweight nature of plastic means that this represents many millions of items. The composition of aquatic debris is 56% plastic bags by weight (**Figure 29**). Assuming a plastic bag weighs approximately 5g, this would represent 10 million plastic bags entering aquatic environments each year! Likewise, although only 8% of the aquatic debris is plastic bottles, assuming an approximate average mass of 20 grams per bottle, this would represent 348 thousand bottles entering aquatic environments per year.

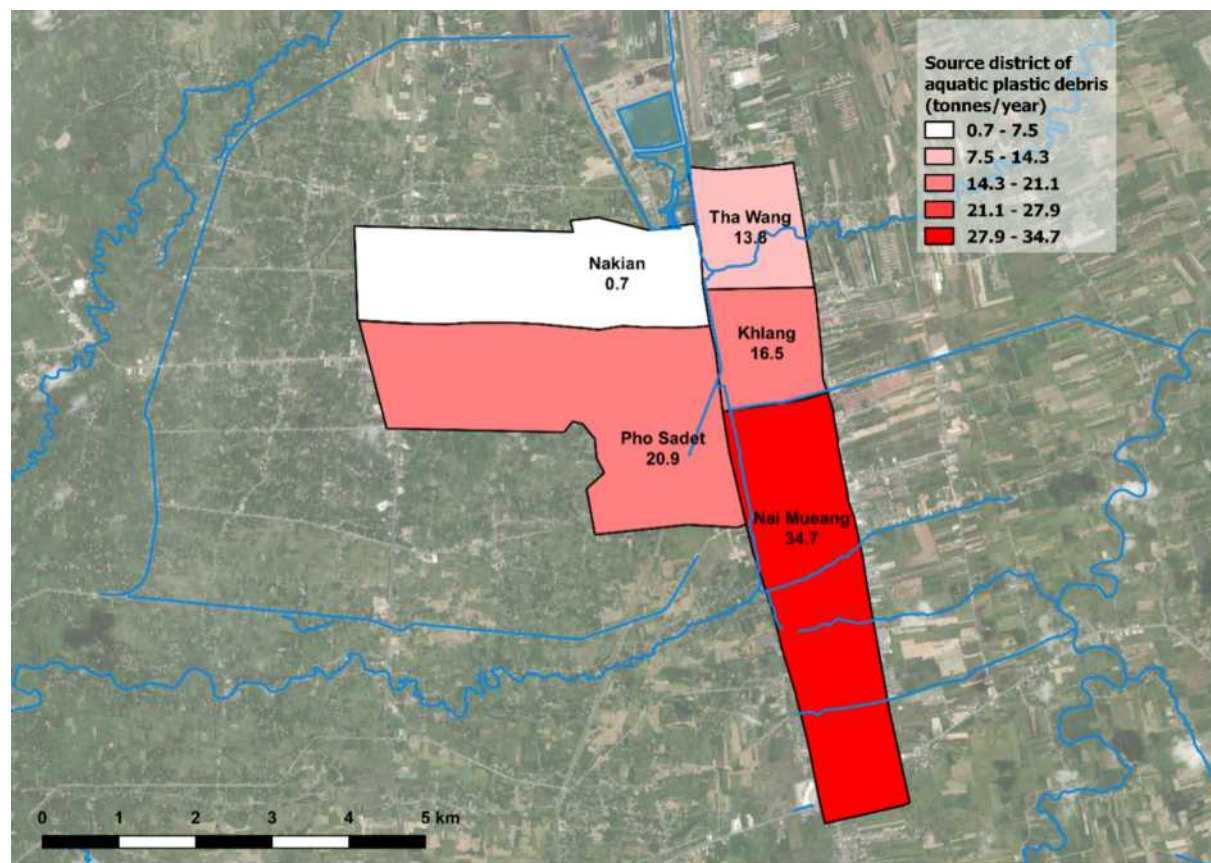


**Figure 29**

Composition of plastic waste entering waterways in Nakhon Si Thammarat City Municipality



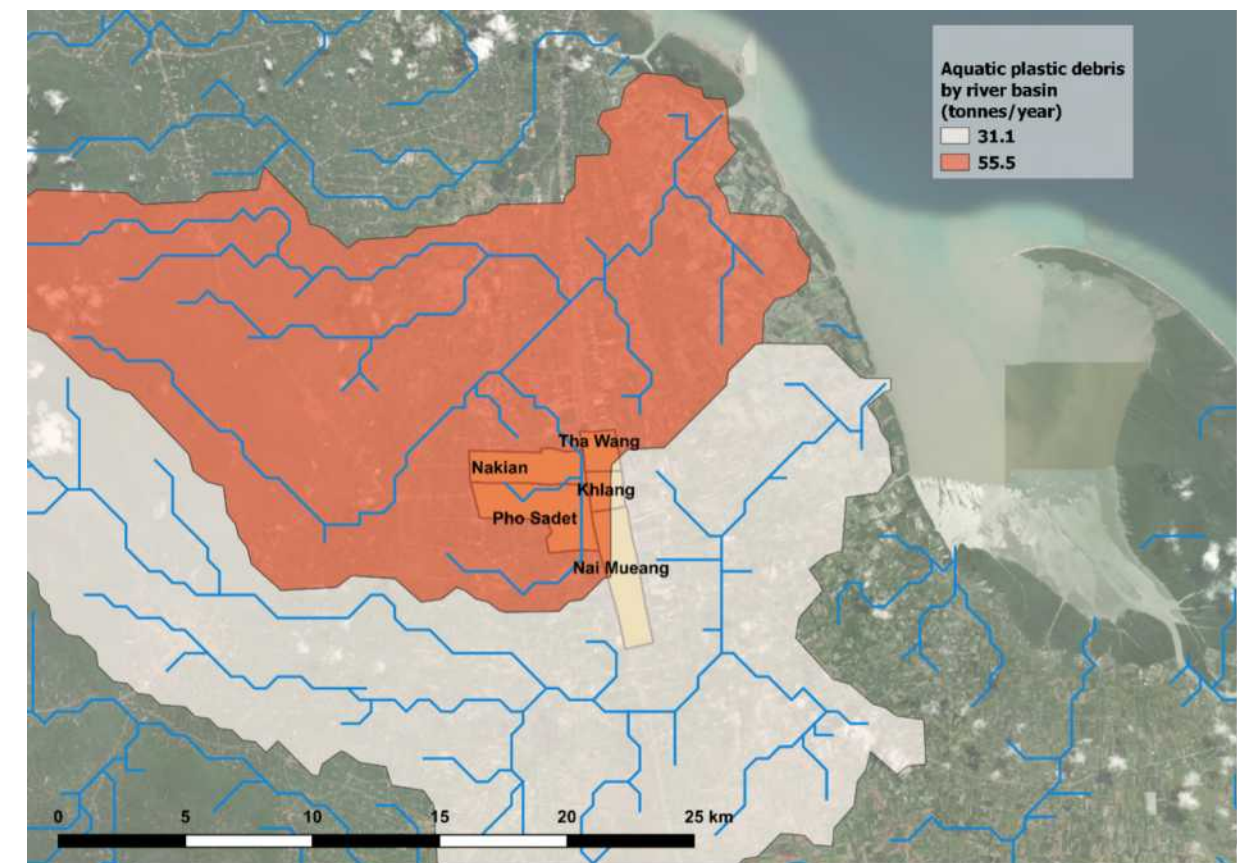
In the previous section, **Figure 21** detailed the sub-districts according to their contribution to plastic emissions; here, a similar approach is taken for only aquatic plastic debris instead. This aquatic plastic debris by source sub-district is shown in **Figure 30**. The sub-district that contributes the most aquatic plastic debris is Nai Mueang, with an estimated 34.7 tonnes of plastic waste entering aquatic environments each year. This sub-district ranks top for aquatic plastic debris partially because it also has the largest amounts of plastic waste emissions into the environment and because an estimated 65% of the population live within 500 metres of a waterway.



**Figure 30**

Contribution towards aquatic plastic debris by sub-district

Although the Plastic Pollution Calculator does not model the flows of plastic waste once in waterways, here likely hotspot locations are presented showcasing where the aquatic plastic debris would enter the ocean. This is achieved by overlaying the river basins<sup>22</sup> with sub-district aquatic plastic debris and noting the outlet of where that river basin drains to, as seen in **Figure 31**. 36% of the aquatic plastic debris is predicted to enter into the Pak Nakhon river basin on the South side of Nakhon Si Thammarat City Municipality. The remaining 64% of aquatic plastic debris is predicted to go to the more Northern Tha Phae river basin, although it is believed the majority of this actually leaves through the Tha Sak River.



**Figure 31**

Aquatic plastic debris by river mouth

<sup>22</sup> River basins are sourced according to the Hydrosheds level 9 definition. These basins are seen to not include some of the small drainage canals and waterways in Nakhon Si Thammarat City Municipality (e.g. Tha Sak River), therefore the actual outlet of these waterways may be slightly different.





# CHAPTER 4

CLOSING THE LOOP ON PLASTIC POLLUTION  
IN NAKHON SI THAMMARAT CITY MUNICIPALITY, THAILAND

## A Review of Governance Aspects

### P84 Institutional Setup

National/ Provincial Institutions Responsible for  
Implementing Plastic Waste/ Marine Litter  
Local (City) Institution Responsible for Implementing  
Plastic Waste/ Marine Plastic Management

### P94 Key Policies and Regulations

National Policies and Legislations  
Nakhon Si Thammarat City Municipality City  
Municipality's Policies

### P104 Financial Capacity

Revenue and Expenditure of Nakhon Si Thammarat  
City Municipality City Municipality



CHAPTER 4

# A Review of Governance Systems

## 4.1 Institutional Setup

### 4.1.1 National/ Provincial Institutions Responsible for Implementing Plastic Waste/ Marine Litter

At the national level, the Pollution Control Department (PCD) of the Ministry of Natural Resources and Environment (MONRE) is mainly responsible for policy planning, including municipal solid waste (MSW) and hazardous waste management. There are also other important line ministries, departments and agencies that regulate waste management. The Ministry of Public Health (MOPH) is responsible for infectious waste from hospitals, clinics and healthcare centres, while the Ministry of Industry (MOI) is responsible for industrial waste.

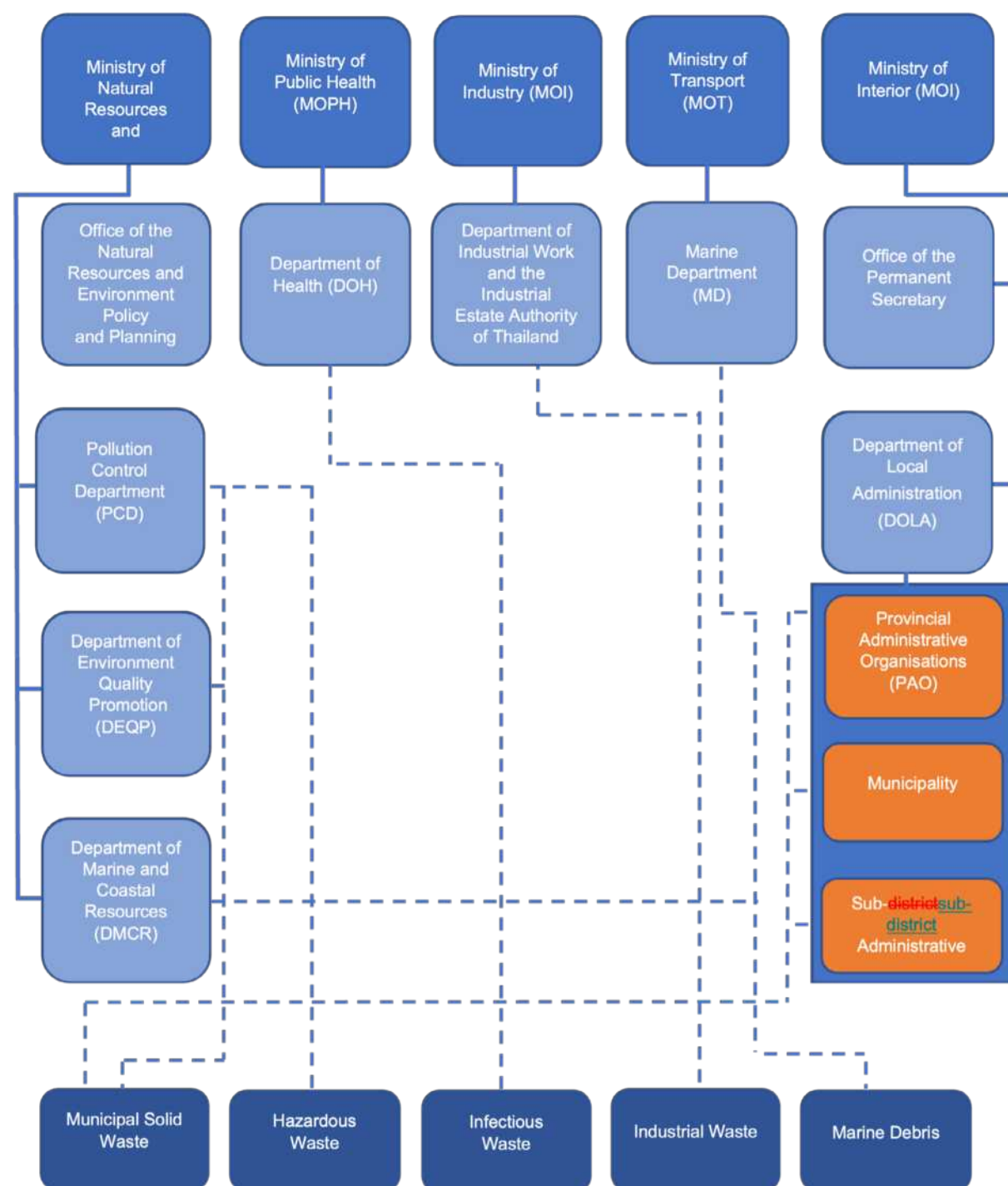
The Department of Marine and Coastal Resources (DMCR) of MONRE deals with marine debris management, including collecting discarded waste from coastal areas. Their responsibility includes beaches, mangroves and coral reefs, along with awareness-raising campaigns (non-smoking on beaches), installation of the waste traps at major river mouths and canals and survey and evaluation. In line with this, the Marine Department of the Ministry of Transport is tasked with setting rules and regulations for safe navigation in the Thai waters, including controlling marine pollution.

Name of the Ministry	Key Roles and Responsibilities
Ministry of Natural Resources and Environment (MONRE)	<ul style="list-style-type: none"><li>formulation of policies, guidelines, programmes, regulations and standards.</li></ul>
Office of Natural Resources and Environmental Policy and Planning	<ul style="list-style-type: none"><li>policy planning and administering the environment fund.</li></ul>
Pollution Control Department (PCD)	<ul style="list-style-type: none"><li>developing laws and policies concerning plastic waste management.</li><li>developing infrastructure planning for solid waste disposal and treatment.</li><li>providing overall control, supervision and monitoring of solid waste and hazardous waste.</li><li>issuing environmental regulations, laws associated with solid waste management.</li></ul>
Department of Environment Quality Promotion (DEQP)	<ul style="list-style-type: none"><li>enhancing environmental quality through research, development, training, and public awareness.</li><li>promoting and disseminating information on MSW management.</li></ul>
Department of Marine and Coastal Resources (DMCR)	<ul style="list-style-type: none"><li>formulating policies, planning and processing laws and legislation and its enforcement.</li><li>managing marine debris.</li></ul>
Ministry of Public Health (MOPH)	<ul style="list-style-type: none"><li>provision of waste management and disposal services.</li></ul>
Department of Public Health (DOH)	<ul style="list-style-type: none"><li>issuing ministerial regulations to stipulate service charges.</li></ul>
Ministry of Industry (MOI)	<ul style="list-style-type: none"><li>management of industrial waste.</li></ul>
Department of Industrial Work, Ministry of Industry and the Industrial Estate Authority of Thailand (IEAT),	<ul style="list-style-type: none"><li>policy guidance, compliance and enforcement.</li></ul>
Ministry of Interior (MOI)	<ul style="list-style-type: none"><li>supervision of finances and waste management of Local Government Organisations (LAOs).</li><li>support for the preparation of Local Development Plans.</li></ul>
Department of Local Administration (DOLA)	<ul style="list-style-type: none"><li>providing overall guidance to local authorities on waste handling and administering financial matters of Local Administrative Organisations (LAOs)</li></ul>
Marine Department of the Ministry of Transport	<ul style="list-style-type: none"><li>setting rules and regulations for safe navigation in the Thai waters which also includes controlling marine pollution.</li></ul>
Department of Fisheries, Ministry of Agriculture and Cooperatives	<ul style="list-style-type: none"><li>regulating and controlling fisheries resources for sustainable utilisation and maintaining diversity.</li></ul>
Port Authority of Thailand	<ul style="list-style-type: none"><li>administration of main ports, i.e. Bangkok Port, Laem Chabang Port, Chiang Saen Port, Chiang Khong Port and Ranong Port.</li><li>providing relevant information to the vessel at a port on solid waste management.</li></ul>

Table 2

Key national ministries and agencies involved in waste management are described below.

Although several line ministries and agencies deal with waste management, duties and responsibilities do not overlap among competent authorities. However, coordination among inter-ministerial/agency should be strengthened towards achieving the national goals.



Source: Compiled by Chochoe Devaporihartakula

**Figure 10**  
Administrative Structure of Waste Management in Thailand

## 4.1.2 Local (City) Institution Responsible for Implementing Plastic Waste/ Marine Plastic Management

### A. Municipal Government

The *Public Cleanliness and Orderliness Act B.E.2535* (1992) was amended in 2017 ((No. 2), B.E. 2560) to decentralise the power to the Local Administrative Organisations (LAOs) in dealing with waste collection and management under the supervision of the provinces and the Ministry of Interior (MOI). In addition, the National Government also initiated the *Clean Province Action Plan* to support the local government with the enforcement of the new law. Along with the *Municipal Act B.E. 2496* (1953) amended (No. 19) 2019, the Municipal Government has become the official entity in charge of the whole range of waste management activities, including solid waste collection and disposal within its governed areas and is entitled to both generate income through public services and receive funding from central government ministries.

Out of 184 LAOs responsible for collecting and managing solid waste, only 7 have sanitary disposal facilities.<sup>23</sup> Thailand's State of Municipal Solid Waste Management – 2017 revealed that more than 1.13 million tonnes of solid waste have accumulated, out of which 1.11 million tonnes has been dumped in Nakhon Si Thammarat City Municipality province. As a result, the Province has become the country's number one province for accumulating unmanaged solid waste. Since provincial collection coverage is estimated at around 63.5%, increasing collection coverage has become a priority issue to be solved<sup>24</sup>.

<sup>23</sup> Ibid.

<sup>24</sup> Pollution Control Department. (2018). รายงานสถานการณ์สถานที่กำจัดขยะมูลฝอยชุมชนของประเทศไทย ปี พ.ศ. 2560 [Thailand State of Municipal Solid Waste Management 2017]. Waste and Hazardous Substance Management Bureau. Bangkok.





## A-1 Waste-to-Energy<sup>27</sup>

In response to the city's growing waste problem, the Ministry of Interior (MOI) approved a 2,900-million Thai Baht (THB) public-private partnership (PPP) for a waste-to-energy project proposed by Nakhon Si Thammarat City Municipality City Municipality in July 2018. With this funding a 20-megawatts stoker-type incineration plant is under development that will be able to process up to 1,000 tonnes of municipal solid waste per day and generate electricity. This includes daily municipal solid waste estimated about 350 tonnes collects by the city and another 650 tonnes per day municipal solid waste excavated from the landfill site. It was estimated that the installed capacity will help the city manage and dispose of all accumulated waste, including plastic waste, within 11 years, to support them in meeting targets.

A waste-to-energy incineration plant will be provided by the Nakhon Si Thammarat City Municipality City Municipality and will be located at the current landfill site in Nakhian. It covers the area of approx. 50 rai (8 hectares), where 30 rai (4.8 hectares) will be allocated for waste disposal plant, and 20 rai (3.2 hectares) will be allocated for wastewater treatment.

Unlike many other cities in Thailand, Nakhon Si Thammarat City Municipality City Municipality manages its waste without outsourcing it to a third party or involving the private sector. Solid waste is collected daily by the municipal waste trucks and then sent to the landfill, where accumulated solid waste of over 1.13 million tonnes so far. This is in part due to the local management that permits other LAOs to dispose of their solid waste at their landfill<sup>25</sup>. The 22.16 Ha landfill site is located within Somdej Phra Srinagarindra 84 Park (Thung Thalad), Nakhon Si Thammarat City Municipality City Municipality. It has been operational since 1977 and receives approximately 261 tonnes of municipal solid waste each day<sup>26</sup>, with over half imported from 58 neighbouring municipalities who are permitted to dispose there by Nakhon Si Thammarat City Municipality City Municipality. A lack of formal management or waste segregation has created significant health and environmental concerns among residents and those who work at the landfill, including waste pickers, and even kills aquatic animals. These effects are particularly harmful to the estimated 120 waste pickers who rely on the landfill as their primary income source.

<sup>25</sup> Ibid.

<sup>26</sup> Pollution Control Department. (2020) โครงการพัฒนาระบบสารสนเทศ ด้านการจัดการขยะมูลฝอยชุมชน [Waste Generation Data of Nakhon Si Thammarat City Municipality City Municipality in 2019], <http://thaimsw.pcd.go.th/province/detail.php?id=80>.

<sup>27</sup> Hoon. (17 March 2021) "Super ลุงโรงไฟฟ้าขยะนครศรีธรรมราช 20 MW คาดรายได้ 500-600 ลบ./ปี." <https://hoonsmart.com/archives/175165>.





Under the build–own–operate–transfer (BOOT) agreement signed with Nakhon Si Thammarat City Municipality City Municipality on 16 March 2021, Green Power Energy Company Limited will exclusively invest, finance, design, build, operate, maintain and manage the incineration plant for 20 years. The Company is considered as a Small Power Producer (SPP) and will supply 16 megawatts of power generation through a 115 kilovolt (kV) transmission line to the state-owned enterprise, Electricity Generating Authority of Thailand (EGAT). The feed-in tariff of 3.66 THB per kWh will be applied for 20 years. In addition, the Company also charges a waste disposal fee of 350 THB/tonne. It is expected that the Company will generate income of approx. 500 – 600 million THB/year with a more than 7 – 8% return on investment. The construction will commence in 2022 and to be completed by 2024.

Under the agreement, Nakhon Si Thammarat City Municipality City Municipality still plays a vital role in solid waste management. Some of the items the City remains responsible for are; providing waste collection services; coordinating with other Local Authority organisations (LAOs); keeping records of waste generation; collecting management fees; carrying out land acquisition for the incineration plant; monitoring the Company’s performance under the agreement; environmental inspection at the implementation site; managing the Energy Development Fund and Environmental Development Fund; assessing potential impacts of and mitigation for humans who live nearby and; developing environmental impact mitigation plan (EIMP).

The incineration plant must comply with the Thai laws and regulations applicable to design criteria, environmental quality standards and pollution control systems. The emissions limits for specific pollutants that occur in the combustion process will be observed by the Continuous Emissions Monitoring System (CEMs), which measures emissions from the power station's stack using real-time data (See table x).

Air Pollutant	Units	Incinerator Capacity >50 tonnes/day
Total Suspended Particles (TSP)	mg/m3	70
Sulfur Dioxide (SO <sub>2</sub> )	ppm	30
Nitrogen Oxide (NOx) as Nitrogen Dioxide (NO2)	ppm	180
Hydrochloric Acid (HCl)	ppm	25
Mercury (Hg)	mg/m3	0.05
Cadmium (Cd)	mg/m3	0.05
Lead (Pb)	mg/m3	0.5
Polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs)	ng/ m3	0.1
Opacity	%	10

**Table 3**  
Air Emission Standard for Municipal Solid Waste Incinerator<sup>28</sup>

<sup>28</sup> Notification of the Ministry of Natural Resources And Environment: The Emission Standard For A Waste Incinerator (16 July 2010).  
[http://infofile.pcd.go.th/law/2\\_106\\_air.pdf?CFID=1123669&CFTOKEN=67875427](http://infofile.pcd.go.th/law/2_106_air.pdf?CFID=1123669&CFTOKEN=67875427)



## B. Other Key Stakeholders

In addition to the Municipal Government, the informal sector, particularly waste pickers and collectors, plays a significant role in managing plastic waste in Nakhon Si Thammarat City Municipality. There are approx. Sixty waste pickers work in the landfill, which is open 24 hours a day. The collected waste/recyclable waste is sold to waste dealers.

In terms of recycling, 23 licensed waste dealers in Nakhon Si Thammarat City Municipality buy recyclable and plastic wastes and sell them to other recycling companies outside Nakhon Si Thammarat City Municipality. However, there is no collaboration or joint programme among the Municipal Government, waste dealers, waste pickers, and waste collectors.

For community-based management, the Municipal Government usually follows the waste management policies from the central government. It has encouraged local communities from time to time to come up with awareness-raising campaigns as well as see the importance of waste separation at source and 3R activities. However, despite several attempts, little attention has been given to the issue as there is a lack of incentives and enforcement.

Stakeholder	Responsibilities
<b>Private sector</b>	
<b>Waste Dealers</b>	There are 23 licensed waste dealers who buy recyclables, including plastic waste and sell the aggregated waste to recycling companies outside the City.
<b>Waste Pickers</b>	There are approx. 60 waste pickers working at the landfill that collect plastic/recyclable wastes and sell them to the waste dealers.
<b>Waste collectors (including municipal waste collection workers)</b>	Collect plastic/recyclable wastes and sell them to the waste dealers.
<b>Thailand Public-Private Partnership for Plastic and Waste Management (PPP-Plastic)</b>	PPP-Plastic has secured support from over 30 organisations, including some leading global companies such as DOW, Coca Cola, PTT, etc. Their common goals are to reduce at least 50% aquatic plastic debris by 2027 through solutions such as sustainable waste management, the Circular Economy, and applying the 3Rs activities.

Stakeholder	Responsibilities
<b>Any other (international agencies/ academic/ research institute)</b>	
<b>Thailand Greenhouse Gas Management Organization (TGO)</b>	Greenhouse Gas Emission Reporting for Local Government (2020 – 2022) project has started to strengthen the capacity of Local Administrative Organisations (LAOs) to calculate the organisation's carbon footprint as a pathway forward to a Low-Carbon city. In Nakhon Si Thammarat City Municipality, the Division of Public Health and Environment is the project's focal point and has given a special focus on wastewater and solid waste management.
<b>Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)</b>	The Project on Support to the Development and Implementation of the Thai Climate Change Policy (CCA) Project (2014 – 2017) was a collaboration between the Ministry of Natural Resources and Environment, Thailand, through the Office of the Natural Resources and Environment Policy and Planning (ONEP) and the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) through GIZ. The project lasted four years, from 2014 to 2017, to support the development and implementation of climate change policy at the regional and sub-national levels. The aim was to elaborate the Thailand Climate Change Master Plan 2015-2050 and develop climate change action plans significantly consistent with each region's context and development directions. This also included wastewater and solid waste management of the Nakhon Si Thammarat City Municipality City Municipality.

**Table 3**

Key Stakeholders involved in Plastic Waste Management in Nakhon Si Thammarat City Municipality

## 4.2 Key Policies and Regulations

### 4.2.1 National Policies and Legislation

Thailand has ranked as one of the top ten largest world contributors to plastic waste in the ocean and continues to be a challenge for the country. Because of this, waste management has been considered as a national priority since 2014. As a result, the Thai government initiated a series of waste management policies, including *Road Map on Waste and Hazardous Waste Management 2014*, *National Master Plan for Waste Management 2016-2021*, and *the Action Plan on Thailand Zero Waste (2016 – 2017)*<sup>29</sup> were introduced to initiate proper waste management throughout the country.

The *National Master Plan for Waste Management 2016 – 2021*<sup>30</sup> mainly focuses on waste generation and collection systems, particularly on 3R Strategies (reduce, reuse, recycle) and the improvement of waste disposal sites.

Targets	By 2019	By 2020	By 2021
Municipal solid waste is disposed of properly	-	-	>75% (19.6 mt)
All accumulated waste is disposed of properly	100% (30.5 mt)	-	
Household hazardous waste is collected and disposed of properly	-	-	>30% (0.17 mt)
All infectious waste is collected and disposed of properly	-	100% (0.05 mt)	-
All hazardous industrial waste management collected and disposed of properly	-	100% (2.06 mt)	-
Local governments have systems for waste separation at the source (households)	-	-	>50% (3,889 LGs)

**Table 4**

National Master Plan for Waste Management 2016 - 2021

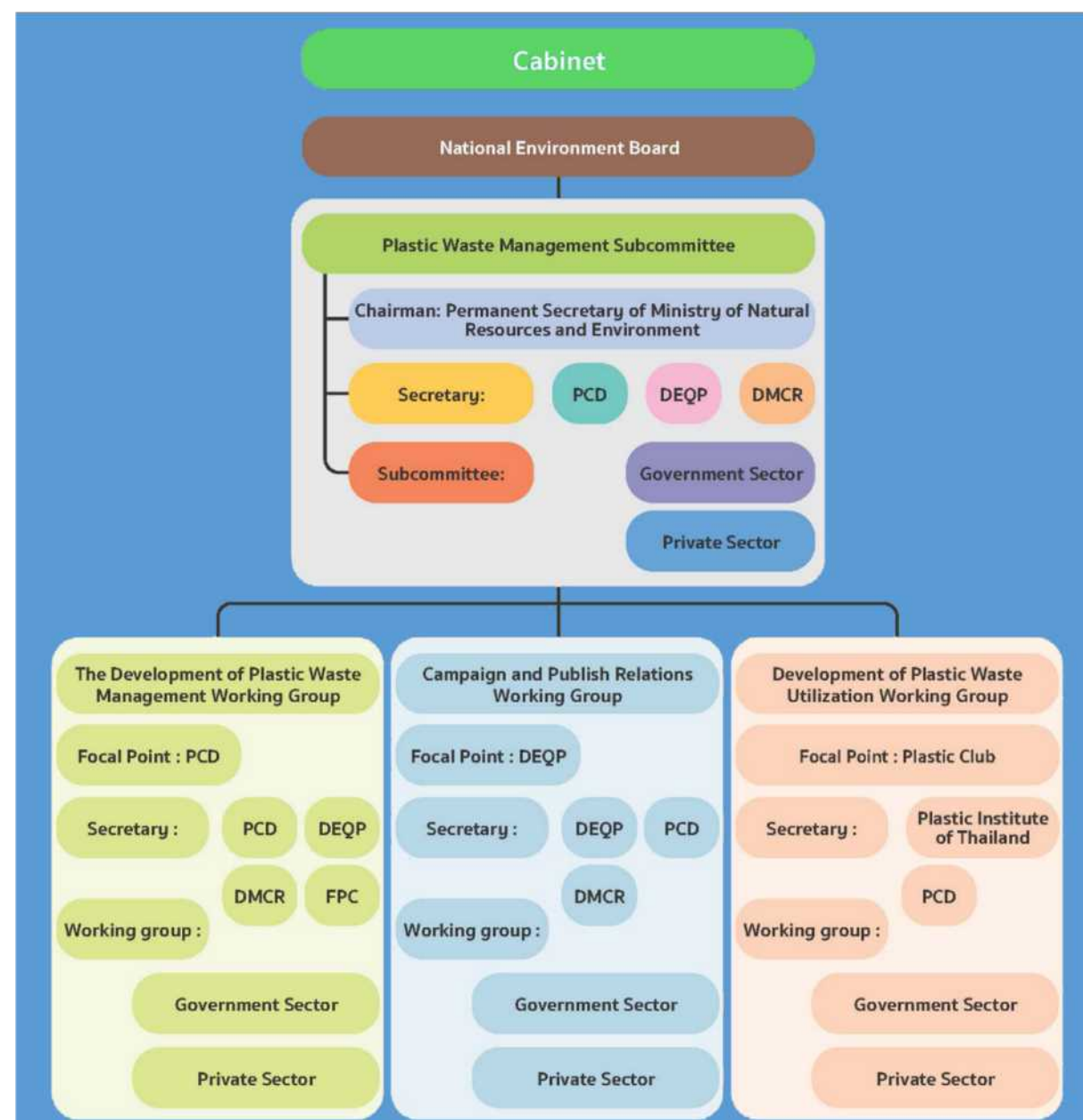


The amount of plastic waste ending up in landfills, being openly burnt or dumped and entering the marine environment is increasing and has become a serious and urgent issue for the Thai Government. The Thai Government initiated the establishment of three working groups, including 1) the Development of Plastic Waste Management and Electronic Waste Working Group; 2) Campaign and Public Relations of Plastic Waste Management and Electronic Waste Working Group; 3) the Development of Plastic Waste Utilisation Working Group under the *National Environment Board (NEB)* where the first working group proposed the *National Roadmap for Plastic Waste Management 2018 – 2030* to be included as part of the framework for Thailand to move towards sustainable plastic management through a circular economic model. There are three measures, including 1) reduction of plastic production; 2) reduction of single-use plastic consumption; 3) proper plastic waste management system after consumption.

<sup>29</sup> Simachaya W. (2017). National Policies, Initiatives and Best Practices for Solid Waste Management in Thailand. <https://www.dmcg.go.th/dmcr/fckupload/upload/147/file/ppt1/ms2-01.pdf>.

<sup>30</sup> Pollution Control Department. (2016). National Solid Waste Management Master Plan 2016-2021. Bureau of Waste Management and Hazardous Substances. Bangkok.





Source: Department of Environmental Quality Promotion

**Figure 11**

Plastic Waste Management Mechanism in Thailand to Achieve the Roadmap Goals

PPP Plastic's Goal: To reduce plastic marine debris by at least 50% by 2027							
Goals	Base-line	2018	2019	2020	2021	2022	2027
1. Waste plastics return into the manufacturing system - circular economy	21%	22%	25%	30%	40%	50%	100%
2. Reduce the usage of seven plastic packaging targets							
2.1 Plastic microbead			100%				
2.2 Cap seal							
2.3 OXO bag							
2.4 <36 microns shopping bag			25%	50%	75%	100%	
2.5 Styrofoam food packaging							
2.6 Single-use plastic cup							
2.7 Straw							

Source: Pollution Control Department (PCD)<sup>31</sup>

**Table 5**

Roadmap on Plastic Waste Management 2018 - 2030

In addition to that, *Public-Private Partnership for Plastic and Waste Management* or *Thailand PPP Plastic* was also established in 2018 to address plastic waste with the aims of achieving plastic waste reduction goals by at least 50% and to be recycled at the rate of 100% by 2027. In 2021, PPP Plastics has scaled up and included 39 partnered organisations from various sectors including government, public, private sector, international organisations and educational institutions.<sup>32</sup>

<sup>31</sup> [https://www.pcd.go.th/wp-content/uploads/2021/10/pcdnew-2021-10-19\\_08-59-54\\_995414.pdf](https://www.pcd.go.th/wp-content/uploads/2021/10/pcdnew-2021-10-19_08-59-54_995414.pdf)

<sup>32</sup> PPP Plastics. (2021). "Role of Public Private Partnership for Sustainable Plastic and Waste Management (PPP Plastics) for solving the plastic waste problem in Thailand."

Starting in January 2020, giant retailers such as CPALL Pcl that operates over 10,000 7-Eleven convenience stores in Thailand, major plastic manufacturers and leading department stores including the Mall Group, Robinson Plc, Big C Supercentre Plc, Siam Makro Plc, Tesco Lotus and the country's largest retailer, Central Group, signed up to the government programme in banning single-use plastic bags and agreed to stop giving out plastic bags to customers.<sup>33</sup> However, this government programme is conducted voluntarily and not mandated by law. Therefore, some retailers still give plastic bags for free. Although billions of plastic bags were significantly reduced from the waste stream,<sup>34</sup> there is still a long way to go to meet targets.

Goals	Baseline in 2019	2022
<b>1. Reduce and stop using 4 types of plastic by replacing them with environmentally friendly materials</b>	Plastic consumption from 3 types of products was 384,024 tonnes. Most were plastic bags.	100%
<b>1.1 &lt;36 microns shopping bag</b>		
<b>1.2 Styrofoam food packaging</b>		
<b>1.3 Single-use plastic cup (&lt;100 microns)</b>		
<b>1.4 Straw (Except for use in cases of necessity e.g. children, the elderly, and patients etc.)</b>		
<b>2. Recycle or reuse 50% of 7 types of plastic by 2022</b>	Plastic consumption from 7 types of products were 1,341,668 tonnes. 50% of this should be recycled and/or reused.	50%
<b>2.1 Thick plastic bags (HDPE, LLDPE, LDPE, and PP)</b>		
<b>2.2 plastic utensils</b>		
<b>2.3 plastic bottle</b>		
<b>2.4 Plastic box, tray</b>		
<b>2.5 Plastic film packaging (HDPE, LL/LDPE)</b>		
<b>2.6 Thick plastic cup</b>		
<b>2.7 Plastic lid</b>		

**Table 6**

Action Plan on Plastic Waste Management Phase I (2020 – 2022)

<sup>33</sup> Ibid.

<sup>34</sup> Prapan Chankaew. (1 January 2020). "Thailand kicks off 2020 with plastic bag ban." Reuters. <https://www.reuters.com/article/us-thailand-environment-plastic-idUSKBN1Z01TR>



To achieve concrete goals with tangible results, the Thai Cabinet approved the *Action Plan on Plastic Waste Management Phase I (2020 – 2022)*<sup>35</sup> in February 2021 to support sustainable plastic waste management through circular economic approaches under the *Roadmap for Plastic Waste Management 2018 – 2030*. According to the *Action Plan*, approximately 780,000 tonnes of plastic waste can be reduced, saving approximately 3,900 million THB/year in waste management fees. It will also help reduce landfill use by up to 400 hectares and reduce greenhouse gas emissions equivalent to 1.2 million tonnes of carbon dioxide.<sup>36</sup> All of these can be achieved through following measures 1) reduction of plastic waste at source; 2) reduction of the use of single-use plastic at consumption process; 3) post-consumption plastic waste management. However, single-use plastic consumption of products like food containers, food wrappers, plastic bottles, plastic cups, cutlery, straws and foams have increased during the COVID-19 pandemic. This could be due to change in consumption patterns with hygiene consciousness and increased purchasing and delivery through online platforms (i.e., Grabfood, FoodPanda, LINEMAN, Lazada, Shopee, JDCentral). Subsequently, the amount of plastic waste is projected to continuously increase, hindering the plastic waste reduction goals under the *Roadmap for Plastic Waste Management 2018 – 2030*.

In addition to the policies already discussed, Thailand also has several other policies and legislations supporting waste management, as detailed in **Table 7**.

<sup>35</sup> Royal Thai Government. (15 February 2021) "สรุปข่าวการประชุมคณะรัฐมนตรี 15 กุมภาพันธ์ 2564." [http://www.thaigov.go.th/news/contents/details/39110?fbclid=IwAR1FPyzmM7FLqNtLE-bwS61ui\\_MP8MUH-VD9dfprhVx6Jlf0m3TJuzTcB4](http://www.thaigov.go.th/news/contents/details/39110?fbclid=IwAR1FPyzmM7FLqNtLE-bwS61ui_MP8MUH-VD9dfprhVx6Jlf0m3TJuzTcB4).

<sup>36</sup> <https://www.nationthailand.com/news/30402739>



Policy, regulation and strategic plans	Any specific explanation/ target/ strategies addressing plastic waste and/or marine plastic in the plan, policy and regulation.
<b>Navigation in the Thai Waters Act B.E. 2456 (1913)</b> <sup>37</sup>	<p>One of the first laws that set rules and regulations for safe navigation in the Thai Waters also includes provisions on the control of marine pollution. While this Act does not specifically mention plastic waste/marine plastic, Section 119 aims at preventing marine pollution by regulating the dumping of wastes and other matters into any rivers, canals, marshes, reservoirs, lakes, or any sea within the Thai Waters.</p> <p>Due to the growing problems of plastic waste in the ocean, the Government of Thailand is now in preparation for acceding to the MARPOL Annex V. In line with this, the public consultation process for amending the existing Act was conducted in September 2020 to include setting regulations for the prevention of pollution by plastic and garbage from all vessels. If endorsed, this will be the first Thai law that specifically addresses the discharge of plastic waste in the marine environment.</p>
<b>State Irrigation Act B.E. 2485 (1942)</b> <sup>38</sup>	<p>This Act provides regulations, management, and control of state irrigation to ensure proper execution. It prohibits discarding solid waste, including carcass, waste crops, ashes, plastic waste into irrigation waterways.</p>
<b>The Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992)</b> <sup>39</sup>	<p>One of the most comprehensive laws that covers a wide range of environmental quality, management, protection and pollution control functions. It also helps to decentralise the administrative authorities from the central government to provincial authorities, encourage public participation process of private sector and NGOs, establish the Environmental Fund and promote the ‘Polluter-Pays’ principle. Section 78 mentions procedures of collection and transportation of solid and hazardous waste and sources of pollution. It also includes preventing and controlling pollution caused by littered wastes and other matters in the sea.</p>
<b>Fisheries Act B.E. 2558 (2015)</b> <sup>40</sup>	<p>This Act lays down the general principles relating to the fishing industry, including cultivation, registration and permits, as well as statistics, inspections, penalties, and establishment of the National Fisheries Committee. Section 26 (Part 5) prohibits pouring, throwing away, draining or disposing that may cause any pollutant in any fishing grounds unless it is for experimental and military purposes.</p>
<b>Public Cleanliness and Orderliness Act B.E.2535 (1992) amended (No. 2), B.E. 2560 (2017)</b> <sup>41</sup>	<p>This Act deals with the maintenance of public sanitation measures and waste disposal throughout the country. It prohibits the dumping of refuse or waste in public surface areas or waterways. It is one of the important laws that decentralises the local administrative organisations' (LAOs) power in dealing with waste collection and management under the supervision of the provinces and the Ministry of Interior (MOI). In addition, the amendment (2017) also includes an amended collection fee to reflect the actual cost. Stricter enforcement for violation is also applied.</p>

<sup>37</sup> Navigation in the Thai Waters Act B.E. 2456 (1913) [http://web.krisdika.go.th/data/document/ext810/810051\\_0001.pdf](http://web.krisdika.go.th/data/document/ext810/810051_0001.pdf)

<sup>38</sup> State Irrigation Act B.E. 2485 (1942). [http://web.krisdika.go.th/data//document/ext810/810051\\_0001.pdf](http://web.krisdika.go.th/data//document/ext810/810051_0001.pdf)

<sup>39</sup> The Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992). [http://web.krisdika.go.th/data/document/ext809/809866\\_0001.pdf](http://web.krisdika.go.th/data/document/ext809/809866_0001.pdf)

<sup>40</sup> Fisheries Act B.E. 2558 (2015). <http://extwprlegs1.fao.org/docs/pdf/tha159734.pdf>

<sup>41</sup> Public Cleanliness and Orderliness Act B.E.2535 (1992) amended (No. 2), B.E. 2560 (2017). [http://www.thailandntr.com/en/trade-in-services/laws/organization/download/283?file=Law\\_TIS\\_512\\_EN.pdf](http://www.thailandntr.com/en/trade-in-services/laws/organization/download/283?file=Law_TIS_512_EN.pdf)

Policy, regulation and strategic plans	Any specific explanation/ target/ strategies addressing plastic waste and/or marine plastic in the plan, policy and regulation.
<b>Public Health Act B.E.2535 (1992) and amended (No. 3), B.E. 2560 (2017)</b> <sup>42</sup>	<p>This Act aims to protect public health, ensure living conditions of the people, facilitate the implementation of environmental health programmes, improve the power of the Local Administration Organisations (LAOs) or the local government, and set strict penalties. Section 20 shows that the power is given to the LAOs or local government to manage waste and sewage collection, transportation and disposal within their governed areas, and issue local ordinances that can prohibit dumping/discharging of solid waste and sewage to the public areas in order to maintain cleanliness and regulate waste and sewage management.</p> <p>The amended No.3 (2017) also emphasises law enforcement and principles of public participation. Section 26 (Part 5) prohibits pouring, throwing away, draining or disposing of that may cause any pollution in any fishing grounds unless it is for experimental and military purposes.</p>
<b>Thailand Environmental Quality Management Plan (2017 – 2021)</b> <sup>43</sup>	<p>It highlights four strategic priorities: 1) Balancing Natural Resources Management; 2) Environmental Quality Management, Protection &amp; Rehabilitation; 3) Increasing Efficiency of Natural Resources Uses; 4) Climate Change &amp; International Cooperation. The 5-year targets include achieving a proper municipal solid waste management of no less than 75% and a recycling rate of no less than 30% of the total solid waste generated in the country. In addition, it includes marine debris management measures by controlling coastal activities such as fishing, tourism, shipping and sea freight. This also includes controlling the amount of solid waste from land to sea by introducing a new legislation related to waste.</p>
<b>Thailand 12th Economic and Social Development Plan 2017-2021</b> <sup>44</sup>	<p>The overarching framework to guide Thailand's development trajectory produced by the Office of the Prime Minister. This is the first 5-year plan of the 2017-2036 National Strategy and sets out national economic, social and environmental goals. It includes a target of 75% waste treatment or reuse and nationwide improvements in river water quality.</p>
<b>National Strategy 2018 – 2027 (20 Years)</b> <sup>45</sup>	<p>It aims to promote efficient reuse of waste, utilise innovation and technology to reduce pollution and environmental impact, set targets from cradle to grave with the 3R goal and a supervision system to track waste and pollution management. It also encourages zero-waste targets and sustainable waste management, particularly in the agricultural sector and marine debris. The Department of Marine and Coastal Resources has continuously implemented marine debris management projects since 2016 by enacting new legislation and conducting environmental campaigns to ensure sustainable marine and coastal resources in the Thai waterways.</p>

**Table 7**  
Other key national policies and plans for waste management in Thailand

<sup>42</sup> Public Health Act B.E.2535 (1992) and amended (No. 3), B.E. 2560 (2017). [http://web.krisdika.go.th/data/document/ext838/838066\\_0001.pdf](http://web.krisdika.go.th/data/document/ext838/838066_0001.pdf)

<sup>43</sup> Office of Natural Resources and Environmental Policy and Planning. แผนจัดการคุณภาพสิ่งแวดล้อม พ.ศ. ๒๕๖๐ – ๒๕๖๔ [Thailand Environmental Quality Management Plan (2017 – 2021)]. <https://www.onep.go.th/ebook/spd/environment-plan-2560-2564.pdf>

<sup>44</sup> Office of the National Economic and Social Development Board (NESDB). The Twelfth National Economic and Social Plan. [https://www.nesdc.go.th/nesdb/en/ewt\\_dl\\_link.php?nid=4345](https://www.nesdc.go.th/nesdb/en/ewt_dl_link.php?nid=4345)

<sup>45</sup> Office of the National Economic and Social Development Board (NESDB). National Strategy 2018 – 2027 (20 Years). <http://nscr.nesdb.go.th/wp-content/uploads/2019/10/National-Strategy-Eng-Final-25-OCT-2019.pdf>

### 4.2.2 Nakhon Si Thammarat City Municipality City Municipality’s Policies

In Nakhon Si Thammarat City Municipality City Municipality, there is currently no robust policy, legislation, or action plans on plastic waste. All of the local plans, such as *Nakhon Si Thammarat City Municipality City Municipality 4-year Development Plan*, *Nakhon Si Thammarat City Municipality 4-year Provincial Development Plan* and *Clean Province Action Plan*, mainly promote 3R activities and waste separation at source. The *Clean Province Action Plan* requires participating LAOs to implement their plans and policies based on the *National Master Plan for Waste Management 2016 – 2021* (See Table 9).

Policy, regulation and strategic plans	Any specific explanation/ target/ strategies addressing plastic waste and/or marine plastic in the plan, policy and regulation.
Municipal Act B.E. 2496 (1953) amended (No. 19) 2019 <sup>46</sup>	This Act sets out rules for duties and functions of the Municipal Government, including maintaining city cleanliness and providing solid waste and sewage disposal management.
Municipal Ordinance of Nakhon Si Thammarat City Municipality City Municipality on Solid Waste and Sewage Disposal B.E. 2538 (1995) <sup>47</sup>	It gives the powers to the Municipal Government to manage and regulate solid waste collection and disposal within its boundaries. It prohibits dumping/discharging solid waste and sewage to public areas, including streets, rivers, canals, drainage systems, ponds and lakes.
Nakhon Si Thammarat City Municipality 4-year Provincial Development Plan 2018 - 2022 <sup>48</sup>	Nakhon Si Thammarat City Municipality Province has appointed the committee to manage and regulate municipal solid waste. All LAOs in the Province have been grouped into six different clusters. Nakhon Si Thammarat City Municipality City Municipality has been grouped into Cluster 1 and also plays the role of a host for Cluster 1. Some of the waste management campaigns/activities of the Nakhon Si Thammarat City Municipality City Municipality includes promotion of plastic bags reduction in 8 markets under the municipality, projects related to solid waste management in schools, implementation of public awareness campaigns on hazardous waste collection and promotion of “Zero Waste Community” competition supported by Regional Environment Office 14 (Suratthani)
Nakhon Si Thammarat City Municipality City Municipality 4-Year Development Plan <sup>49</sup>	One of Nakhon Si Thammarat City Municipality Municipality's development strategies is moving towards “Green Municipality” by creating more green spaces, improving landscape and architecture, and managing solid waste and sewage properly.
Clean Province Action Plan <sup>50</sup>	The Clean Province Action Plan focuses mainly on 1) minimizing waste by separation at source where 3R principle can be applied; 2) efficient collection and transportation of solid waste to the disposal site; 3) waste is appropriately managed (i.g. sanitary landfill). Each LAOs will be required to implement the plans based on indicators of National Master Plan for Waste Management 2016 – 2021 (See Table 9).

**Table 9**  
Targets of National Master Plan for Waste Management 2016 - 2021

Targets	By 2016	By 2017	By 2018	By 2019	By 2020	By 2021
Municipal solid waste are disposed properly	50%	55%	60%	65%	70%	75%
All accumulated waste are disposed properly	75%	85%	95%	100%	100%	100%
Household hazardous waste are collected and disposed properly	5%	10%	15%	20%	25%	30%
All infectious waste are collected and disposed properly	80%	85%	90%	95%	100%	100%
All hazardous industrial waste management collected and disposed properly	60%	70%	80%	90%	100%	100%
Local governments have systems for waste separation at the source (households)	5%	10%	20%	30%	40%	50%

**Table 8**  
Other key local policies and plans for waste management in Nakhon Si Thammarat City Municipality

<sup>46</sup> พระราชบัญญัติเทศบาล (ฉบับที่ ๑๔) พ.ศ. ๒๕๖๒ [Municipal Act B.E. 2496 (1953) amended (No. 19) 2019]. [http://www.ratchakitcha.soc.go.th/DATA/PDF/2562/A/050/T\\_0164.PDF](http://www.ratchakitcha.soc.go.th/DATA/PDF/2562/A/050/T_0164.PDF)

<sup>47</sup> เทศบัญญัติเทศบาลนครนครศรีธรรมราช เรื่อง การกำจัดขยะมูลฝอยและสิ่งปฏิกูล พ.ศ. ๒๕๓๘. [Municipal Ordinance of Nakhon Si Thammarat City Municipality City Municipality on Solid Waste and Sewage Disposal B.E. 2538 (1995)].

<sup>48</sup> แผนพัฒนาจังหวัดนครศรีธรรมราช (พ.ศ. ๒๕๖๑-๒๕๖๕) [Nakhon Si Thammarat City Municipality 4-year Provincial Development Plan 2018 - 2022]. [http://www.nakhonsithammarat.go.th/web\\_52/datacenter/doc\\_download/plan\\_devel2561\\_2565\\_n.rar](http://www.nakhonsithammarat.go.th/web_52/datacenter/doc_download/plan_devel2561_2565_n.rar)

<sup>49</sup> แผนพัฒนาท้องถิ่น (พ.ศ.2561 – 2565) เทศบาลนครนครศรีธรรมราช [Nakhon Si Thammarat City Municipality City Municipality 4-Year Development Plan]. <https://www.nakhoncity.org/document/plan/2561%20-%2025651.pdf>

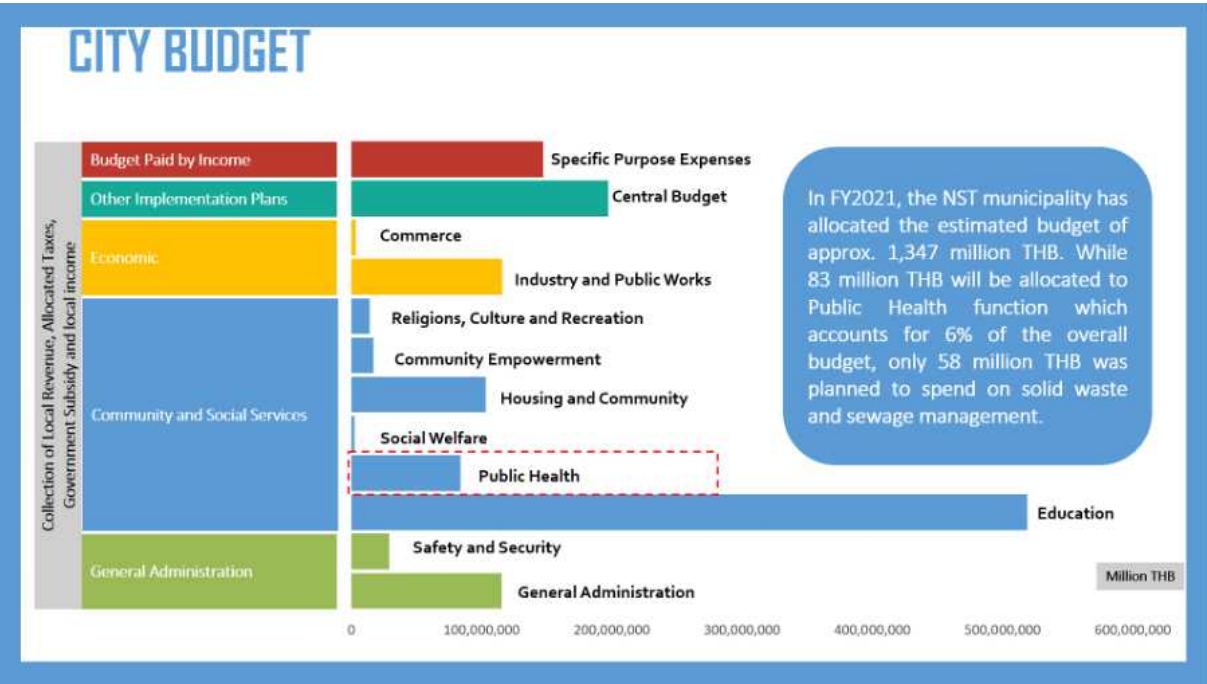
<sup>50</sup> แผนปฏิบัติการจัดการขยะมูลฝอยชุมชน "จังหวัดสะอาด" ประจำปี พ.ศ. ๒๕๖๓ [Clean Province Action Plan 2020]. <https://www.nakhonlocal.go.th/detail.php?id=10494>



### 4.3 Financial Capacity

#### 4.3.1 Revenue and Expenditure of Nakhon Si Thammarat City Municipality City Municipality

According to the Municipal Act of 1953, the Municipal Government revenue comes from taxes, fees and fines, income from assets, public services fees, revenue from bond issuance and borrowing (prior to municipal bond issuance and borrowing they must receive approval from the municipal council and the Ministry of Interior), borrowing from central ministries, departments, organizations and other public entities, subsidies from central government and Provincial Administration Organisation (PAO), donation and other revenue as indicated by law.



Source: City Ordinance Budget FY2021, Nakhon Si Thammarat City Municipality City Municipality

**Figure 12**  
Nakhon Si Thammarat City Municipality City Municipality's Budget in FY 2021

For waste management, the Division of Public Health and Environment receives the allocated annual budget from the Municipal Government based on their proposed activities, including purchasing waste trucks, waste bins and other associated management fees. In addition, the Division of Public Health and Environment also received the overall budget of 25 million THB and 27 million THB that were allocated for waste management purposes, including waste collection and disposal activities in the fiscal year 2018 and 2019, respectively.

The Municipal Government provides waste collection services without outsourcing to the private sector. Also, it permits other LAOs to ship and dispose of their solid waste at the Nakhon Si Thammarat City Municipality City Municipality's landfill, provided that a management fee of 400 THB/tonne is charged. The city residents pay a waste collection fee of 10 THB per household per month, which is included in the water bill monthly. In FY2018 and 2019, the Municipal Government collected fees of 6,008,720 THB, 5,930,140 THB, respectively. The breakdown of the latter is summarised as follows:

- 30,698 households (or 68.36%) out of a total of 44,908 households.
- 816 users from other sectors (52.8%) out of a total of 1,601 users. (See more details below).

It is also important to note that the Municipal Government has been using the *Municipal Act on Solid Waste and Sewage Disposal B.E. 2538* (1995) amended B.E. 2543 (2000) until now without any revisions in the past 20 years, which is not in line with the *Act on the Maintenance of the Cleanliness and Orderliness of the Country B.E. 2560* (2017). The waste collection fee for households in the latter law is 150 THB per month, while the city residents must pay only 10 THB per household per month under the current Municipal Act.

In FY2019, it was reported that the Municipal Government was only able to collect waste management fees from 815 users (or 52.8%) - out of a total of 1,601 users from several sectors. Waste management fees for each sector is summarised as follows:

Type of Waste Generator(s)	Waste Collection Fee
Markets	100 – 65,000 THB per month
Industry	20 – 200 THB per month
Hotels/Resorts	10 – 5,000 THB per month
Education	10 – 2,550 THB per month
Government Offices	10 – 2,000 THB per month
Temples/Mosques	10 – 3,000 THB per month
Restaurant	10 – 3,000 THB per month
Shopping Malls	200 – 14,000 THB per month
Apartments/Condos	10 – 5,000 THB per month

Source: Division of Public Health, Nakhon Si Thammarat City Municipality City Municipality

Table 8

Waste Generators and Collection Fees in Nakhon Si Thammarat City Municipality City Municipality

Item	FY2020	FY2021
1. General Administration		
1.1 Generation Administration	122,041,100	115,400,100
1.2 Safety and Security	36,344,800	29,097,000
2. Community and Social Services		
2.1 Education	525,317,500	519,017,000
2.2 Public Health	81,698,300	83,601,200
2.3 Social Welfare	2,735,400	2,435,400
2.4 Housing and Community	100,609,000	103,089,800
2.5 Community Empowerment	15,147,700	17,181,100
2.6 Religions, Culture and Recreation	16,312,100	13,825,700
3. Economic		
3.1 Industry and Public Works	128,069,400	115,623,100
3.2 Commerce	3,609,100	3,586,100
4. Other Implementation Plans		
4.1 Central Budget	168,115,600	197,143,500
5. Budget Paid by Income		
5.1 Specific Purposes Expenses	148,309,000	147,241,700
Total	1,348,309,000	1,347,241,700

Source: City Ordinance Budget FY2020-2021, Nakhon Si Thammarat City Municipality City Municipality

Table 9

Nakhon Si Thammarat City Municipality City Municipality's Budget in FY2020-2021 (Unit: THB millions)





# CHAPTER 5

CLOSING THE LOOP ON PLASTIC POLLUTION  
IN NAKHON SI THAMMARAT CITY MUNICIPALITY, THAILAND

A Level of Digital Readiness



## CHAPTER 5

# A Level of Digital Readiness

Digital technologies are becoming increasingly important in both business and society in Nakhon Si Thammarat City Municipality. Therefore, the Municipal Government has created new pathways for citizens to better communicate and share information with the city government as follows:

- Developing a municipal website: [www.nakhoncity.org](http://www.nakhoncity.org), where the citizen can easily access municipal news/activities, PR news, procurement and bidding news.
- Providing a 24-hour One-Stop Service for the citizen to submit a service request and/or file a complaint through <https://onestop.nakhoncity.org/>
- Establishing the Information and Communication Technology (ICT) Centre that can track 300 CCTVs available throughout the city.
- Allocating budget to develop a website and provide internet coverage for ten municipal schools.
- Using IT to promote educational and learning activities in science, arts, technology, culture and ASEAN-related issues for youth and citizens through City Learning Park (CLP): <https://web.facebook.com/CLPcitylearningpark/>.
- Promoting municipal activities via City-owned radio: <https://www.nakhoncity.org/radio.php> and social networking platforms: Facebook (<https://web.facebook.com/pr.nakhoncity1>), Youtube (<https://www.youtube.com/channel/UCB5t255etCMHr-5mQQZEor5A>).



For solid waste management, the Division of Public Health and Environment is the responsible agency and sometimes uses a drone to monitor solid waste at the landfill site during flooding situations and has a plan to introduce Global Positioning System (GPS) tracking for waste collection services to optimise routing and reduce energy consumption. However, human resources and capacity are still very limited and need to be further explored.

In addition, the Municipal Government also includes the Thailand 4.0 Model initiated by the Thai Government in the local development plan and is striving to become a smart city, although not much progress has been made. Currently, there are no existing regulations and financial/tax incentives to use the digital innovations in Nakhon Si Thammarat City Municipality.





# CHAPTER 6

CLOSING THE LOOP ON PLASTIC POLLUTION  
IN NAKHON SI THAMMARAT CITY MUNICIPALITY, THAILAND

## Conclusions and Recommendations

P115 **Management-Level Recommendations**

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## CHAPTER 6

# Conclusions and Recommendations

Solid waste management in general and plastic pollution, in particular, is a massive challenge for Nakhon Si Thammarat City Municipality, thus need to address immediately more strategically and holistically to mitigate the plastic pollution and marine litter from land-based sources. Based on the report's analysis and assessment, the recommendations should be considered.



## 6.1 Management-Level Recommendations

### 1. Target High Emission Single-Use Plastics - Such as Plastic Bags

Plastic bags are a severe problem in Nakhon Si Thammarat City Municipality, being the plastic item generated in the largest quantities (48% of plastic waste stream), and found to be emitted to the environment (57%) and entering waterways (56%) at the greatest proportions. Potential interventions to address these plastic bags could therefore significantly reduce plastic pollution and include:

- Introduce bans on light-weight plastic bags
- Introduce a tax or levy for single-use plastic bags. The tax referred to customer charges for the targeted single-use plastic products or taxes paid by the stores that sell them.
- Assess the availability of alternatives to consumers such as paper bags/containers, reusable bags, biodegradable bags/containers., and ensure preconditions for their uptake in the market.
- Sign a voluntary agreement with the retail sector to encourage them to take measures to reduce their distribution of plastic bags freely.
- Introduction of extended producer responsibility (EPR) schemes, even if just voluntarily.



## 2. Improve Storage Containers

While waste is waiting for collection, leakage is the highest emission source of plastic in Nakhon Si Thammarat City Municipality, accounting for 47% of emissions. Interventions to address this include:

- Provision for dedicated waste storage for every household. Dedicated containers for every household can alleviate some of the problems often seen when residents are forced to share waste containers. For example, residents may care less about where they place their waste if the container is off their property and shared between multiple households because of a lack of accountability.
- Improve the quality of existing waste containers. Overflowing waste containers and poorly maintained or damaged containers were some of the major reasons for plastic escaping the collection system. To reduce this, the waste containers provided should be as secure as possible. Important qualities of waste containers are:
  - **Size:** The storage volume should be sufficient to allow waste to be stored in between collection days. As seen in the images of **Figure 18**, many containers overflowing with waste in Nakhon Si Thammarat City Municipality. Storage size should account for the number of people using the container, waste generation rate per capita, bulk density of the waste in the container and the number of days between collections. Storage capacities required for commercial and institutional premises can be determined according to the size and nature of the activities and the number of people involved. If the calculated size of the container exceeds practicalities, collection coverage must be increased.
  - **Loading:** The waste loading into the collection vehicle should be economical and consider the labour required and timing for vehicles. It also needs to be hygienic and safe to mitigate risks to workers' during collection.
  - **Shape:** Containers should be tapered (having bigger plan dimensions at the top than at the bottom) so that they are easy to empty when tipped, even if the waste has been compacted into them.
  - **Isolating:** There should be no access to the waste for flies, animals, wind and rain, but these objectives may be difficult to achieve in practice, especially if many people use the container. A well-fitting lid can be practical for these purposes, provided that the lid is kept closed most of the time.
  - **Durability:** The containers should be sufficiently durable, resistant to mechanical damage and corrosion.
  - **Maintenance:** Old and damaged waste containers should be replaced. Many containers are seen to be damaged within Nakhon Si Thammarat City Municipality.
- Reduce the need for waste to be stored next to bins. If bins are overflowing, waste will often be placed next to the bins by residents. This can cause problems such as:
  - Plastic bags are easily torn open by dogs and cats, and sharp objects can easily pierce them to cause injury to the person who is carrying them or release waste into the street.
  - Cardboard boxes lose their strength when they become wet because of the waste they contain or when coming into contact with rain or moisture from the ground.
  - Some improvised metal containers have sharp edges which can cut hands that lift them or may be difficult to load into the collection vehicle when full, particularly if they are not portable.
- The use of larger and more durable containers with sufficient capacity should be provided to ensure waste is not stored next to the bins, thereby limiting plastic emissions. Additionally, designated areas or services should be allocated to collect bulky waste items to avoid these being placed in collection containers or fly-tipped nearby.



### 3. Reduce Littering/ Improve Street Sweeping

Littering was highlighted as the second-largest emission source in Nakhon Si Thammarat City Municipality, accounting for 34% of all plastic emissions, equivalent to around 4 grams of plastic litter per person per day. Interventions to address this include:

- Establish a sufficient network of public litter bins and provide frequent evacuation of bins. Litter bins should be provided at regular intervals in streets where there are many pedestrians and where there are no community bins into which passers-by can drop unwanted items.
- Place signboards alerting polluters on fines for littering and fly-tipping. Introduce fixed penalty notices on littering incidents and small-scale fly-tipping.
- Establish comprehensive and targeted street sweeping to remove any littered items and promote a clean living environment.
- Organise awareness and education campaigns around littering.

### 4. Ensure Disposal Site Is Run as an Engineered, Controlled Landfill

The disposal site in Nakhon Si Thammarat City Municipality is mainly uncontrolled and, in particular, does not have any form of litter mitigation techniques being practised. Therefore it is at high risk of emitting plastic waste into the environment. This is evidenced by it ranking third in the Plastic Pollution Calculator (PPC) for emissions, accounting for 8% of all plastic emissions. The leakage from the disposal site is significant during the rainy season, where the disposal site is known to regularly flood, leading to large amounts of plastic emitted into neighbouring waterways. Possible interventions to address the disposal site include:

- If a suitable budget exists, the existing dumpsite should be closed and a new sanitary landfill built in a suitable location, not at risk from flooding. Alternative options include ensuring flood mitigation measures are put in place around the disposal site to stop any future flooding.
- To reduce wind-blown leakage from the disposal site, ensure controlled measures are introduced and adhered to such as:
  - Regular (daily) cover applied to waste
  - Control of waste placement to ensure site stability
  - Installation of perimeter fencing
  - Allocated discharge zones with protection from wind
  - Compaction of waste (subject to a check of bulk density currently achieved)



## 5. Reduce Fly-Tipping/ Illegal Dumping

Fly-tipping was the fourth-largest source of plastic emissions into the environment accounting for 6% of all plastic emissions. Interventions to address this include:

- Place signboards alerting polluters on fines for fly-tipping. Introduce fixed penalty notices on fly-tipping incidents.
- Perform regular clean-up of fly-tipping sites and, if possible, install surveillance to catch perpetrators.
- Establish a free or affordable collection of bulky household items for residents.
- Ensure cooperation between the local authority and private landowners for prevention and clean-up of fly-tipping.

## 6. Increase Plastics Recycling (Collection for and Supply Chain)

The informal recycling sector currently carries out all plastics recycling in Nakhon Si Thammarat City Municipality. Therefore any interventions must support their efforts and protect their livelihoods. Unfortunately, only 0.7% of plastic is recycled in Nakhon Si Thammarat City Municipality. Therefore interventions should be applied to increase this substantially. For instance, three models to enhance the inclusion of the informal sector are:

- Incentive the inclusion of the informal sector through associations and cooperatives.
- Enhance the inclusion of the informal sector through microenterprises.
- Enhance the inclusion of the informal sector through public-private partnerships. In such partnerships, the municipality may, for instance, provide infrastructure and equipment while waste pickers provide labour. Alternatively, the municipality may choose to provide the operation of a sorting plant to the informal sector.

- Recycling can be boosted by encouraging community-based waste management schemes, involving the beneficiaries and waste collectors as the main actors. Financial and managerial support is often provided by formal and informal community leaders, who work mainly voluntarily. The responsible municipality, which plays a minor role, is active only as the initiator of a scheme. It is entrusted with issuing regulations or as a supporter in terms of providing access to handcarts or loans.
- Encourage source separation of waste (dry recyclables and wet/biodegradable waste). Although source-separated bins are provided in Nakhon Si Thammarat City Municipality, these are not used by residents in an intended manner, with instead mixed waste being placed in all bins. Source separation is often a fundamental prerequisite for achieving high recycling rates and, therefore, should be prioritised within the city. Likewise, currently, the municipality treats the recyclables collection containers the same as regular bins, simply being taken directly to the disposal site. If source separation can be achieved, this needs to be combined with suitable infrastructure and practices of the formal sector to adequately further sort this source-separated waste for recycling.
- Establish neighbourhood collection stations and urge residents to bring recyclable materials to the stations where they are bought at fixed prices or exchange them with lottery coupons that give discounts at department stores. In order to increase interest in residents' participation, run a campaign to raise awareness of the value of recycling among many of the worst affected and most vulnerable communities.
- When recyclable materials are not recovered at the household level, it is advised to sort waste for recycling at waste sorting units (material recovery facilities) or transfer stations prior to disposal.

## 6.2 Policy-Level Recommendations

### 1. Public Participation and Consultation

Public participation in the decision-making processes is highlighted in Thai laws. *The Constitution of the Kingdom of Thailand B.E. 2550 (2007)* included promoting public participation in various aspects and arrangements of a public hearing of relevant stakeholders. The Ministry of Interior's *Regulation on Local Administrative Organisation Development Planning* requires the public to participate in the planning process and prioritise the projects in the 3-year development plan. The Ministry of Interior also requires the provincial development planning to seek the public opinions during the drafting process and return the draft to the people before it is finalised. However, there are some limitations because some critical decisions are often made prior to getting public involvement.

### 2. Level of Public Involvement

The Thai government has set solid waste management as part of the National Agenda, which requires support and involvement from all sectors. However, the public, including local communities, plays little or no role in decision-making processes in Nakhon Si Thammarat City Municipality. Instead, the municipal government supports the national policy through collaborating with other Local Administrative Organisations (LAOs) under the solid waste cluster management system. Further collaborations between the municipal government and the public are needed, particularly on waste at source, awareness-raising and incentive measures.

### 3. Public Feedback Mechanisms

- A 24-hour One-Stop Service for the citizen to submit a service request and/or file a complaint: <https://onestop.nakhoncity.org/>
- Webboard: <https://www.nakhoncity.org/home.php>
- City-owned radio (FM 88.5 MHz): <https://www.nakhoncity.org/radio.php>
- Facebook: <https://web.facebook.com/pr.nakhoncity1>
- Telephone: +66-7534-2880





## 4. Public Education & Awareness

The Municipal Government does not have any programmes that address plastic waste and marine litter directly. However, 3R campaigns have been encouraged and promoted through the *Low Carbon School Programme* in all ten municipal schools. In addition, the Municipal Government has also determined to focus more on how to put existing modules/contents into practice and educate the young generation to understand the 3R activities and increase their quality of life. The Municipal Government would also like to include the environmental education curriculum in their development plan as well.

## 5. Effectiveness in Achieving Behaviour Change

While waste separation at source and 3R initiatives have widely been addressed and promoted to support sustainable practices, these initiatives did not affect the waste management behaviour of local communities in Nakhon Si Thammarat City Municipality. This failure is due to factors like traditional beliefs/practices, inefficient waste collection system (solid waste gets mixed up by waste collection trucks although some households practice waste separation.), lack of incentives, and low value of plastic waste due to the reduce of export after the banning of plastic waste import by China.

## 6. Effectiveness in Waste Separation at Source

Waste separation at source methods have not widely been practised not only in NST but also throughout the nationwide. This is in large part due to lack of understanding of people on how to make use of waste as a resource and create value from it. A guideline should be in place for people to understand types of waste, separation at source, waste value, and channels where waste can be sold. Therefore, the local government can play a key role in developing waste separation guidelines/toolkit and disseminate it to the public to ensure waste separation practices. In addition, logistics mechanism for purchasing recyclable waste should be developed, especially those that have potential to create value but no markets. The public should be provided with information on value of waste to promote waste separation at source. In order to achieve this, public involvement is very crucial. Groups of community leaders and work teams (or youth groups) should be established to support the municipality's waste separation at source. Educational institutions can fill gaps by improving environmental courses and adding contents on solid waste management including plastic waste for communities, classrooms or outdoor activities. This can be done in collaboration with the local government and private sector to encourage young students to sustainably manage their wastes while also implementing waste separation activities in educational institutions. Waste separation at source should be encouraged for the private sector as well by providing attractive incentives such as tax reduction or applying Polluter Pay Principle (PPP) to enhance their participation.



## 7. Strengthening Recycling Businesses

- Register waste collectors, saleng (scrap collectors on tricycles), and junk shops.
  - Organize training to provide knowledge about health and environmental protection.
  - Provide an annual health check-up and health and accident welfare for registrants.
  - Issue certification cards for people who have completed training and regulatory development to motivate registrants to receive training.
  - Make sure recycling business is located at a suitable place away from residential areas to prevent contamination to communities.
- Develop standards for recycling businesses and offer reduction fees for those who meets the standards.
- Prepare a manual for handling hazardous substances from waste separation.

## 8. Effectiveness in Waste Collection System

- Zero waste bins in communities project.
- Provide garbage bags with different colours for different types of waste (e.g. general waste, recyclable waste, organic waste, hazardous waste, infectious waste etc.).
- Schedule collection time by types of waste such as non-recyclable waste, recyclable waste, hazardous waste, and heavy trash.
- Develop channels for communication between communities and the municipality relating to waste management issues.

## 9. Cost Recovery

The Municipal Government has been using the existing Municipal Act on waste collection fee without any revisions for over 20 years which does not cover waste management operations and also not align with the National Act. As a result, the Municipal Government has to allocate its own budget for waste collection and disposal activities. A new waste collection fee system should be introduced by incorporating polluter-pay-principles and actual operational costs.



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